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ORIGINAL

Reimaging maritime education and training using latest technologies

Reimaginar la educación y formación marítimas utilizando las últimas tecnologías

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ABSTRACT

The world is moving towards technological advancements and every industry is rapidly changing its approach. Thus, industry looks for more technically knowledgeable and analytically persons to adapt to the fast-changing world. This revolutionized the higher education system across the world. The education system changes its traditional method of teaching to more practical based blended learning. Whereas, the maritime industry which used to take people at the age of 12 and train them at the ship for various works is also selecting their candidates with basic subject knowledge and analytical skills. Because at present the maritime education is more of traditional based theoretical learning. The maritime education course contents are designed in such a way that it should meet the minimum requirement of Standards of Training, Certification and Watch keeping for Seafarers (STCW) convention adopted by the International Maritime Organization (IMO) which were not been revised after 2010. The shipping companies are looking beyond this minimum requirement as the ship is automated and has more advanced machineries onboard the ship. The seafarers with more analytical and basic theoretical knowledge find it difficult to adapt them to the technologically advanced marine environment. The present students studying the maritime courses lack interest in studying the theoretical based traditional learning. Since the STCW conventions are under review, this paper discusses about the blended learning techniques which can be adopted to the course contents. The data has been collected using structured questionnaire from different set of people. The collected data was analyzed and validated using AMOS and SPSS software. The results shows that the blended learning techniques like Augmented reality and Virtual reality techniques considerably solves the problem. This technique also gives the student hands on training which will be more helpful when they are onboard.

Keywords: Maritime Education; Course Contents; Blended Learning; Simulator; Augmented Reality; Virtual Reality Technology.

RESUMEN

El mundo avanza hacia los avances tecnológicos y todas las industrias cambian rápidamente su enfoque. Así pues, la industria busca personas con más conocimientos técnicos y analíticos para adaptarse a un mundo en rápida evolución. Esto ha revolucionado el sistema de enseñanza superior en todo el mundo. El sistema educativo cambia su método tradicional de enseñanza por un aprendizaje combinado más basado en la práctica. Por su parte, la industria marítima, que solía tomar a personas de 12 años y formarlas en el barco para diversos trabajos, también está seleccionando a sus candidatos con conocimientos básicos y capacidad analítica. En la actualidad, la formación marítima se basa más en el aprendizaje teórico tradicional. Los contenidos de los cursos de formación marítima se diseñan de manera que cumplan los requisitos mínimos del Convenio sobre Normas de Formación, Titulación y Guardia para la Gente de Mar (STCW) adoptado por la Organización Marítima Internacional (OMI), que no se revisó después de 2010. Las compañías navierasestán mirando más allá de este requisito mínimo, ya que el buque está automatizado y tiene maquinarias más avanzadas a bordo.

Los marinos con conocimientos teóricos más analíticos y básicos tienen dificultades para adaptarlos al entorno marítimo tecnológicamente avanzado. Los actuales estudiantes de los cursos marítimos carecen de interés por el aprendizaje tradicional basado en la teoría. Dado que se están revisando los convenios STCW, en este documento se analizan las técnicas de aprendizaje combinado que pueden adoptarse a los contenidos de los cursos. Los datos se han recogido mediante un cuestionario estructurado de diferentes grupos de personas. Los datos recogidos se analizaron y validaron con los programas AMOS y SPSS. Los resultados muestran que las técnicas de aprendizaje mixto, como la realidad aumentada y la realidad virtual, resuelven considerablemente el problema. Además, esta técnica proporciona a los estudiantes una formación práctica que les resultará más útil cuando estén a bordo.

Palabras clave: Educación Marítima; Contenidos del Curso; Aprendizaje Combinado; Simulador; Realidad Aumentada; Tecnología de Realidad Virtual.

INTRODUCTION

Training of seafarers is done generally to meet the STCW convention adopted by IMO, which is ratified by member states. This gives a ground level standardization of training of seafarers across the world. Also, this gives the port states to expect and verify the seafarers' qualifications and operation of vessels against the requirements of STCW and SOLAS. This ensures safety of vessel operation and protection of marine environment as well. STCW convention has the following revisions, 1978 – London – introduced, 1995 – Comprehensive revision, 2010 – Manila Amendments.

Thus, one could see the over a period of 43 years there has only been 3 major revisions. IMO is in the process preparing for next revision. Member states training standards is based on minimum requirements to meet STCW competencies for a given Certificate of Competency. The STCW convention which was originally created was not meeting its objectives, hence revision of those conventions was carried out. The latest revision STCW2010 doesn't reduce the human element in the marine accident. The new revision STCW 2010 convention doesn't suit the current education system where it is more digitalized and practical method of learning.[1,2] This leads to the failure of this convention. The mariners feels that the training or education that they are receiving through this type was not at all benefiting them when they actually onboard the vessel.[5]

This gives rise to a problem. When achieving minimum standard becomes the aim or goal of training then scope for improvement becomes less. This is because maritime training by nature is very technical and improvement is imperative. This should be given lot of importance.[4] Unfortunately, with tradition of meeting minimum requirement improvement suffers. It would be worthwhile in the Indian context to assess how well the Pre Sea training meets the requirements of current trends and operational standards of todays' seafaring.[10] The ship-owning companies as stakeholders and their opinions should be also assessed to ascertain the need for change in training requirements.[3,6] The problem is the intention of maritime education and training institute, the intention of the syllabus and the experience which the students expect contradict each other. This results in the students; losing interest in learning maritime courses.[7]

Theoretical framework

The maritime industry is more digitalized now and the equipment on board the vessel was mostly automated. Information technology and Artificial Intelligence plays a key role in modern day navigation systems and bridge systems.[1] The present-day seafarers itself finding it difficult or to cope up with those modernized or digitalized equipment's. They don't get proper training anywhere once they are graduated out of their maritime education and training institute.[8]

This underlying fact is that the cadets or the seafarers coming out of maritime education training institute were not competent enough to handle these digitalized vessels.[9] It is because the training institute were not having the digitalized equipment and the STCW Conventions minimum requirements doesn't includes those trainings. Thus, the students graduating with a high-class degree from these maritime institutes doesn't have skills or awareness of these kind of equipment. The maritime education training systems shouldn't be treating everyone the same.[17] The competencies should be set in a way that it should assess the strength and weakness of each cadet and customized training should be given to each individual.

This study has been carried out in order to find that how much effects the latest technologies were having when they were incorporated in the present-day MET system.[19] The latest technologies being giving hand on training importance in order to avoid the human element in the marine accidents, and the adaptation of ICT tools[3] such as Simulator Trainings, Virtual Reality[16] and Augmented Reality[15] in Marine environments, and Blended Learning techniques.[18]

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METHOD

1. Sample Size was determined using surveysystems.com: a structured questionnaire was circulated among 500 seafarers and mariners as the study calls for heterogeneity. Around 400 responded.
2. Study Design: a qualitative Descriptive Research Design.
3. Target population: seafarers, mariners.
4. Sampling technique: probability sampling techniques.
5. Study Instruments: Structured Questionnaire (Google Forms).
6. Data Source:
    a. Primary data: using structured questionnaire for collecting data from sea farers and mariners.
    b. Secondary Data: literature reviews from National and International Journals, Websites, Manuscripts, Online database, Reports.
7. Scale adopted – close ended questionnaire, Likert scale - measure the perceptions of the subjects with the statements, Demographics - Multiple Choice Questions, Rating Scale - Strongly Agree, Agree, Partially Agree, Disagree, strongly disagree.

Study Design

Variables of the study: the study variables were identified from the literature review and were listed in the table 1 below:

Table 1. Study Variables

Independent Variables - Presea Training	Mediating Variables - Marine Standards	Moderating Variables - ICT	Dependent Variables - KPI of Marine Industry
• Course Contents / Training Modules • Subjects • Ship in campus equipment • Hands on Training • Seaboard Training Slot	• STCW Convention based competence • Legal / Mandatory document requirements • Theoretical knowledge-based Competence	• Human Elements Importance • Simulator Trainings • Virtual Reality and Augmented Reality in Marine • Blended Learning	• Onboard Equipment Handling • Competence Adequacy • Interpersonal and communication Skills • Diversified Environment Adaptability • Environmental Deficiencies • Crew Planning and their role onboard • Shipment Process and Supply Chain metrices

Architectural Design

Figure 1 shows a Conceptual model of Pre Sea-Training for satisfying Key performance Indicators through Marine Standards and ICT tools and latest technologies.

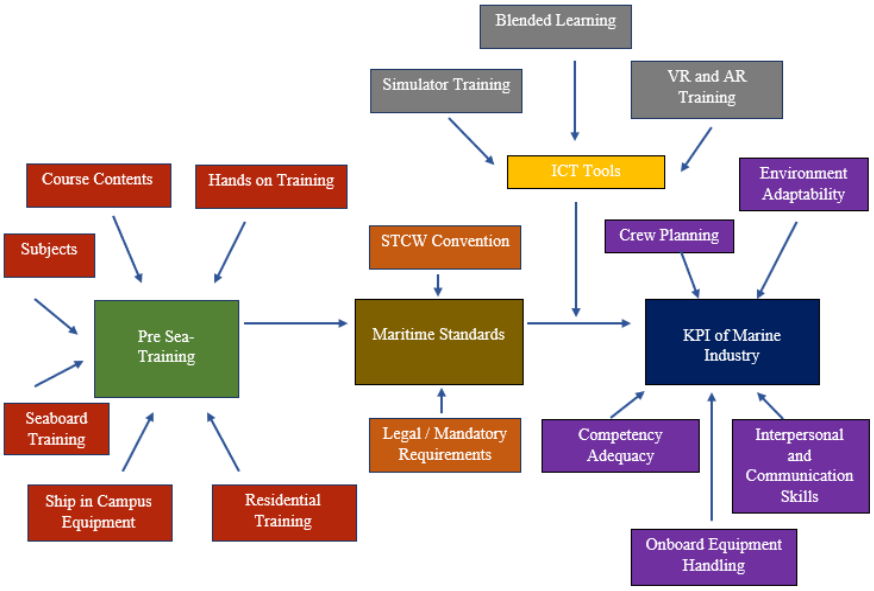

Figure 1. Conceptual model of Pre Sea-Training for satisfying Key performance Indicators through Marine Standards and ICT tools and latest technologies

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Objectives and Hypothesis

I. To study about the Presea Training, Marine Standards, ICT Tools, KPI of Marine Industry based on the demographic variables (ANOVA).

H1 -Significant difference in the opinion about Presea Training.
H2 -Significant difference in the opinion about Marine Standards.
H3 -Significant difference in the opinion about ICT Tools.
H4 -Significant difference in the opinion about KPI of Marine Industry.

II. To find out the dependency of KPI of Marine Industry by Presea Training, Marine Standards and ICT Tools (Multiple Regression).

H5 -KPI of Marine Industry depends on Presea Training, Marine Standards and ICT Tools.

III. To study about the interdependency of KPI of Marine Industry, Presea Training, Marine Standards and ICT Tools (Correlation).

H6 -There is relationship between KPI of Marine Industry, Presea Training, Marine Standards and ICT Tools.

IV. To study about the effect of Presea Training on KPI of Marine Industry when Marine Standards is Mediating (Hayes Mediating Effect).

H7 -There is significant indirect effect among Presea Training and KPI of Marine Industry when Marine Standards is a mediating.

V. To study about the effect of Presea Training on KPI of Marine Industry when ICT Tools is Moderating (Hayes Moderating Effect).

H8 -There is significant effect among Presea Training and Marine Industry KPI when ICT Tools is a moderating Variable.

VI. To develop model for attaining KPI of Marine Industry by Presea Training, Marine Standards and ICT Tools (PATH Analysis).

H9 -Presea Training, Marine Standards and ICT Tools has positive influence on the KPI of Marine Industry.

Data Analysis

Analysis has been carried out using AMOS 21,0 SPSS 21,0 The following test were conducted to validate the data.

- Reliability (Cronbach Alpha)
- Descriptive statistics
- Chi- square
- ANOVA
- Pearson Correlation
- Multiple Regression
- Multiple Discriminant analysis
- F. Hayes - Mediation, Moderation

RESULTS AND DISCUSSION

The reliability of primary data was checked for the total by its Cronbach's alpha values and based on standardized items. The alpha values for Presea Training, Marine Standards, ICT Tools, KPI of Marine were 0,783, 0,160, 0,877, and 0,924 respectively, and for the standardized items version 0,771, 0,85, 0,877, and 0,924 respectively. Thus, reliability of the items was good for the total data the Reliability Statistics shows in table 2.

Table 2. Reliability Statistics

Overall Reliability Statistics			
	Cronbach's Alpha	**Cronbach's Alpha Based on Standardized Items**	**No of Items**
	0,938	0,935	19
Presea Training	0,783	0,771	6
Marine Standards	0,160	0,85	3
ICT Tools	0,877	0,877	3
KPI of Marine Industry	0,924	0,924	7

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The Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's test of Sphericity test results shows in table 3. The KMO test measures 0,959 and it possible to conduct factor analysis. From the Bartlett's Test it clearly shows that the correlation matrix is indeed not an identity matrix as represented in the table 3 below.

Table 3. Kaiser-Meyer-Olkin and Bartlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0,959
Bartlett's Test of Sphericity	Approx. Chi-Square	6 134,534
	df	171
	Sig.	0,000

In order to find that the samples are normally distributed the normality test was run in SPSS and the result is positive and is given in table 4.

Table 4. Normality Test

N	PreseaTraining	MarineStandards	ICTTools	KPIofMarineIndustry
Valid	462	462	462	462
Missing	0	0	0	0
Mean	3,3463	3,0693	3,5216	3,4583
Median	3,3333	3,0000	3,3333	3,2857
Mode	4,33	3,67	5,00	5,00
Skewness	0,012	0,004	-0,026	.065
Std. Error of skewness	0,114	0,114	0,114	0,114
Kurtosis	-1,434	-1,115	-1,723	-1,526
Std. Error of Kurtosis	0,227	0,227	0,227	0,227

ANOVA—HRM Activities results are shown in table 5. The Pearson Corelation method is used to validate the variables using SPSS. The results are shown in table 6 below and its graphs are shown in figure 2.

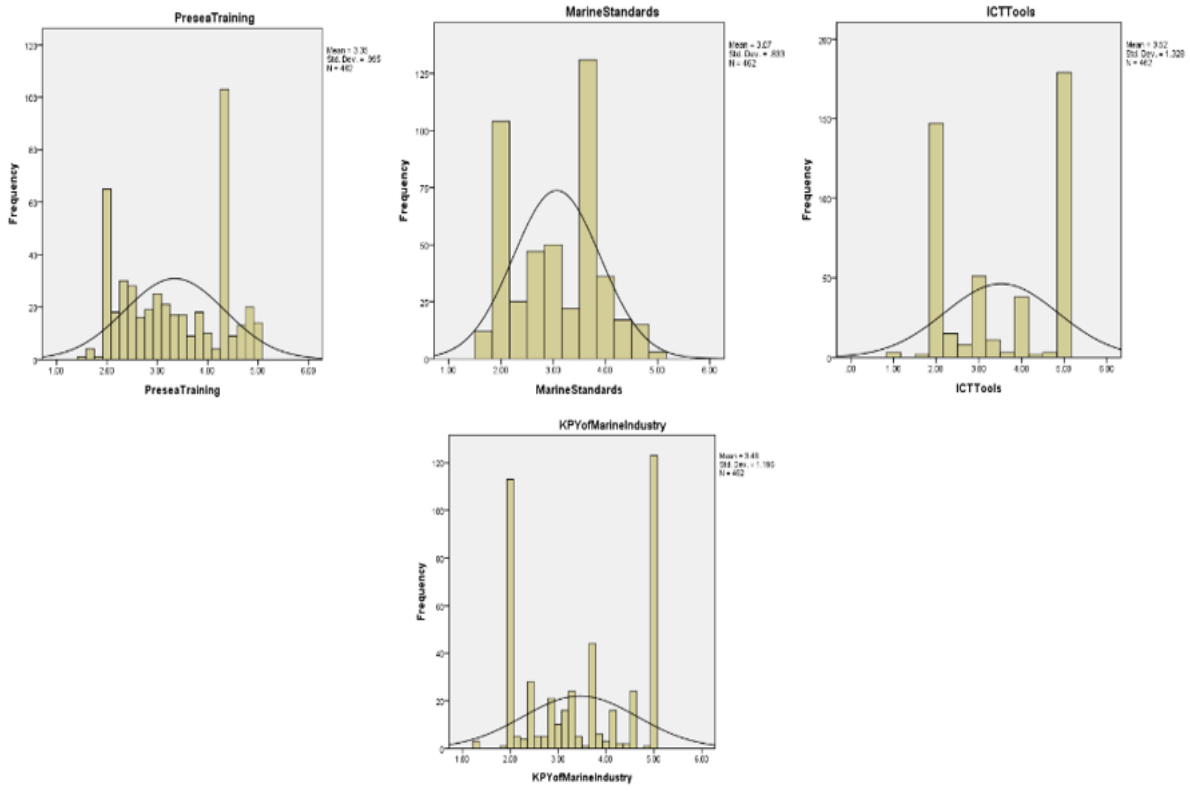

Figure 2. The Pearson Corelation Method – test validation

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Table 5. ANOVA—HRM Activities

Variable			Sum of Squares	df	Mean Square	F	Sig.
Presea Training	Experience	Between Groups	29,701	21	1,414	1,302	0,168
		Within Groups	477,946	440	1,086		
		Total	507,647	461			
	Institution Studied	Between Groups	2,632	21	0,125	1,711	0,026
		Within Groups	32,242	440	0,073		
		Total	34,874	461			
Marine Standards	Experience	Between Groups	27,790	10	2,779	2,612	0,004
		Within Groups	479,858	451	1,064		
		Total	507,647	461			
	Institution Studied	Between Groups	3,228	10	0,323	4,600	0,000
		Within Groups	31,647	451	0,070		
		Total	34,874	461			
ICT Tools	Experience	Between Groups	34,680	11	3,153	3,000	0,001
		Within Groups	472,967	450	1,051		
		Total	507,647	461			
	Institution Studied	Between Groups	1,206	11	0,110	1,465	0,142
		Within Groups	33,669	450	0,075		
		Total	34,874	461			
KPIof Marine Industry	Experience	Between Groups	49,587	22	2,254	2,160	0,002
		Within Groups	458,060	439	1,043		
		Total	507,647	461			
	Institution Studied	Between Groups	2,896	22	0,132	1,807	0,014
		Within Groups	31,978	439	0,073		
		Total	34,874	461			

Table 6. Pearson Correlation test validation results

		PreseaTraining	Marine Standards	ICTTools	KPIofMarineIndustry
PreseaTraining	Pearson Correlation	1	0,651**	0,714**	0,757**
	Significance(2-tailed)		0,000	0,000	0,000
	N	462	462	462	462
MarineStandards	Pearson Correlation	0,651**	1	0,592**	0,658**
	Significance(2-tailed)	0,000		0,000	0,000
	N	462	462	462	462
ICTTools	Pearson Correlation	0,714**	0,592**	1	0,835**
	Significance(2-tailed)	0,000	0,000		0,000
	N	462	462	462	462
KPIofMarineIndustry	Pearson Correlation	0,757**	0,658**	0,835**	1
	Significance(2-tailed)	0,000	0,000	0,000	
	N	462	462	462	462

**Correlation is significant at the 0,01 level (2-tailed).

Multiple regression test was conducted in order to find the value of variable dependencies and the results are show in table 7 and table 9. The dependent variable was set as KPIofMarineIndustry whereas the independent variables or Predictors: (Constant), ICT Tools, MarineStandards, PreseaTraining.

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Table 7. Multiple Regression Test results using ANOVA				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	0,875[a]	0,765	0,763	0,58169
a. Predictors: (Constant), ICTTools, MarineStandards, PreseaTraining				

Tabla 8.						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	504,133	3	168,044	496,639	0,000[b]
	Residual	154,970	458	0,338		
	Total	659,103	461			

Table 9. Multiple Regression Coefficients Result						
Model B		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		Std. Error	**Beta**			
1	(Constant)	-0,048	0,109		-0,440	0,660
	PreseaTraining	0,304	0,042	0,253	7,145	0,000
	MarineStandards	0,235	0,044	0,164	5,335	0,000
	ICTTools	0,502	0,030	0,558	16,738	0,000
a. Dependent Variable: KPIofMarineIndustry						

Figure 3 shows the Structural Equation Modelling of the observed variables. The analysis is carried out using ANOVA and the results are shown in table 9.

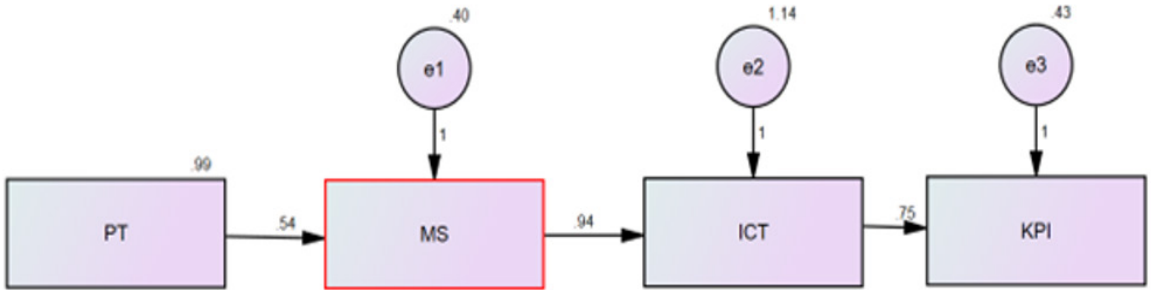

Figure 3. Sem Path Model

Table 11. AMOS Output					
Model	**NPAR**	**CMIN**	**DF**	**P**	**CMN / DF**
Default Model	7	273,467	3	0,000	91,156
Saturated Model	10	0,000	0		
Independence Model	4	1276,626	6	0,000	212,771

Table 12. RMR, GFI				
Model	**NPAR**	**CMIN**	**DF**	**P**
Default Model	0,220	0,819	0,396	0,246
Saturated Model	0,000	1,000		
Independence Model	0,677	0,401	0,002	0,241

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Table 13. Baseline Comparison

Model	NF1 Delta 1	Rf1 rho1	IFI Delta2	TLI rho2	CFI
Default Model	0,786	0,572	0,788	0,574	0,787
Saturated Model	1,000		1,000		1,000
Independence Model	0,000	0,000	0,000	0,000	0,000

Table 14. Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default Model	0,500	0,393	0,394
Saturated Model	0,000	0,000	0,000
Independence Model	1,000	0,000	0,000

Table 15. NCP

Model	NCP	LO 90	HI 90
Default Model	270,467	219,868	328,476
Saturated Model	0,000	0,000	0,000
Independence Model	1270,626	1156,868	1391,756

Table 16. F MIN

Model	FMIN	F0	LO 90	HI 90
Default Model	0,593	0,587	0,477	0,713
Saturated Model	0,000	0,000	0,000	0,000
Independence Model	2,769	2,756	2,509	3,019

Table 17. RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default Model	0,442	0,399	0,487	0,000
Independence Model	0,678	0,647	0,709	0,000

```
 KPY

Model Summary
        R       R-sq        MSE          F        df1        df2          p
   .7573      .5736      .6110   618.6938     1.0000   460.0000      .0000

Model
             coeff         se          t          p       LLCI       ULCI
constant     .4141      .1277     3.2435      .0013      .1632      .6650
PT           .9097      .0366    24.8736      .0000      .8378      .9816

************** TOTAL, DIRECT, AND INDIRECT EFFECTS OF X ON Y **************

Total effect of X on Y
     Effect         se          t          p       LLCI       ULCI
      .9097      .0366    24.8736      .0000      .8378      .9816

Direct effect of X on Y
     Effect         se          t          p       LLCI       ULCI
      .6853      .0455    15.0773      .0000      .5960      .7747

Indirect effect(s) of X on Y:
       Effect     BootSE   BootLLCI   BootULCI
MS      .2244      .0355      .1553      .2958

************************ ANALYSIS NOTES AND ERRORS ************************

Level of confidence for all confidence intervals in output:
  95.0000

Number of bootstrap samples for percentile bootstrap confidence intervals:
  5000

------ END MATRIX -----
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Figure 4. Hayes Mediation Effect

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Hayes Mediation test was conducted in order find whether the mediator is having effect on dependent and independent variables. X-Independent Variable (Presea Training), Y- Dependent Variable (KPI of Marine Industry), M- Mediation Variable (Marine Standards). The result is shown in figure 4.

From the result tables the value of BootLLCI 0,1553 and BootULCI 0,2958. This confirms that the there been a Mediation Effect

CONCLUSIONS

Various training methods to be explored and approved as valid competency development tools could be as follows:

- Simulator based training.
- Virtual reality, Augmented reality, Mixed reality.
- MOOC - E- Learning.

This paper doesn't mean to say that the traditional training method in not competent enough for the cadets or the seafarers passing out of the maritime training institutes. The recommendation being the blended learning techniques which adapts the simulators would be of ad added advantage The simulators and blended learning techniques were not to replace the technical qualified or the skillful experienced instructors, it is to completement them to achieve the fullest of training objectives. This blended learning techniques eases out both the instructors and the trainees by assisting the learning framework of the maritime training institutes.

Simulators were being used by the maritime training institute and also for seafarer's certification.[13] Initially bridge simulators were used to train the cadets in the training institutes and later it has been introduced to the professionals to overcome the safety work competencies. Those simulators were used to train the cadets on radar plotting, passage planning and ship handling.[14] Later this simulator technology was introduced in engine room where the ship operations and cargo handling would be carried out. Likewise, this simulator technology now been introduced to maritime training institutes to train the cadets in handling fire and maintain safety, and practicing to handle emergency situation and train them to operate deck machineries and some of the administrative skills such as wheelhouse and training for managing the crew resource. But the problem arises when the time given for such trainings were taken into considerations. There is not going to much time allotted for the students to train those simulators in the maritime training institutes. The recommendation being more simulator-based training should be given to the cadets in order for the students to familiarize those techniques.[12] In future this will in turn reduces the human element in the marine accidents.

The next recommendation being the E-Learning for the cadets. E- learning uses Information technology as tool and provides variety of learning materials and resources to the cadets as well as the professionals taking the competency exams.[11] This e -learning techniques is now being used in the competency test for marine professionals. This gives a great advantage to the learners by giving the flexibility in timing and reduces the cost of those trainings. This also gives the learners the location and geographical flexibility, which allows the user can access those learning materials from anywhere in the world. The eLearning method also eliminates age factors which also the users to learn new things regardless of their age. This eLearning also gives the user continuous and lifelong learning. This eLearning method allows the user the customized their training needs. this eLearning should also be introduced to Presea courses in the maritime training institute.

The Modern-day ICT Techniques like VR, AR, MR supports well with the current traditional method of teaching as well as the simulator-based learning. The technologies give the users a new different experience one can only have when they really onboard the vessel. These techniques allow the user to simulate the environment they require and time they want to travel. But on the other hand, installation of these techniques in the maritime training institutes needs huge infrastructure and enormous investment. The MET institute should seriously consider installing these latest techniques in their training institutes. This allows the cadets and marine professionals familiarize with the latest techniques they use on board the vessel. This will enhance the learner skills and gives the better candidate for the industry which in turn give the industry more productivity. Digitalization and automation are the next recommendation. Data are being the most important asses in most of the merchant shipping sector. Ships, ports and maritime. This needs a tremendous work force for analyzing those data and convert them information for better decision making onboard the vessel. These training should be given to the trainees which transform the seafarers acquire new competencies. Those maritime professionals can effectively manage the digitalized marine transportation system.

The maritime education colleges and training institutes should seriously consider implementing the simulator-based training with maximum work hours, eLearning Methods of training data, Implementation of latest technologies like Virtual reality, Augmented reality and mixed reality in order to give the cadets and maritime professionals the state of art facility. This will enhance the cadets' interest in the doing the maritime course and also reduces the human element in the maritime accidents. The maritime institutes shouldn't only be helping their learners to satisfy the STCW minimum convention, they also take responsibility to make the

sea farers and maritime professional competent enough in the work they are doing. Thus, the training institute should adopt these latest techniques in their training modules.

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