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Exploring the Discrimination Factors of Marine Women Officers Onboard

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Abstract: *Seafaring is a challenging working environment for women. For the last two decades, mainly in western countries, women have been showing their existence in the fleet, but as the chief marine, women officers such as captain, executives, or leader posts aboard are very poor with respect to other services. In practice, women continuously face many problems from working environments, and it may be very high in seafaring. The current article aims to determine the factors related to discrimination of women officers (DOWO) onboard based on a data set containing 149 female officers' responses from 18 different countries. The aimed response DOWO is marked as heteroscedastic. It is derived that the mean (or average) of DOWO is directly linked to women nationality (Spanish = 1; Others = 2) (P=0.0022), while it is reciprocally linked to her professional qualification (P=0.0290) and their male companion's support (P<0.0001). The DOWO's variance is reciprocally linked to women nationality (P= 0.0356), while it is directly and partially linked to their age (P=0.1343) and contract's type (P=0.0799). It is observed that women officers with Spanish nationality, higher qualifications and their male companion's support can reduce the degree of discrimination against women.*

Keywords: Discrimination, Women officers, Joint mean & dispersion modelling, Mariners, Unequal variance, Seafaring.

1. Introduction

Discrimination due to gender and cultural reason for promotional cases of marine women officers are recently focused on in an article by Das (2021), and related literature is illustrated very explicitly by Cordon et al. (2020) and Carol-Dekker and Khan (2016). In the current report, the related literature is presented very shortly. Recently, women's interests are increasing to take part in the traditional male transportation work positions such as marine officers, air-space scientists, air-pilot, air-force, etc. Women are generally considered cleaners, receptionists, flight attendants, or other kinds of work, which do not need extra academic qualifications or exceptional skills (UIC, 2019). During the last twenty years, several females registered in Seafaring Academies in Western Europe, and they began to join as marine Officers (International Labour Office [ILO], 2019). Still, women participants as marine officers or captains are very low compared to other services such as health, teaching, enterprise management, law, engineering, among others.

The United Nations specialised agency known as the International Maritime Organization (IMO) is liable for the management, security, safety and maintenance of navigation and the marine contamination prohibition from ships (IMO, 2019a). For the above purpose, IMO (2019a) has introduced a female integration policy in managerial levels to perform all the functions smoothly onboard and ashore. Nowadays, it is very common to see women as Officers on board in western countries, which the sincere efforts of IMO have achieved. Note that IMO has introduced a sequence of films focusing the working situations on board females to make it popular to women. Many vacant positions for marine officers, captains, managers, leadership levels for women are frequently announced by IMO (2019a). In addition, Women Integration Programs conducted by IMO in the Maritime Sector (IMO, 2019b) encourages women participation to reach the highest positions.

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The Busan notice (IMO, 2031) leads the IMO functions properly; consequently, the IMO can fight with legal power for female integration and their equal facilities onboard as men. This step verbally implies work to increase awareness of the women's role as a valuable resource for the maritime industry (IMO, 2031). The Women's International Shipping & Trading Association (WISTA International) has gathered a lot of females (greater than 3000) from 40 different developed & western countries around the maritime industry for several training posts such as officers, executives, captains, seafarers, and all others (WISTA, 2019). The joint efforts of International Seafarers' Welfare and Assistance Network (ISWAN, 2019) and Anglo-Eastern Ship Management Limited regularly published a booklet to inspire readers to grasp the diversity ideas on board merchant ships. Generally, diversity topics, sex differences, isolation, persecution, and attitudes towards females on board are discussed in these booklets.

Carol-Dekker and Khan (2016) discussed female's avoidance onboard that makes the marine working conditions highly stressful for females. However, the following research shows that misbehaved attitudes towards women fellows were common in the fleet (ISWAN, 2019; IMO, 2019a). An extensive work by Manzano (2014) has reported females' sexual harassment and the misbehaviour towards females for not following male fellows in the fleet. Women are not tolerated for the physical strength purpose on board by many men. The World Maritime University (WMU, 2020) has collected a selection of articles on topics in the book *Maritime women: Global leadership* by Kitada et al. (2015). Recently an article by Cordon et al. (2020) has discussed all the problems associated with women's working environments aboard. There are very few articles related to the causal factors determination of women's discrimination on board based on any scientific modelling method. Hence, this report aims to derive the causal factors of women's discrimination on board based on a real data set using advanced statistical methods.

1.1 Research Questions

The aim of the report, as stated above, is a kind of *hypothesis-testing in* social science research. Generally, in social science research problems for studying a causal relationship (i.e., cause-and-effect) among the variables/factors, the researchers need to derive an appropriate mathematical model which can reveal the relationships among the variables. This is the *only* scientific method for studying causal social science relationship problems. In practice, the effect is the dependent variable, and the causes are considered the independent variables. Generally, the dependent variable may be heteroscedastic in most of the social science cases, as there are different sources of variation in the data set. The derived model should be verified by different model diagnostic tools. Therefore, the current article aims to examine some research questions stated in the next section.

- What are the discrimination factors of women marine officers on board?
- How can the factors be derived?
- What are the roles of the discrimination factors?

The article addresses the above queries using the sections materials & methods, statistical analysis & results, discussions and conclusions. Note that all the derived discrimination factors are reported in Table 1, and the factors are derived based on statistical joint generalised linear models, which are reported in the result section. In addition, the roles of the discrimination factors are reported in the discussion section.

2. Research Materials

The current research paper considers a secondary data set of 149 marine women officers from 18 different countries which were collected by Prof. Jose R Cordon (Published: 09-10-2019| Version 1 | DOI: 10.17632/ 4ffk2hbz32.1). The data set was collected based on a survey answered by 151 female officers from 18 different countries, out of which two subjects' information was incomplete. The data set is clearly illustrated in the article by Cordon et al. (2020). The data set is accessible at (https://forms.gle/f3GdmBLZkHfKDuFn6). The data set covers many areas of marine women officers such as Socio-Demographic, Work-Life Balance, Labour, Harassment situations, Leadership Style, and an open section where they can express their ideas. The data set contains 54 variables, out of which only ten characteristics are considered as the proper explanatory variables of the response variable "I have experienced onboard discrimination because of being a woman", which is shortly written as discrimination of women officers (DOWO). The considered ten explanatory variables are V1=Age; V2=Nationality; V3=Group; V4=Cohabitation; V5=Type of contract; V6=Current position on board; V7=Professional qualification; V8=Years sailing as Officer; V9=Vessel and route characteristics; V10=My

male companions support me. Other variables are not reported herein as most of the other variables can be considered as the response variables. Some of the other factors/variables are reported as follows for ready reference. These are: Year of first boarding; Type of Vessel; Crew Nationalities; Officers Nationalities; I have experience on board discriminating for racial or cultural reason (treated as the dependent variable in the article by Das (2021); I am not promoted as I am a woman (treated as the dependent variable in the article by Das (2021); I think I have to work harder physically than peers (can be used as the dependent variable); I feel to perform better than male intellectually (can be used as the dependent variable); My superior demanding more as I am a woman (can be used as the dependent variable); My colleague use act condescending as I am a woman (can be used as the dependent variable); Physical effort is most stressful thing in my joining on board (can be used as the dependent variable); The psychological burden is the most stressful thin in my position on board (can be used as the dependent variable); Sometimes I take advantage as I am a woman not to do certain job (can be used as the dependent variable); I have felt economically discriminated as I am a woman (can be used as the dependent variable), etc. Similarly, the rest of the variables can be used as the dependent variables, which are not reported herein.

The considered data set was reported in Cordon et al. (2020) article. The data set was collected from 151 marine women officers through emails by sending the questionnaire to the randomly selected investigation subjects. Based on their survey answers, the data set was prepared. The survey covered some areas as stated above. The questionnaire was prepared by group of seafarers and psychologists (both men and women), partitioned in many sections consisting questions related to: (a) Socio-Demographic factors: age, type of contract, marital status, qualification, experience and environmental components, position on board; (b) Labour factors: support, discrimination perceived, stressing factors, different treatment for being a woman and family tradition, some questions about the feelings of having to perform better than male officers; (c) Work-Life Balance: queries about motherhood, relations, family life, relationships on board, work satisfaction, etc.; (d) Leadership Style: queries try to identify any dissimilar behaviour within colleagues, focusing on leadership characteristics, port staff and subordinates because of gender differences; (e) Harassment Conditions: from colleagues or any other, clear or veiled harassment situations from superiors, application of a masculine behavior, and the ability to handle unpleasant conditions; (f) Free Section: to express their suggestions for any other matters.

2.1 Statistical Methods

The article considers the marine women officers' data as stated above. It is identified herein that the response DOWO is heterogeneous, positive and non-normally distributed. In addition, the response variance is not stabilised under any suitable transformation, so it is modelled herein using joint generalised linear models (JGLMs), which is illustrated in the book by Lee, Nelder and Pawitan (2017) and by Das (2014). For ready reference, JGLMs are very shortly presented herein.

JGLMs under lognormal distribution: For a positive response (herein DOWO) random variable DOWO=Y_i's with unequal variance (σ_i^2), if E(DOWO=Y_i) = μ_i (mean) and Var(DOWO=Y_i) = $\sigma_i^2 \mu_i^2$ = $\sigma_i^2 V(\mu_i)$ say, where $V(\cdot)$ represents the dispersion function, the log transformation Z_i = log(DOWO=Y_i) is commonly used to stabilize the variance Var(Z_i) ≈ σ_i^2, but the variance may not be stabilized always. For improving a better model, JGLMs for the mean and dispersion can be considered. For lognormal distribution, JGLM of the mean and dispersion (with Z_i = logY_i) are given by

$E(Z_i) = \mu_{zi}$ and $Var(Z_i) = \sigma_{zi}^2$,

$\mu_{zi} = x_i^t \beta$ and $\log(\sigma_{zi}^2) = g_i^t \gamma$,

where x_i^t and g_i^t are the vectors of 10 explanatory variables (as stated above) associated with the regression coefficients β and γ, respectively.

JGLMs under gamma distribution: For the above DOWO=Y_i's, the variance has two components such as σ_i^2 (free of means) and $V(\mu_i)$ (depending on the mean parameters). The dispersion function presents the GLM family distributions. For illustrations, if $V(\mu) = \mu^2$, it is gamma, normal if $V(\mu) = 1$, Poisson if $V(\mu) = \mu$, etc. Gamma JGLMs mean and dispersion models are

$$\eta_i = g(\mu_i) = x_i^t \beta \text{ and } \varepsilon_i = h(\sigma_i^2) = w_i^t \gamma,$$

where $g(\cdot)$ and $h(\cdot)$ are the GLM link functions for the mean and dispersion linear predictors, respectively, and are the 10 explanatory variables (as stated above) vectors related to the mean and dispersion parameters, respectively. The maximum likelihood (ML) method is applied to estimate mean parameters, while the restricted ML (REML) method is used to estimate dispersion parameters, which are clearly described in the book by Lee, Nelder and Pawitan (2017). Very shortly, JGLMs are derived using two inter-related mean and dispersion models based on the observations of the dependent variable and gamma deviance. Regression coefficients are derived by the iterative weighted least squares (IWLS) method using the dispersion values, which directly affect the estimates of regression coefficients. The whole computation is performed using two interconnected IWLS methods such as (a) given the estimate of dispersion regression coefficients, IWLS is applied to update the mean regression coefficients, (b) given the mean regression coefficients, IWLS is applied to update the estimate of dispersion regression coefficients with deviances as data. These two iteration steps are continued until it converges.

3. Statistical Analysis and Result

This section deals with statistical analysis and results based on the research questions and methodology. This was done under the following sub-headings; statistical analysis and presentation of results.

3.1 Statistical Analysis

The response DOWO is identified as heteroscedastic, which has been modelled by JGLMs using both the gamma and lognormal distributions. The considered all the ten explanatory variables are used to explain the mean and dispersion of DOWO. Only the significant and model fitting necessary explanatory variables are included in both the models of DOWO. The best model is approved depending on the lowest Akaike information criterion (AIC) value (within each class), which reduces both the squared error loss and predicted additive errors (Hastie et al., 2009; p. 203-204). According to the AIC criterion, JGLMs gamma (AIC=358.679) fit of DOWO is better than lognormal (AIC=375.5) fit (Table 1), as the AIC difference is greater than one, which is significant. These two models are different, and they support Das (2012) and Das and Park (2012). In the mean model, V9(=Vessel and route characteristics), an insignificant factor, is included for better fitting due to Hastie et al. (2009). Age is a partially significant factor included in the dispersion model due to Hastie et al. (2009). Both the model fitting analysis outcomes are shown in Table 1.

Table 1: *JGLMs gamma and lognormal fitted models for discrimination of women officers on board*

Model	**Variables**	**Gamma fit**				**Lognormal fit**			
Mean		**Estimate**	**s.e.**	t(145)	**P-value**	**Estimate**	**s.e.**	**t(15)**	**P-value**
	Constant	1.6147	0.11854	13.621	<0.0001	1.5776	0.12566	12.554	<0.0001
	V2	0.1704	0.05245	3.248	0.0022	0.1918	0.05485	3.497	0.0011
	V7	-0.1695	0.07517	-2.255	0.0290	-0.1728	0.07995	-2.162	0.0360
	V10	-0.1360	0.02406	-5.651	<0.0001	-0.1389	0.02540	-5.469	<0.0001
	V9	-0.0611	0.05301	-1.153	0.2550	-0.0645	0.05594	-1.153	0.2550
Dispersion	**Constant**	-3.388	0.6248	-5.423	<0.0001	-3.175	0.6423	-4.944	<0.0001
	Age (V1)	0.030	0.0195	1.525	0.1343	0.028	0.0202	1.386	0.1726
	V2	-0.620	0.2861	-2.166	0.0356	-0.743	0.2902	-2.560	0.0139
	V5	0.491	0.2738	1.792	0.0799	0.548	0.2795	1.959	0.0563
AIC		**358.679**				**375.5**			

The derived DOWO's gamma model fitting is better based on the AIC rule, which is to be accepted based on diagnostic examining plots in Figure 1. Figure 1(a) presents the absolute residuals plot for the DOWO gamma fitted model (Table 1) with respect to the fitted values, which is closely a flat straight line, concluding that variance is equal with the running means. Figure 1(b) reveals the normal probability plot of the residuals of DOWO gamma fitted mean model (Table 1), which does not show any lack of fit, as all the points are in a smooth curve. Therefore, Figure 1 implies that the derived DOWO gamma fitted model is almost a true unknown model.

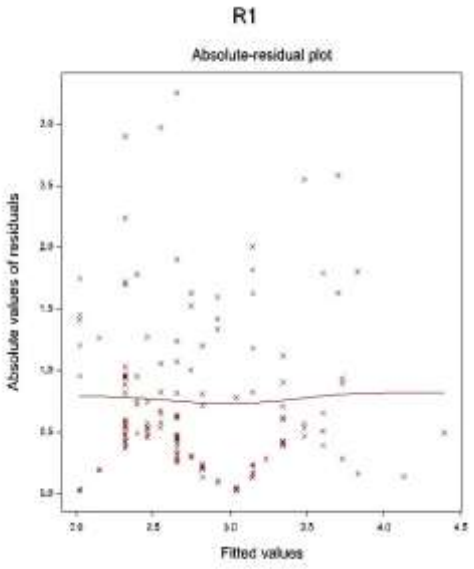

Figure 1(a)

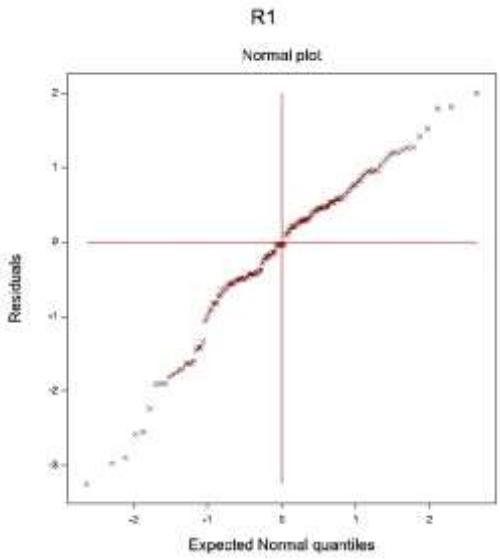

Figure 1(b)

Figure 1: *For the joint DOWO gamma fitted model (Table 1), the (a) absolute student residuals plot with the fitted values, and (b) the normal probability plot for the mean model.*

3.2 Presentation of Results

The summarised DOWO analysis results using JGLMs for both the gamma and lognormal models are displayed in Table 1. From the derived gamma fitted model (Table 1), it is observed that mean DOWO is directly linked to her nationality (P=0.0022), while it is inversely linked to her professional qualification (P=0.0290) and her male companion's support (P<0.0001). The variance of DOWO is inversely linked to her nationality (P= 0.0356), while it is directly partially linked to her age (P=0.1343) and contract's type (P=0.0799).

Gamma DOWO mean model (Table 1) is

$\hat{\mu}$ =exp(1.6147 + 0.1704 Fx2 2 -- 0.1695 Fx72 -- .1360 x13 -- 0.0611 Fx92).

The gamma fitted DOWO dispersion ($\hat{\sigma}^2$) model is

$\hat{\sigma}^2$ = exp(-- 3.388 + 0.030 x1 -- 0.620 Fx22 + 0.491 Fx52).

4. Discussions

The article has derived JGLMs of DOWO under both the gamma & lognormal distributions. Final models are considered based on graphical diagnosis (Figure 1), comparing two probability distributions of DOWO (Table 1), lowest AIC value, with the stable estimates having small standard errors (Table 1). The research should have a stronger trust in the present results of DOWO.

From the derived DOWO gamma fitted model (Table 1), it is found that mean DOWO is directly linked to her nationality (Spanish = 1; Others = 2) (P=0.0022), implying that discrimination experience on board being a woman is higher for other nations than the Spanish. In practice, the count of Spanish marine women officers is larger than other nations all over the world. Also, mean DOWO is inversely linked to her professional qualification (Other = 1; Master = 2) (P=0.0022), concluding that discrimination experience on board being a woman is higher for other degree qualified women officers than the master degree. Actually, master degree women marine officers play a great role on board. In addition, mean DOWO is inversely linked to her male companion's support (P<0.0001), interpreting that discrimination experience on board being a woman decreases as her male companion's support increases. This is natural otherwise, agitation may occur at any time.

From the derived DOWO gamma fitted model (Table 1), it is observed that the variance of DOWO is directly linked to her nationality (Spanish = 1; Others = 2) (P= 0.0356), implying that discrimination experience on board being a woman is highly scattered in other nations women marine officers than the Spanish. It implies that the discrimination experienced on board being a woman is higher in other nations than the Spanish, which is concluded in the mean model as in the above. Also, the variance of DOWO is directly and partially (13.43 % level of significance) linked to her age (P=0.1343), concluding that discrimination experience on board being a woman is highly scattered in older ages than the younger women marine officers. In addition, the variance of DOWO is directly partially (7.99 % level of significance) linked to her contract's type (Temporary=1; Permanent=2) (P=0.0799), implying that discrimination experience on board being a woman is highly scattered for permanent marine women officers than the temporary women officers.

There is no similar study for the DOWO using statistical modelling or other descriptive methods, so the current findings cannot be compared with the previous articles. Recently, Das (2021) has derived the determinants of two responses (1) "I have experience onboard discriminating for a racial or cultural reason" and (2) "I am not promoted as I am a woman". The determinants are different for the two responses (Das, 2021). In addition, they are different from the current response "I have experienced onboard discrimination because of being a woman". Cordon et al. (2020) focused on the problems of marine women officers based on descriptive and some graphical methods, and their research objectives were different. To the best of our knowledge, the current social research problems are considered initially in the present article. Moreover, it is observed that there are many response variables in the data set (Materials Section). So, for each response, a similar study may be performed. It is expected that many interesting outcomes will appear for different responses. The remaining responses will be examined in our subsequent studies, and their determinants will be reported in our subsequent articles.

Previous studies regarding the women harassment situations in the working environments are done only based on percentage. To the best of our knowledge, there is not a single article regarding women harassment based on statistical modelling, which can only identify the causal factors of women harassment in the working environments. The current derived outcomes and models are clearly verified by Figure 1. In social science research studies, multivariate variables (herein 11 variables) are commonly used, which are generally interrelated. The interrelationship can be formulated by some statistical hypotheses. Based on the hypotheses, suitable statistical methods can be used to derive the appropriate relationship among the variables. Appropriate techniques should be taken for handling many social science attribute variables. Note that in social science studies, there are a few discrete and continuous variables.

5. Conclusions

The report has identified the discrimination factors against women by modelling the response "I have experienced onboard discrimination because of being a woman" based on JGLMs using both the lognormal and the gamma models. In Table 1, it is found that the gamma model fit gives better results than the lognormal fit. The best model is accepted based on graphical analysis in Figure 1. The model is not verified for a similar data set, as we do have not any similar data set. One can examine the derived results in Table 1 using the data set mentioned in the article. It is observed that marine women officers with Spanish nationality, higher qualification and her male companion's support can reduce the degree of discrimination on board being a woman. Higher qualification marine women officers and her male companion's support are highly essential to reduce the discrimination experience onboard being a woman.

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