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International Journal of e-Navigation and Maritime Economy 3 (2015) 150 – 160

International Journal of e-Navigation and Maritime Economy

www.elsevier.com/locate/enavi

Original article

The Malaysian Seafarers Psychological Distraction Assessment Using a TOPSIS Method

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Abstract

Human error with regards to ship handling is the main cause of maritime accidents. The error happens because of the psychological problem of distraction. Despite the use of modern equipment, standard working procedures and competent crews, still accidents occur because of the physical and psychosocial stresses during the working period on board the ship. This creates undesirable results such as injuries, ill health and even loss of life. The aims of this study are to analyse the possible root causes for distractions and the affected areas for three groups of Malaysian seafarers, 1) Senior Deck Cadets, 2) Senior Deck Officers and 3) Junior Deck Officers. A Technique for Order Performance by Similarity to the Ideal Solution (TOPSIS) method has used for ranking the alternatives in the order of how affected they are. A Malaysian seafarers', Senior Deck Cadets (SDC) has recorded as the most affected by distractions when they are engaged in the ship's operation. The outcome of this study will help both seafarers and shipping companies to establish some solutions around this matte.

Keywords: Psychological Distractions, Malaysian Seafarers, Risk Assessment, TOPSIS Method, Maritime Transport

I. Introduction

Working on board the ship as a seafarer is among one of the most dangerous careers in the world. Seafarers are exposed to a higher-level of risk than other onshore based workers (Bloor et al., 2006; Roberts, 2002; Roberts and Marlow, 2005; Hetherington et al., 2006). As reported by the UK P&I (2004, 2005), accident rate in the shipping industry is still at a high-level. The report reveals that on average, 137 ships put in total loss claims and 700 lives have been lost in accidents between 2001 and 2007 (Maritime Knowledge Centre, 2008). Therefore, in spite of the radical changes and improvements to sailing conditions, seafarers may face particular situations potentially affecting their psychological well-being. Because of that, the real causes contributing to such a phenomenon are still uncertain and continue to affect seafarers' conditions on board. Most of the threats are a result of psychological distractions, which continue to affect their mental and physical conditions as described by Geijerstam and Svensson (2008). The objectives of the paper are to study the contributing factors to the psychological distraction on 1) Senior Deck Cadets (20 respondents), 2) Senior Deck Officers (20 respondents) and 3) Junior Deck Officers (20 respondents) among the Malaysian seafarers. The reason for focussing this study on the Malaysian seafarers is because they are a valuable asset to the nation and play a crucial role in contributing to the increment of the shipping business industry. Therefore, any psychological problem of the Malaysian seafarers will have huge impacts on the shipping industry and the Malaysian economy as a whole. A test case was created based on the current situation faced by selected groups of Malaysian seafarers using a TOPSIS Method.

II. Literature Review

A poorly designed ship or a system where manned crews are fatigued or are unaware of cultural differences are contributing to the (uncertain) level of safety operation of the ship (IMO, 2010). This statement is also supported by Rothblum (2000) who details that human error is result of an incorrect decision, improperly performed action, or an improper lack of action by the individuals who failed to carry out his or her duty. Rothblum (2000) suggests that the most severe problems in human factor analysis are fatigue, lack of communication and coordination between the crew, as well as poor technological skills concerning, for example, the use of radar. The human error is very often caused by the social organization of the personnel on board, error of judgment and improper lookout or watch keeping as well as misunderstandings between the pilot and the master or the officer on watch (Hetherington et al., 2006). Horck (2010) adds that the major reasons for accidents are poor communication, loss of situation awareness, poor decision making, a lack of effective leadership and a breakdown of team performance. The discrepancy that exists between the level of demands and the person's ability to cope (personal resources) is one of the important factors in determining the experience of distraction or stress (Hafez, 1999).Long working hours, non-existent or inadequate rest, repetitive tasks, exhaustion caused by heavy physical work, a hostile environment, fatigue and premature aging caused by a fast work pace and the need for instance vigilance, are bad working conditions, which adversely affect seafarer's health, equilibrium and, consequently, productivity (Hafez, 1999). It can be worse when faced with a shorter turnaround time, combined with reduced crew size, restricting and contravening rest periods, crew are facing fatigue and stress, which today have been recognized as causal factors in a number of maritime accidents (Grech et al., 2008). In addition, employees' motivation and work morale are important factors in enhancing safety as well as easing fatigue and risk taking. So, if their health and safety related behaviour is affected by their occupation, there is something not right within the environmental and organizational factors of the job.

III. Methodology

The technique for order performance has similarity to the ideal solution (TOPSIS) method, which is a method used to solve the multi-criteria decision making (MCDM) problems, which were first developed by Hwang and Yoon in 1981 (Olson, 2004; Wu and Olson, 2006; Jahanshahloo et. al., 2006; Hung and Chen, 2009; Tsai et. al., 2008; Balli and Korukoglu, 2009; Mohammad et. al., 2010; Abdul Rahman, 2012). The primary concept of the TOPSIS method is that the preferred alternative should not only have the shortest distance from the positive ideal solution (PIS), but also have the farthest distance from the negative ideal solution (NIS) or nadir (Wu and Olson, 2006; Jahanshahloo et. al., 2006; Hung and Chen, 2009; Tsai et. al., 2008; Balli and Korukoglu, 2009; Mohammad et. al., 2010; Abdul Rahman, 2012). Such a method is a practical and useful technique for ranking and selecting a number of alternatives through distance separation measures (Shih et al., 2007; Abdul Rahman, 2012). Finally, all alternatives will be ranked based on the preference order. The TOPSIS method provides a number of attributes or criteria in a systematic way (Wu and Olson, 2006; Abdul Rahman, 2012). Moreover, the advantages of the TOPSIS method are 1) the ability to identify the best alternative quickly (Olson, 2004; Abdul Rahman, 2012), 2) the simple and rationally comprehensive concept (Abdul Rahman, 2012), 3) the simple computational process that can be easily programmed into a spreadsheet (Shih et al., 2007; Abdul Rahman, 2012), 4) the ability to measure the relative performance of each alternative in a simple mathematical form (Hung and Chen, 2009; Mohammad et al., 2010; Yeh, 2002; Abdul Rahman, 2012), 5) large flexibility in the definition of the choice set (Mohammad et al., 2010; Abdul Rahman, 2012), and 6) a sound logic that represents the rationale of human choice (Abdul Rahman, 2012). Such advantages make this technique an appropriate method to be used in this paper to determine the ranking of the three groups of Malaysian seafarers. The TOPSIS method can be concisely expressed in a matrix format as follows (Jahanshahloo et al. 2006; Abdul Rahman, 2012):

Table 1: A decision matrix form in TOPSIS method

	C_1	C_2	…	C_n
A_1	X_{11}	X_{12}	…	X_n
A_2	X_{21}	X_{22}	…	X_{2n}

A_m	X_{m1}	X_{m2}	…	x_{mn}

where A_1, A_2, …, A_m are the possible alternatives that shipping companies or related parties can choose; C_1, C_2, …, C_n are the possible evaluation criteria or attributes against which an alternative performance is measured; x_{ij} is a crisp value indicating the performance rating of each alternative A_i with respect to each criterion C_j (Mahmoodzadeh et al., 2007; Abdul Rahman, 2012).

IV. The Seafarers' Psychological Distraction Assessment

Step 1. Determine the criteria, sub-criteria and goals

The model developed contains the goal, evaluation criteria and sub-criteria. All the information represented in a table structure and all the criteria and sub-criteria were directly linked to all the alternatives. The sample model of analysis in this study is shown in table 2. Each criteria and sub-criteria is grouped and categorised based on the expert surveys and the cause and effect analysis is made using the selected literature as discussed in Section 1. The function of the goal of each sub-criterion is to determine the PIS and NIS in this analysis. There were two possible levels of goal used for each variable parameter which are named either “Benefit” or “Cost” goal. The goal “Benefit” is related to a positive solution, while the goal “Cost” is associated with the negative solution in determining the PIS and NIS. “Benefit” goal is focused on the sub-criteria that contribute to advantages in operation, meanwhile, “Cost” goal is focused on the sub-criteria that may contribute to disadvantages in operation.

Table 2: Model of analysis used in this research

Criteria	Sub-criteria	Goal	Alternatives
Working condition (WC)	Staffing or crewing strength/ number **(SS)**	Benefit	
	Burden of system in used/ Technological inventions **(BS)**	Cost	
	Arrangement of working hours **(AWH)**	Benefit	
	Work pace/ demands /pressure **(WP)**	Cost	
	Distribution of works **(DW)**	Benefit	
	Personal abilities /experiences **(PAE)**	Benefit	
Living condition (LC)	Comfortability of accommodations **(CA)**	Benefit	
	Recreational activities / facilities **(RAF)**	Cost	
	Periods of rest **(PR)**	Benefit	
	Shore alienation / leaves **(SL)**	Benefit	
	Intensified activities **(IA)**	Cost	
	Hygiene and tidiness **(HT)**	Benefit	
Human interactions (HI)	Language barriers among crews **(LB)**	Cost	
	Quality of relationship **(QR)**	Benefit	
	Social isolation / family separation / away from home **(SI)**	Cost	
	Level of autonomy (e.g. freedom from external control & influence) **(LA)**	Cost	
	Multi-national crews/ cultures/ beliefs **(MC)**	Cost	
	Supportive cultures (e.g. motivation & tutoring)**(SC)**	Benefit	
Behaviours/ Individual factors (IF)	Discipline **(DI)**	Benefit	
	Mind set (e.g. way of thinking, awareness) **(MS)**	Benefit	
	Approachability **(AP)**	Benefit	
	Firmness **(FI)**	Cost	
	Responsibility **(RE)**	Benefit	
	Vigilance/ alertness/ sensitivity **(VAS)**	Benefit	
Onboard environment (OE)	Ship motions **(SM)**	Cost	
	Climatic Condition **(CC)**	Benefit	
	Weather and Mother nature **(WM)**	Cost	
	Visual condition **(VC)**	Benefit	
	Exposure to hazardous substances/ cargoes **(EC)**	Cost	
	Noise and vibrating circumstances **(NV)**	Cost	
Food/ Nutrition (FN)	Organization of food nutrition/ composition **(OF)**	Benefit	
	Adequate supply of food **(ASF)**	Benefit	
	Quality of food preparation **(QFP)**	Benefit	
	Hygiene **(HY)**	Benefit	
	Equality in distribution of food / needs **(EDF)**	Benefit	
	Satisfaction on food preparation **(SFP)**	Benefit	

Step 2. Identify the alternatives

The goal of this analysis is to rank the alternative/source of responses in addition to identifying which group of manned ships' are most affected in terms of their psychological condition. To achieve the goal, three different levels of the manned ships' are use as the alternatives, which are 1) Senior Deck Cadet (SDC), 2) Junior Deck Officers (JDO), and 3) Senior Deck Officers (SDO).

Step 3. Perform calculation and analysis using TOPSIS method

Step 3.1 – Estimate the weight of each criteria and sub-criteria

The weight estimation process of the evaluation criteria and sub-criteria are conducted using the average rating value technique. The implementation of this technique is associated with a number of the selected expert judgements for analysing the priority of each criterion to another by incorporating the ratio scale of the weight of the sub-criteria involved in each criterion. Table 3 and appendix 1 summarise the average rating value of all sub-criteria and criteria evaluated, respectively.

Table 3: The total average rating value of each criteria

	Total average rating value of each criteria, Av_{cr}						
Main Criteria / Category	WC	LC	HI	IF	OE	FN	Total, CR_T
SDC	22.28	21.33	21.36	23.59	21.09	22.04	131.69
JDO	22.70	23.10	21.30	21.90	18.90	23.40	131.30

SDO	21.95	20.83	19.60	21.22	20.88	21.37	125.85

The calculation process of the weight values of all the criteria is using Equation 1 and the weight values are summarised in table 4. These weights represent the contribution of all the possible factors tested as per category in the study.

$$\text{Weight of the criteria} = \frac{\text{Total average rating value of each criteria, } Av_{cr}}{\text{Total average rating value of all criteria, } CR_T} \quad \text{... (Eq. 1)}$$

Table 4: The weight value of all the main criteria for each category

Category/ criteria	WC	LC	HI	IF	OE	FN
Senior deck cadets	0.1692	0.1620	0.1622	0.1791	0.1602	0.1674
Junior deck officers	0.1729	0.1759	0.1622	0.1668	0.1440	0.1782
Senior deck officers	0.1745	0.1656	0.1558	0.1687	0.1656	0.1699

Based on the information in table 4, the main criteria are ranked by overall assessment concerning the issue of being distracted. The calculation for determining the overall ranking is by using the average weight formula as shown in Equation 2 and all weighted values are summarised in table 5. The criterion "Working conditions" is ranked in top place, followed by food/nutrition in second place and individual factors in third place.

$$\text{Average weight for overall ranking} = \frac{\text{weight in SDC + weight in JDO + weight in SDO}}{\text{Number of categories}} \quad \text{... (Eq. 2)}$$

Table 5: Ranking of the main criteria for deck side manning/ operation

Ranking	Criteria	Average weight
1	Working condition	0.1722
2	Food/ Nutrition	0.1718
3	Individual factors	0.1715
4	Living condition	0.1678
5	Human interactions	0.1601
6	Onboard environment	0.1566

The weighting vector values of all the thirty-six sub-criteria in Level 2 are calculated using Equation 3 and summarised in appendix 2. The new weights (normalized weighting vectors) of all the sub-criteria are calculated after obtaining the weighting vector values of all the main criteria and sub-criteria. By referring to the data in table 4 and appendix 2, the normalized weighting vector ($W(NS_sB_sAW_HW_pD_wPA_E)$) values of all the sub-criteria in this group are obtained as follows:

$$\text{Weight of the main criteria} = \frac{\text{Average rating value of each sub-criteria}}{\text{Total average rating value of all sub-criteria}} \quad \text{... (Eq. 3)}$$

$$(w(NS_sB_sAW_HW_pD_wPA_E)) = \begin{matrix} SS \\ BS \\ AWH \\ WP \\ DW \\ PAE \end{matrix} \begin{bmatrix} 0.1607 \\ 0.1526 \\ 0.1791 \\ 0.1764 \\ 0.1674 \\ 0.1638 \end{bmatrix} \text{X } 0.1692 = \begin{matrix} SS \\ BS \\ AWH \\ WP \\ DW \\ PAE \end{matrix} \begin{bmatrix} 0.02719 \\ 0.02582 \\ 0.03030 \\ 0.02985 \\ 0.02832 \\ 0.02772 \end{bmatrix}$$

The normalised weighting vector values of all the evaluation criteria is summarised as in appendix 3, specifically for the group "Senior Deck Cadet". By using a similar calculation concept, the normalised weighting sector values for both groups of "Senior Deck Officer and "Junior Deck Officer" can be calculated.

Step 3.2 – Construct the normalized decision matrix, R_{ij}

The normalized decision matrix of the analysis is computed using Equation 4 in association with a set of data in appendix 1. The calculation technique is applied to all the alternatives with respect to all of the attributes for calculating the R_{ij} values. Appendix 4 summarises the normalized decision matrix value.

$$R_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x^2{}_{ij}}}, \qquad i = 1, 2, \ldots\ldots, m; \quad j = 1, 2, \ldots \;\ldots, n \quad \text{... (Eq. 4)}$$

Step 3.3 – Construct the weighted normalized decision matrix, V_{ij}

Referring to the normalized weighting vector value of each criterion in appendix 3 and the normalized decision matrix value in appendix 4, the weighted normalized decision matrix of this analysis is calculated using Equation 5. The output of the calculation obtained is shown in appendix 5.

$$V_{ij} = w_j \times R_{ij} \quad , i = 1, 2, \ldots\ldots, m; \quad j = 1, 2, \ldots\ldots, n \quad \text{... (Eq. 5)}$$

Step 3.4 – Determine the positive ideal solution (PIS), V^+ and negative ideal solution (NIS), V^-

Next, the positive and negative ideal solutions are determined respectively. In this analysis process, the values of positive and negative ideal solutions are determined using the algorithms described in literature written by Mahmoodzadeh et al., 2007 and Abdul Rahman, 2012. The goal of each criterion in the NIS is changed to the opposite of the PIS, for instance, from "Benefit" to "Cost" and the other way around.

Step 3.5 – Calculate the distance separation measure for PIS, D^+ and NIS, D^-

The distance separation is divided into two parts which are related to the PIS and NIS. The $D^+{}_i$ is computed using Equation 6, while the $D^-{}_i$ is calculated using Equation 7. Table 6 summarises the values of the distance separation and closeness of each alternative.

$$D^+{}_i = \sqrt{\sum_{i=1}^{n}(V_{ij} - V^+{}_2)^2} \;, i = 1, 2, \ldots\ldots, m \qquad \text{... (Eq. 6)}$$

$$D^-{}_i = \sqrt{\sum_{i=1}^{n}(V_{ij} - V^-{}_2)^2} \;, i = 1, 2, \ldots\ldots, m \qquad \text{... (Eq. 7)}$$

Table 6: Distance separation and closeness of each alternative

Alternative	$D^+ = \sqrt{V_{ij} + V^+_{ij}}$	$D^- = \sqrt{V_{ij} + V^-_{ij}}$
SDC	0.01213	0.01412
JDO	0.03389	0.01450
SDO	0.01470	0.01246

Step 3.6 – Calculate the relative closeness to the ideal solution, (RC_i^+)

The relative closeness to the ideal solution is obtained using Equation 8 in association with the values of D_i^+ and D_i^- in Step 3.4. The best alternative for the most affected group is chosen based on the $RC^+{}_i$ value closest to the one which has the shortest distance from the positive ideal solution point and the farthest distance from the negative ideal solution point. The $RC^+{}_i$ values of all the alternative sources are shown in table 7.

$$RC_i^+ = \frac{D^-{}_i}{D^+{}_i + D^-{}_i} \qquad , i = 1, 2, \ldots\ldots, m \qquad \text{... (Eq. 8)}$$

Table 7: The relative closeness to the ideal solution, (RC_i^+)

Alternatives	$RC_i^+ = \frac{D^-}{D^+ + D^-}$
SDC	0.53790 (1)
JDO	0.29965 (3)
SDO	0.45876 (2)

Step 3.7 – Rank the preference alternatives

Table 7 shows that the relative closeness to the ideal solution (RC_i^+) values of all the alternatives used in the study. The value of each alternative represents the weight of the contribution of the distractions for each group of the selected Malaysian seafarers. It shows the extent to which they being affected by this issue. As a result, the ranking preference orders of all the alternatives, “SDC” is ranked as the most affected group in ship manning, followed by “SDO” and “JDO” respectively. The ranking position of the alternative “SDC” is based on the evaluation made through a survey among cadets to identify the possible distractions experienced by them while they were on-board. It can be concluded that this alternative is the most affected group compared to other two groups involved in this study.

V. Conclusions

The factors affecting the Malaysian seafarers’ psychological condition are identified, as shown in table 2 which is meeting the research objective concerning the contributing factors. According to the analysis results shows in table 5, the factor "Working Conditions" is ranked in top place, followed by "Food/Nutrition" in second place and "Individual Factors" in third place. Having said that, these three contributing factors are dynamic and uncertain in terms of the matter of risk assessment. Sometimes, these factors can be beneficial for some seafarers and via versa. The Working Condition variable is highly dependent on the types of ships that the seafarers joined. For example, if they are joining the tanker ship (LNG, LPG), the work task will be very heavy and challenging because they are dealing with dangerous cargoes carried by the ship. They have to be careful when handling any equipment on the tanker vessel in order to ensure that a high standard safety regulation is applied every time, as a simple mistake can lead to dangerous situations such as fire and fatality. However, the situation is much simpler for seafarers joining the containership, because the system in the ship is automatically set up. Besides this, the outcome of the study also stated that arrangement of working hours, period of rests and working places too are common causes of distractions experienced by deck side operation, however the working condition is recorded as the factor that affects seafarers’ psychological condition the most.

The TOPSIS method is used to rank the alternative (category) based on the relative closeness to the ideal solution concerning psychological distractions. The result in table 7 shows that the senior deck cadets (SDC) are identified as being most affected by psychological distractions. Such a situation is not only contributed to by the elements on-board, but it is worsened by the differing levels of experiences of each individual including the combination of the high extent/challenge of their work and the level of knowledge and skills required. The “SDC” is relatively more affected by distractions because they are still considered to be at entry level in the shipping industry, but they are also assigned with a high workload in when compared their level of knowledge and skill. Senior Deck Officer (SDO) is ranked in second place and followed by the “JDO” as they have already determined their range of work and are responsible for particular area only. These are the reasons why such distractions keep distracting the seafarers which can then lead to undesirable incidents.

This information helps both seafarers and shipping companies to prepare and establish effective solutions for overcoming this situation. The application of the TOPSIS method and a list of parameters are not only limited to Malaysian seafarers, but it can be applied to other nationalities accordingly. However, different countries may apply different policies and be subject to different working conditions and environments. As a result, the parameters and literature may be different according to the situations faced by the seafarers. By developing a solid analysis, seafarers or shipping companies can produce relevant outcomes and make a rational decision to identify the most affected group based on the multiple criteria requirement. Also, this could assist the shipping company to reduce the number of marine accidents due to the seafarer distraction.

Submitted: February 28, 2015 Accepted: November 5, 2015

Acknowledgements

A huge appreciation delivered to Universiti Malaysia Terengganu for providing the research facilities. Also, a deep gratitude goes to Malaysia Maritime Academy (MMA) for the valuable cooperation and also extended to all the individuals in MMA who were participated in this survey.

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Appendices

Appendix 1: Average rating value of all sub-criteria evaluated using ARV technique

Criteria	Sub-criteria	Categories			Total
		SDC	JDO	SDO	
WC	***SS***	3.58	3.90	3.67	**11.15**
	BS	3.40	3.50	3.28	**10.18**
	AWH	3.99	4.30	3.80	**12.09**
	WP	3.93	4.10	3.98	**12.01**
	DW	3.73	3.50	3.63	**10.86**
	PAE	3.65	3.40	3.58	**10.63**
LC	***CA***	3.46	3.70	3.53	**10.69**
	RAF	3.32	3.90	3.13	**10.35**
	PR	4.00	4.00	3.98	**11.98**
	SL	3.65	4.20	3.57	**11.42**
	IA	3.43	3.60	3.33	**10.36**
	HT	3.47	3.70	3.28	**10.45**
HI	***LB***	3.56	3.50	3.28	**10.34**
	QR	3.68	3.60	3.40	**10.68**
	SI	3.82	4.20	3.58	**11.60**
	LA	3.55	3.80	3.30	**10.65**
	MC	3.27	3.00	3.02	**9.29**
	SC	3.48	3.20	3.02	**9.70**
IF	***DI***	4.00	3.50	3.67	**11.17**
	MS	4.02	3.80	3.62	**11.44**
	AP	3.81	3.30	3.28	**10.39**
	FI	3.67	3.10	3.23	**10.00**
	RE	4.06	4.00	3.68	**11.74**
	VAS	4.03	4.20	3.73	**11.96**
OE	***SM***	3.56	3.30	3.75	**10.61**
	CC	3.36	2.80	3.18	**9.34**
	WM	3.50	3.30	3.60	**10.40**
	VC	3.61	3.00	3.47	**10.08**
	EC	3.60	3.40	3.62	**10.62**
	NV	3.46	3.10	3.27	**9.83**
FN	***OF***	3.64	3.70	3.58	**10.92**
	ASF	3.61	3.80	3.67	**11.08**
	QFP	3.78	4.20	3.68	**11.66**
	HY	3.62	3.80	3.57	**10.99**
	EDF	3.59	3.90	3.35	**10.84**
	SFP	3.80	4.00	3.52	**11.32**

Appendix 2: The weighted values of all sub-criteria (sc), W_{SC}

Criteria	Level 2 (Sub-criteria)	SDC	JDO	SDO
WC	**SS**	W_{sc1}= 0.1607	W_{sc1}= 0.1718	W_{sc1}= 0.1671
	BS	W_{sc2}= 0.1526	W_{sc2}= 0.1542	W_{sc2}= 0.1496
	AWH	W_{sc3}= 0.1791	W_{sc3}= 0.1894	W_{sc3}= 0. 1731
	WP	W_{sc4}= 0.1764	W_{sc4}= 0.1806	W_{sc4}= 0.1815
	DW	W_{sc5}= 0.1674	W_{sc5}= 0.1542	W_{sc5}= 0.1655
	PAE	W_{sc6}= 0.1638	W_{sc6}= 0.1498	W_{sc6}= 0.1632
LC	**CA**	W_{sc1}= 0.1622	W_{sc1}= 0.1642	W_{sc1}= 0.1696
	RAF	W_{sc2}= 0.1557	W_{sc2}= 0.1688	W_{sc2}= 0.1504
	PR	W_{sc3}= 0.1875	W_{sc3}= 0.1732	W_{sc3}= 0.1912
	SL	W_{sc4}= 0.1711	W_{sc4}= 0.1818	W_{sc4}= 0.1712
	IA	W_{sc5}= 0.1608	W_{sc5}= 0.1558	W_{sc5}= 0.1600
	HT	W_{sc6}= 0.1627	W_{sc6}= 0.1602	W_{sc6}= 0.1576
HI	**LB**	W_{sc1}= 0.1667	W_{sc1}= 0.1643	W_{sc1}= 0.1675
	QR	W_{sc2}= 0.1723	W_{sc2}= 0.1690	W_{sc2}= 0.1735
	SI	W_{sc3}= 0.1788	W_{sc3}= 0.1972	W_{sc3}= 0.1828
	LA	W_{sc4}= 0.1662	W_{sc4}= 0.1784	W_{sc4}= 0.1684
	MC	W_{sc5}= 0.1531	W_{sc5}= 0.1409	W_{sc5}= 0.1539
	SC	W_{sc6}= 0.1629	W_{sc6}= 0.1502	W_{sc6}= 0.1539
IF	**DI**	W_{sc1}= 0.1696	W_{sc1}= 0.1598	W_{sc1}= 0.1728
	MS	W_{sc2}= 0.1704	W_{sc2}= 0.1735	W_{sc2}= 0.1705
	AP	W_{sc3}= 0.1615	W_{sc3}= 0.1507	W_{sc3}= 0.1548
	FI	W_{sc4}= 0.1556	W_{sc4}= 0.1416	W_{sc4}= 0.1524
	RE	W_{sc5}= 0.1721	W_{sc5}= 0.1826	W_{sc5}= 0.1736
	VAS	W_{sc6}= 0.1708	W_{sc6}= 0.1918	W_{sc6}= 0.1760
OE	**SM**	W_{sc1}= 0.1688	W_{sc1}= 0.1746	W_{sc1}= 0.1796
	CC	W_{sc2}= 0.1593	W_{sc2}= 0.1481	W_{sc2}= 0.1524
	WM	W_{sc3}= 0.1660	W_{sc3}= 0.1746	W_{sc3}= 0.1724
	VC	W_{sc4}= 0.1712	W_{sc4}= 0.1587	W_{sc4}= 0.1660
	EC	W_{sc5}= 0.1707	W_{sc5}= 0.1799	W_{sc5}= 0.1732
	NV	W_{sc6}= 0.1641	W_{sc6}= 0.1640	W_{sc6}= 0.1564
FN	**OF**	W_{sc1}= 0.1652	W_{sc1}= 0.1581	W_{sc1}= 0.1677
	ASF	W_{sc2}= 0.1638	W_{sc2}= 0.1624	W_{sc2}= 0.1716
	QFP	W_{sc3}= 0.1715	W_{sc3}= 0.1795	W_{sc3}= 0.1724
	HY	W_{sc4}= 0.1642	W_{sc4}= 0.1624	W_{sc4}= 0.1669
	EDF	W_{sc5}= 0.1629	W_{sc5}= 0.1667	W_{sc5}= 0.1568
	SFP	W_{sc6}= 0.1724	W_{sc6}= 0.1709	W_{sc6}= 0.1646

Appendix 3: Normalized weight values of all criteria for Senior Deck Cadets (SDC)

Weight of Criteria, W_{CR}	Weight of sub-criteria, W_{SC}	Normalized weight values of all criteria, W_j
WC= 0.1692	SS= 0.1607	0.02719
	BS= 0.1526	0.02582
	AWH= 0.1791	0.03030
	WP= 0.1764	0.02985
	DW= 0.1674	0.02832
	PAE= 0.1638	0.02772
LC= 0.1620	CA= 0.1622	0.02628
	RAF= 0.1557	0.02522
	PR= 0.1875	0.03038
	SL= 0.1711	0.02772
	IA= 0.1608	0.02605
	HT= 0.1627	0.02636
HI= 0.1622	LB= 0.1667	0.02704
	QR= 0.1723	0.02795
	SI= 0.1788	0.02900
	LA= 0.1662	0.02696
	MC= 0.1531	0.02483
	SC= 0.1629	0.02642
IF= 0.1791	DI= 0.1696	0.03038
	MS= 0.1704	0.03051
	AP= 0.1615	0.02893
	FI= 0.1556	0.02787
	RE= 0.1721	0.03082
	VAS= 0.1708	0.03059
OE= 0.1602	SM= 0.1688	0.02704
	CC= 0.1593	0.02552
	WM= 0.1660	0.02659
	VC= 0.1712	0.02743
	EC= 0.1707	0.02735
	NV= 0.1641	0.02629
FN= 0.1674	OF= 0.1652	0.02765
	ASF= 0.1638	0.02742
	QFP= 0.1715	0.02871
	HY= 0.1642	0.02749
	EDF= 0.1629	0.02727
	SFP= 0.1724	0.02886

Appendix 4: The normalised decision matrix value, R_{ij}

DECK	SDC	JDO	SDO
SS	0.555755	0.605432	0.569727
BS	0.578281	0.59529	0.557872
AWH	0.570874	0.615227	0.543689
WP	0.566684	0.591197	0.573894
DW	0.594693	0.558023	0.578749
PAE	0.594468	0.553751	0.583067
CA	0.560384	0.599254	0.571721
RAF	0.553108	0.649736	0.521455
PR	0.578313	0.578313	0.575421
SL	0.552097	0.63529	0.539996
IA	0.573151	0.601558	0.556441
HT	0.574443	0.612518	0.542989
LB	0.595971	0.585927	0.549097
QR	0.596485	0.583518	0.551101
SI	0.569143	0.62576	0.533386
LA	0.576398	0.61699	0.535807
MC	0.609188	0.558888	0.562614
SC	0.620334	0.570422	0.538336
DI	0.619289	0.541878	0.568198
MS	0.608081	0.574803	0.547575
AP	0.633554	0.548748	0.545422
FI	0.633968	0.535504	0.557961
RE	0.598445	0.589601	0.542433
VAS	0.582934	0.607524	0.539539
SM	0.580371	0.537984	0.611345
CC	0.621349	0.517791	0.588063
WM	0.582525	0.549238	0.599168
VC	0.618446	0.513944	0.594462
EC	0.586905	0.554299	0.590165
NV	0.609041	0.545672	0.575596
OF	0.577298	0.586814	0.567782
ASF	0.564193	0.593888	0.573571
QFP	0.560564	0.622849	0.545735
HY	0.570314	0.598672	0.562436
EDF	0.572512	0.621949	0.534238
SFP	0.580641	0.611201	0.537857

Appendix 5: Weighted normalised decision matrix, Vij

Sub-Creatia	SDC	JDO	SDO
SS	0.015111	0.017981	0.016613
BS	0.014931	0.01587	0.014566
AWH	0.017297	0.020149	0.016425
WP	0.016916	0.018463	0.018175
DW	0.016842	0.014877	0.016714
PAE	0.016479	0.014342	0.016606
CA	0.014727	0.017306	0.01606
RAF	0.013949	0.019291	0.012989
PR	0.017569	0.017621	0.018218
SL	0.015304	0.020317	0.015309
IA	0.014931	0.016483	0.014746
HT	0.015142	0.017261	0.014172
LB	0.016115	0.015615	0.014331
QR	0.016672	0.015994	0.014896
SI	0.016505	0.020018	0.015191
LA	0.01554	0.01785	0.01406
MC	0.015126	0.012771	0.013491
SC	0.016389	0.013895	0.012909
DI	0.018814	0.014441	0.016563
MS	0.018553	0.016635	0.015748
AP	0.018329	0.013796	0.014246
FI	0.017669	0.012649	0.014345
RE	0.018444	0.017959	0.015888
VAS	0.017832	0.019435	0.016019
SM	0.015693	0.013525	0.018181
CC	0.015857	0.011044	0.014843
WM	0.015489	0.013808	0.017106
VC	0.016964	0.011744	0.016342
EC	0.016052	0.014356	0.016926
NV	0.016012	0.012883	0.014908
OF	0.015962	0.016531	0.016176
ASF	0.01547	0.017187	0.016725
QFP	0.016094	0.019925	0.015985
HY	0.015678	0.017326	0.015951
EDF	0.015612	0.018478	0.014232
SFP	0.016757	0.018611	0.015044