EFFECTIVENESS OF SEAFARER'S TRAINING USING MARITIME SIMULATORS

By

SURENDER KUMAR

COLLEGE OF MANAGEMENT AND ECONOMICS STUDIES
(DEPARTMENT OF LSCM & OPERATIONS)

Under the guidance of

Guide

Dr. NEERAJ ANAND

Professor and HOD - LSCM & Operations
College of Management and Economics Studies, UPES - Dehradun

Registered Co-Guide

Dr. DEVENDRA KUMAR PUNIA

Professor – Computer Science Engineering
JK Lakshmipat University, Jaipur

External Guide

Dr. BRIJENDRA K SAXENA

Principal - Tolani Maritime Institute, Induri (Pune)

Submitted

UPES
THE NATION BUILDERS UNIVERSITY

In partial fulfillment of the requirement of the degree of

DOCTOR OF PHLOSOPHY
TO
UNIVERSITY OF PETROLEUMAND ENERGY STUDIES
DEHRADUN

MAY 2015

DEDICATED

To

The seafarers

Of

The world

ACKNOWLEDGEMENT

The studies described in this thesis were performed under the guidance of Dr. Neeraj Anand, Dr. Devendra Kumar Punia and Dr. Brijendra K Saxena. I must admit that I have always received tremendous mental support from my guides and felt comfortable within the UPES system. I hold heartiest respect for my guides and take this opportunity to thank them from the bottom of my heart for their kind guidance and support.

UPES is an excellent place of learning where the idea of my research blossomed into a reality. I feel that I have achieved a long cherished dream at the end of my PhD journey which was indeed a very tough path. I wish rededicate myself to develop more management researchers in the society based on the knowledge I have gained during my PhD program.

While conducting this research project I received support from many people in one way or another, without whose support, this thesis would not have been completed in its present form. It is my pleasure to take this opportunity to thank all of you. I would like to apologize to those I do not mention by name here; however, I highly valued your kind support.

First, I would like to sincerely thank my industry guide and teacher, Dr. Brijendra Kumar Saxena from Tolani Maritime Training Institute, who provided me with the freedom to explore research directions and choose the routes that I wanted to investigate. Your encouragement, excellent guidance, creative suggestions, and critical comments have greatly contributed to this thesis.

Dr. Neeraj, Dr. Punia and Dr. Saxena, I would like to thank you very much for your supervision and kind guidance. I have learnt a great deal from you. Without you, I would never have had that opportunity. I strongly believe that what I have learned during this PhD study period will be beneficial for me for the rest of my life. For this I am eternally grateful. Thank you, from deep in my heart!

I am indebted to the faculty members at Sir Derek Bibby Maritime Training Centre for their critical comments and advice. I am also thankful to Prof. Hemangi Bhalerao and Dr. Kirti Arekar from Somaiya Institute of Management, Mumbai (SIMS), who have provided suggestions and contributed to improvement of my work. I cherish the discussions we had during my visits to Somaiya.

I would like to thank all my colleagues at Bibby Ship Management, in particular Mr. Prakash M Agarwal, the managing director, for your great help, guidance and support. Sir, I wish to let you know that I owe you my gratitude and indebtedness.
I wish to express my sincere thanks to my parents for the values they taught me, for their support, encouragement, love and prayers.

Finally, I would like to thank my wife, Rajeshwari, for her understanding, encouragement, care and unlimited support. Thank you so much. It wouldn't have been possible without your support and understanding.

Surender Kumar

Date: 15.5.2015

DECLARATION

I, Surender Kumar, PhD (Management) student of University of Petroleum & Energy studies, Dehradun, hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by other person nor material which has been accepted for the award of any degree or diploma of the university or other institute of higher learning, except where due acknowledgement has been made in the text.

Surender Kumar

Date: 15.5.2014

THESIS COMPLETION CERTIFICATE

This is to certify that the thesis on "Effectiveness of Seafarer's Training Using Maritime Simulators" by Surender Kumar in Partial completion of the requirements for the award of the Degree of Doctor of Philosophy (Management) is an original work carried out by him under our joint supervision and guidance.

It is certified that the work has not been submitted anywhere else for the award of any other diploma or degree of this or any other University.

Dr. BK SAXENA
External Guide

Dr. NEERAJ ANAND
Internal Guide

Dr. D K PUNIA
Registered Co-Guide

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EXECUTIVE SUMMARY

Introduction:

Safety of ships, the people onboard, and the environment have always been a matter of concern. The recent marine accidents and the after effects of the same have drawn the attention to training. Also in focus are the maritime simulators which are being used for the training of seafarers, their performance evaluation, and licensing assessment by the authorities. Substantial investments have been made in the maritime training industry for the use of simulators for training the seafarers. The investigators not only emphasised the importance of training but also emphasised upon the use of simulators for maritime training, assessment andperformance evaluation of mariners around the world.

Training and professional development of seafarers:

Seafarers' duties and responsibilities are mainly dictated by their work environment. Most often the seafarershave to work in quite stressfuland equally demanding conditions onboard advanced automated vessels. These vessels generally have a veryshort turnaround times in port. Over the years the crew sizes onboard have become smaller keeping in view the competition and mergers, and this combined with self-contained independence of long sea voyages put the seafarers under tremendous stress. Owners/charters demands to meet targets put the seafarers at the more than ever before stress. All seafarers are required to be knowledgeable in skills ranging from watchkeeping in engine room, power management, ships propulsion system, navigational bridge, cargo handling, and radar to medical care, lifesaving, maritime law, and ship's business.

Going by the history, the professional development and training of mariners have been based on a well proven and strong tradition of on-the-job learning. New mariners supplement training received in a structured academic environment ashore with colleague-assisted training while working onboard.

A wide range of marine simulators are available to train seafarers worldwide. A simulator, in the simplest way, may be defined as a machine with a similar set of controls, to that of the real equipment, designed to provide a realistic imitation of the operation of a ship, vehicle, aircraft, or other equipment. Simulation, in its simplest way, may be defined as the imitation of the real operation or system. If you need to simulate something, you first require to develop a model. This model, in general, represents the key characteristics and behaviors of the process or the system. The simulation or the simulator represents the operation of the system over time and can be used to learn the process by its users. In contrast, amodel of a system represents the system itself.

The training capabilities of computer-based simulators may vary from a simple task based simulator to a full mission simulator capable of simulating a 360-degree visual simulation of the environment. Modern day maritime simulators are capable of simulating a wide range of shipsand environmental conditions, various operating conditions which may include different sea conditions and types of vessels. Mariners can be trained using simulators on different skills like rules of the road (ROR),emergency procedures in maneuvering the shipand running and maintaining the engine control room (ECR) in good working condition. There are other types of models like the physical scale-model. They are also called as manned-model and these are capable of simulating the specific vessels, ship motions and quick response of the vessel. Ship handling and ship maneuvering skills can be effectively taught to the seafarers using simulators having physical scale model and manned-model.

•Irrespective of weather conditions one can use simulators to train in various conditions.

•Trainers/Instructors are capable of changing the training scenarios at any time, can also stop and restart the training session at their convenience.

•Training scenarios and settings can be repeated or can be set differently for different trainees.

•These simulators also have functionality wherein the instructor can record and replay the whole exercise.

•Training takes place in a "safe" environment there by giving confidence to the trainees to learn better.

While applying simulation to training needs, due consideration must be given to different levels of simulator component capabilities.

Most experts in simulator training field would like to agree that a high state of realism may not be required for effective learning transfer. Also it is not necessary to utilize highly sophisticated training simulators to meet various training needs and objectives. The fact still remains that the accuracy required and the reality of the situation training should be in line with the objectives of the training to have the desired results from the simulator based training.

Notwithstanding the above it is important to note that accuracy and realism of simulator must match the training objectives to have the desired results from the simulator based maritime training. It's interesting to compare the ship bridge simulator with the airline simulators where one can find that most commercial aviation simulators are built specific to the air frames. These simulators are also subject to prevalent aviation standards

Most of the aviation simulators are validated and thereafter revalidated periodically by the appropriate authorities. In contrast, most countries do not have validation programmes/standards for the maritime simulators, though these are approved by certain agencies like the flag state and the classification societies.

Maritime training:

2015 is a big milestone for the maritime industry. It is a known fact that the majority of the world's seafarers work on board ships which are registered with an administrative authority that is different from the nationalities of the seafarers. International Maritime Organization (IMO) being the overall authority for the globalized maritime workforce have brought out under the "Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW)" certain regulations which highlight the need of training.

The STCW 2010 'Manila' amendments are currently being brought in phases and all this isexpected to be in place by end of 2017. As it is, the IMO enforced and instructed all the member countries to ensure that all new seafarers are trained according to new standards with effect from 1st July 2013.

Methods of Training:

Several avenues exist to train employees, but it is important to match and tailor the training method to a particular situation. These training methods implemented for a specific purpose must be evaluated to see if the trainees have learnt as planned. Thereafter these results must be taken into consideration to design a specific training programme which may be effective.

Depending upon the situations, training may be imparted using various methods. The simulator based training is one of them and also very widely used and popular method around the world now. All training methods should to be evaluated to find if they are suitable for the situation/organisation/people being trained.

Training Evaluation:

To understand whether the training programme had the desired results or not, the training programme needs to be evaluated. How do you know your training was effective? Even if the participants leave the training room looking presumably happy and they also give high scores on an evaluation or feedback sheets, it may not necessarily mean that the course participants learned or if they can apply what they learned to their job. Of course, on face value it may be taken that course participants enjoyed themselves for the time spent in the training session with some of old friends or shipmates. It has been observed and recommended by the experts in the field that only a systematic, targeted approach to training evaluation will help you answer the question, did participants learn?

There are many models and different ways to evaluate training in general. The Four-Level Model approach is regarded and used more often to evaluate trainingprogrammes and also is used to design new programmes. This process focuses on four levels of training outcomes which are as below:

- Reactions,
- Learning,
- Behaviour and
- Results.

The important issue guiding this type of training evaluation is to ask whether the training had any impact on the participants in terms of their reactions, learning, behaviour, and organizational results."The training effectiveness matrix used for this study is based on the work of Donald L. Kirkpatrick, who introduced a four-level approach to training evaluation in 1959. These four levels are commonly known as:

- Customer satisfaction (internal and external) – level one,
- Learner performance – level two,
- Training process performance – level three, and
- Returned value – level four evaluations.

The Kirkpatrick model of evaluation provides a good platform to evaluate the training programmes. Kirkpatrick defined the four levels of training evaluation as given below;

- Level 1—Reaction
- Level 2—Learning
- Level 3—Behaviour
- Level 4—Results

Background & Need for the research:

The marine and offshore market is booming with activities. More and more vessels, ranging from general use to much specialized applications are being added to the existing fleet. To safely man these vessels and to carry out the operations with least down time and maintaining highest standards of safety, it is the need of the hour that we have very high standards of training procedures in place. To ensure that these training standards are implemented, the training simulators are already contributing a lot.

Research Methodology

In order to study the effectiveness of seafarer's training using simulators, it was decided to design a set of questionnaire for data collection. The data collection was done in four steps as below;

Level 1: To know the reaction of the trainees towards the training imparted.

Level 2: To understand if the learning has taken place and if there is change in knowledge, skill and attitude of the trainees.

Level 3: To know if the changed behaviour due to the training imparted is being used by the seafarers on the job.

Level 4: This crucial stage tries to investigate if the organisation has been benefitted by employing the seafarers trained on simulators.

In the beginning of the study, a literature review was undertaken and at various stages, the same was updated at every stage. The literature review covered the following:

• Papers and articles from journals

• Available books

• Non-journal materials which were accessible online.

The study made use of multiple choices Likert scale questionnaires based on Kirkpatrick's evaluation model for all the four stages, suitably adapted to marine training. The following statistical tests were utilized for data analysis.

One sample z-test:

A one sample z-test is a type of Univariate analysis. It is used whenever the variable is on Interval scale or Ratio scale. For this study, all the factors i.e. motivating, knowledge, attitude of the trainees and benefits of training to the organisation are on interval scale.

Paired sample t-test:

This test comes under the category of bivariate analysis. The researcher used the two variables namely pre training and post training scores of the trainees. Both the variables are related to each other. The data for both the variables is on ratio scale.

A hypothesis test uses sample data to test a hypothesis about the population from which the sample was taken. One sample t-test using SPSS is one of many procedures available for hypothesis testing. Testing a hypothesis means making inferences about one or more populations when sample data are available. The following tools are utilized for this research:

- Charts and tables for diagrammatic representation
- Microsoft: Excel, power point and word
- Cronbach's Alpha test
- One sample z-test
- Paired sample t-test

Analysis and outcome of the study:

For all four levels, there was a statistically significant difference between means ($p < .05$) and, therefore, we can reject the null hypothesis and accept the alternative hypothesis.These results suggest that;

1. Trainees rate the simulators in marine training a motivating aid to learning.
2. There is a change in the knowledge, attitude and skills of participants after the training.
3. The knowledge acquired during training is being used by the seafarers on the job.
4. The organizations get benefitted by seafarers trained on maritime simulators.

ABBREVIATIONS

3D	3 Dimensional
ABS	American Bureau of Shipping
AIS	Automatic Identification System
APEC	Accreditation of Seafarer Manning Agencies
ARI	Applied Research International
ARPA	Automatic Radar Plotting Aids
BIMCO	Baltic and International Maritime Council
CAORF	Computer Aided Operations Research Facility.
CBT	Computer Based Training
CIPP	Context Input Process Product
DNV	Det Norske Veritas
DP	Dynamic Positioning
ECDIS	Electronic Chart Display and Information System
ECR	Engine Control Room
FOV	Field of View
GMDSS	Global Maritime Distress and Safety System
GPS	Global Positioning System
HIS	Institute for Human Studies
ICERS	International Conference on Engine Room Simulators.
ILO	International Labor Organization
IMEC	International Maritime English Conference.
IMO	International Maritime Organization
INSLC	International Navigation Simulator Lecturers Confernece.
IPO	Input Process Output
ISC	Integrated Simulation Centre.

ISF	International Shipping federation
ISM	International Safety Management Code.
ITF	International Transport Federation
ITOPF	International Tanker Owners Pollution Federation
IUMI	International Union of Marine Insurance
KUP	Knowledge, Understanding and Proficiencies
LORAN-C	Long Range Radio Navigation position fixing system
MAIB	Marine Accident Investigation Board
MARiSa	Maritime Risk and System Safety
MARPOL	MARPOL International Convention for Prevention of Pollution from Ships.
MARSIM	International Conference on Marine Simulators.
MET	Maritime Education Training
METIC	Maritime Educational Training Institutes and Centers.
MLIT	Ministry of Land, Infrastructure and Transport, Japan.
MMI	Man Machine Interface
MSS	Marine Systems Simulator
MSTC	Maritime Simulator Training Centre.
NAUTIS	Naval Autonomous Tactical Information Systems
NMD	Norwegian Maritime Directorate.
OBO	Ore Bulk Oil carrier
OJT	On the Job Training
OOW	Officer Of the Watch
OPRF	Ocean Policy Research Foundation.
PMA	Pakistan Marine Academy.
QSS	Quality Standard System.
RADAR	Radio Aided Detection And Ranging
ROC	Radar Observers Course

ROI	Return On Investment
ROR	Rules of the Road
SHS	Ship Handling Simulator.
SOLAS	International Convention for the Safety of Life at Sea.
SPSS	Statistical Package for Social Sciences
STCW	Standards of Training, Certification and Watchkeeping
TVS	Training Valuation System
UMS	Unmanned Machinery Spaces
UNCTAD	United Nations Conference on Trade And Development
USCG	United States Coast Guard.
USMMA	United States Merchant Marine Academy.
VLCCs.	Very large Crude Carriers
VTS	Vessel Traffic System
WHO	World Health Organization
WMU	World Maritime University.

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CHAPTER 1

1. Introduction

The chapter starts with a brief introduction about marine industry and the seafarers, covers the history of marine accidents. Highlighting the need of maritime training and use of simulators in maritime training, the chapter also covers various types of simulators used in training of seafarers. The importance of evaluating training and various methods of evaluating training are also covered.

1.1 Marine industry and Seafarer

The fact that around 90% of the world cargo is transported by ships is good enough introduction to the marine industry. The cargo transported by the merchant fleet over the years has shown a steady increase and hence the number of ships engaged in this important activity of the world economy.

The ship owning pattern around the world, till the 19th century, was that the ships were owned either by the merchant or by the trading company. Liners or what was then called, a common cargo carrier service, was not available. A new beginning was made by a company based in USA on January 5, 1818. On this day an American ship named James Monroe, arrived from New York City to Liverpool. This vessel was owned by the Black Ball Line, and this event went down in the history as the first common-carrier line service on a dependable schedule. This historic event by Black Ball line revolutionised the shipping. They started a regular ship service on that route and cargo which was not the full load capacity was accepted for delivery.

This is marked as the beginning of a new era in the shipping industry. The industry never looked back thereafter, though there have been lots of ups and downs.

The definition of a Seafarer, according to McKay and Wright (2008 is a person who works or has worked in any capacity within the Maritime Industry. Nowadays, seafarers' duties have experienced dramatic transfiguration, responsive to changes in the industry, such as extensive use of containerization and as also transportation under flags of convenience. The competition has altered the way in which seafarers perform and rest. Performance has been restricted to fewer personnel (of Multinational origin), and port stay drastically reduced. ITF in study in 2006 indicates that seafaring as a choice of career, for several youth is nowadays ending. Just about 700000 persons presently work within the shipping industry, and this number is dwindling considerably!

The Industry has seen reduction in manpower, accompanied by drastic changes in infrastructure by the introduction of containerization between the 60's and 70's, thanks to leading Shipping Companies resorting this method of transport; plying their vessels under flags of convenience enable the engagement of seafarers on poor terms and conditions of employment, as also to avoid compliance with international laws which might have limited their activities. Roberts (2000) states that seafaring is a risky job, as personnel involved face several issues which their counterparts in other fields of employment do not….such as, the inability to maintain a regular day to day routine, separation from family and home, performing constantly in the restricted proximity of co-workers, without the privilege of 'taking the day off' for a 'romp in the Park'. This results an alarming increase in accident and associated mortality rate.

Cahoon and Haugstetter (2008) comment that, numerous training and development opportunities be provided to attract persons to seafaring careers, as also retain them there. Such initiatives should enhance the qualifications and knowledge of seafarers, motivating trainees and ratings to advance to officer's level, or prepare them for shore based careers within the industry. The maritime industry will certainly benefit from the availability of numerous highly skilled performers, as also prevent them from being lured away to other professions.

Garlic, Lusic and Pusic (2012) have described that as at this time, the maritime traffic in the world is immense, and on the rise by the day. However as an outcome of that has been an increase in hazards of accidents, downtime due various reasons in the industry especially in areas where the volume of traffic is large, and which reflects significantly on overall output and performance. (By developing the density of traffic the hazards of breakdowns and collisions and the consequences of such circumstances are not enough. The root cause of this type of disasters, more often than not, seems to point toward the severe lack of skilled and competent personnel.

There is a continuing global scarcity of qualified and dedicated seafarers, according to a current study by ISF (International Shipping federation) and BIMCO (Baltic and International Maritime Council). The worldwide provision of seafarers was evaluated at nearly 624000 officers and the present requirement of ratings is 637000. The figure below shows the leading supplier countries of seafarers in the world:

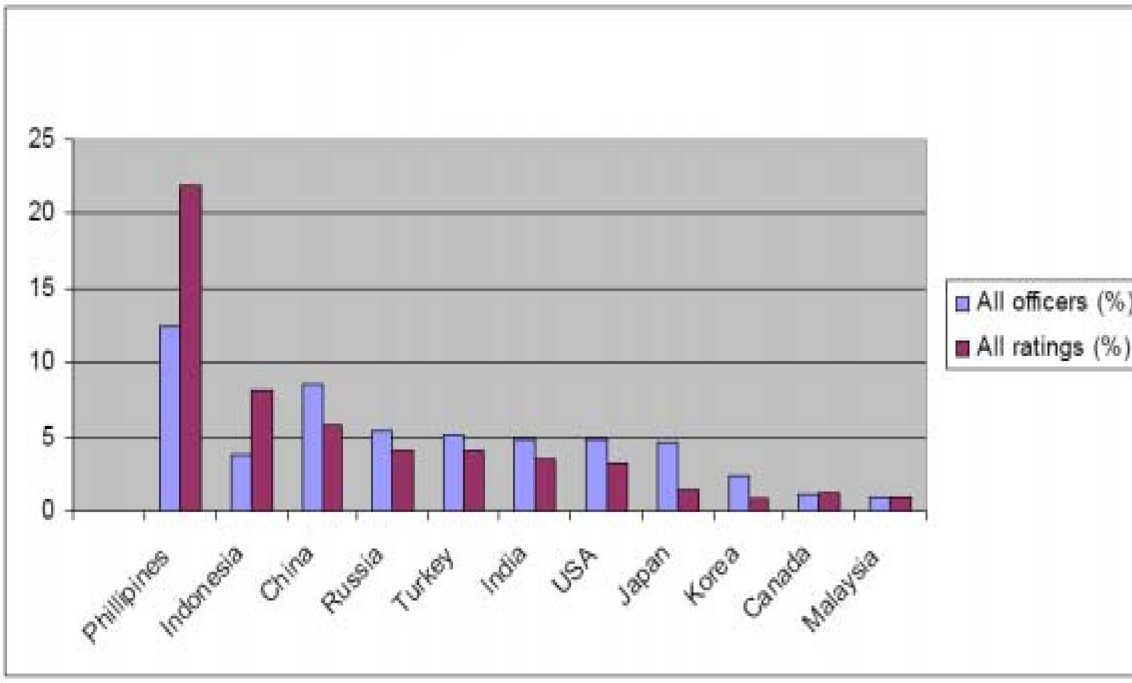

Figure 1.1 Leading Supplier Countries of Seafarer in the World

Source: Garlic, Lusic and Pusic, 2012

Supplementing statistics shown in the figure, confirmation on the same is an APEC (Accreditation of Seafarer Manning Agencies) evaluation that in addition to countries namely Indonesia, Russia, Philippines and China the other large seafarer suppliers are India and Turkey. It can be inferred that the leading sources of Seafarers, are the relatively poor countries. The reason for the decrease of seafarers from developed countries and a growth of seafarers from poorer nations in principally lies on cost of labor costs in those countries. Some other factors which impact the selection of some countries are training, reliability and loyalty, ship distance, rapport between demand and supply, tradition of maritime, statistics of irregularities an accidents during cruise, national restrictions, feasibility of training and education and trade unions (Suplice, 2011).

The industry has been growing at a steady rate as shown in the table below. (courtesy UNCTAD).

“Developments in international seaborne trade, selected years
(Millions of tons loaded)”

Year	Oil and gas	Main bulks[a]	Other dry cargo	Total (all cargoes)
1970	1 440	448	717	2 605
1980	1 871	608	1 225	3 704
1990	1 755	988	1 265	4 008
2000	2 163	1 295	2 526	5 984
2005	2 422	1 709	2 978	7 109
2006	2 698	1 814	3 188	7 700
2007	2 747	1 953	3 334	8 034
2008	2 742	2 065	3 422	8 229
2009	2 642	2 085	3 131	7 858
2010	2 772	2 335	3 302	8 409
2011	2 794	2 486	3 505	8 784
2012	2 841	2 742	3 614	9 197
2013	2 844	2 920	3 784	9 548

Table 1.1 **<u>Developments in International Seaborne Trade</u>**

Shipping industry is considered as highly globalised industry as far as operations and the ownership are concerned. Estimated 67% of the global fleet (in tonnage) is under a flag of convenience, thereby saving on operating costs. The industry is dominated by large vessels and to add to it mergers, acquisitions and strategic alliances are some of the factors which are forcing the industry to cut costs in all possible ways.

This can be inferred from the above that during the period from January 2013 to December, 2014 the growth in this sector was observed to be 4.1 per cent as compared to previous year 2013.The growth of the world fleet was seen at 65.9 million DWT. The annual growth rate, though lower than the previous ten years. This information is sourced from the Review of Maritime Transport 2014.

This growth in the shipping industry requires seafarers who are trained, to take up the challenging jobs on-board different types of ships. Specific types of ships require specific skills for the seafarers to work there and hence specific training. Training is an integral part of the process to prepare the seafarers for the job on-board. The training imparted to the seafarers could thereby divided into two segments, pre-sea and post sea. The training experts would agree that most pre-sea trainings could be imparted without the use of simulators but the post-sea training requires the much needed simulators to train the seafarers once they have gained an experience on-board.

1.2 Marine Accidents

Being a global industry even the accidents are also known to have global impacts. If we look at the recent history (after Titanic) the oil tanker 'Exxon Valdez' ran aground in Prince William Sound, Alaska, on the 24 March 1989. Though there were no human loss in this accident but the pollution to the environment was immense. This was superseded by the Gulf of Mexico offshore drilling disaster (BP) of 2010 in the terms of oil pollution). There have been a series of accidents wherein loss of lives have been high starting from the Titanic till recently (16 April 2014) when the ferry accident, involving MV Sewol in Korea carrying 476 passengers, capsized, resulting in the death of 304 passengers. Though there have been a series of accidents, yet it is heartening to see the trend of the accidents is showing a down trend as shown by the graph below.

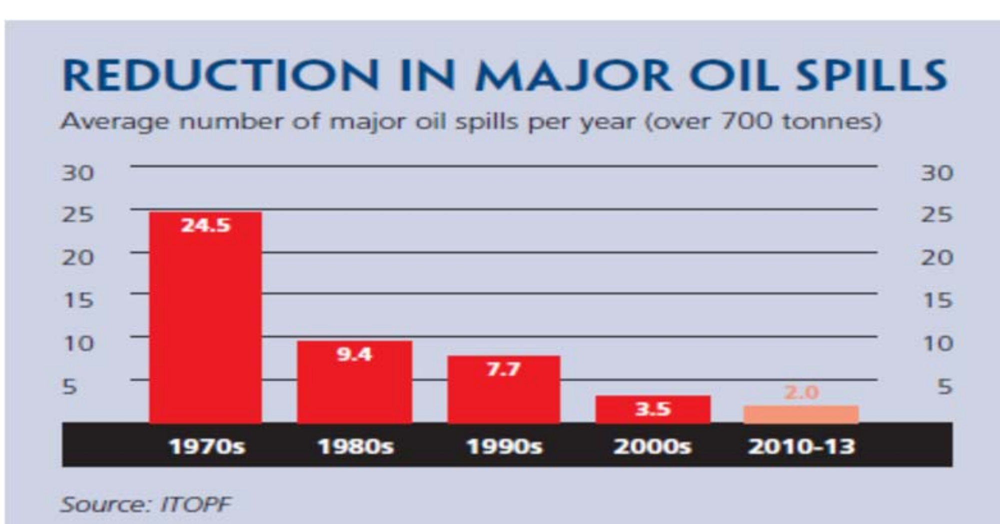

Figure 1.2 Reduction in Major Oil Spills

The graph below indicates the figures of the lives lost on-board and this too gives a good indication that from a peak in 2008-9 the trend seems to be showing a down trend in the year 2013.

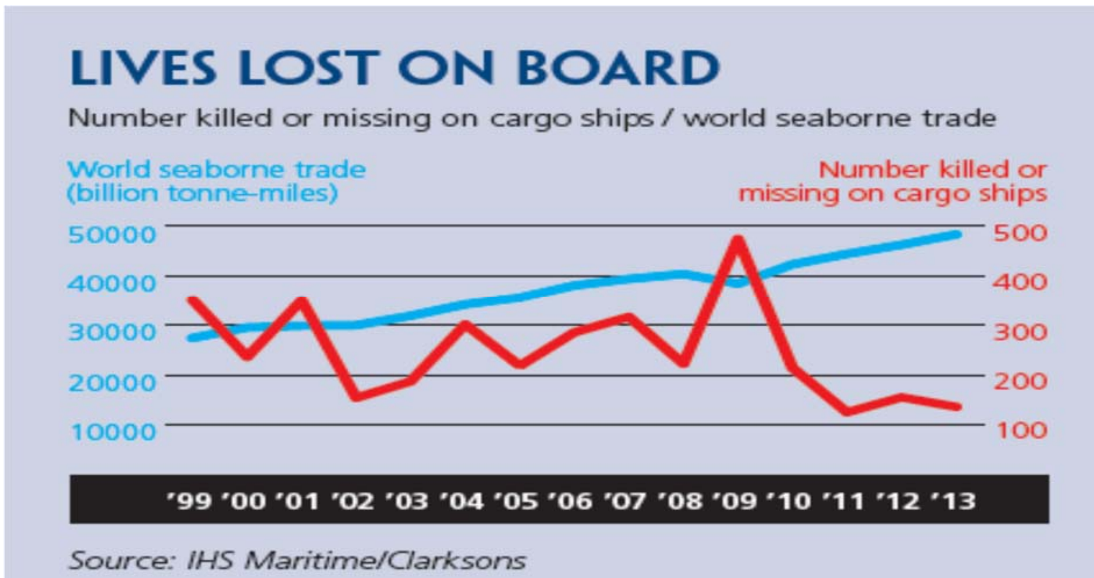

Figure 1.3 Lives Lost Onboard

The graph below shows the trend of maritime casualties on board various types of ships. It is evident that the maximum casualties occurred in the general cargo ships.

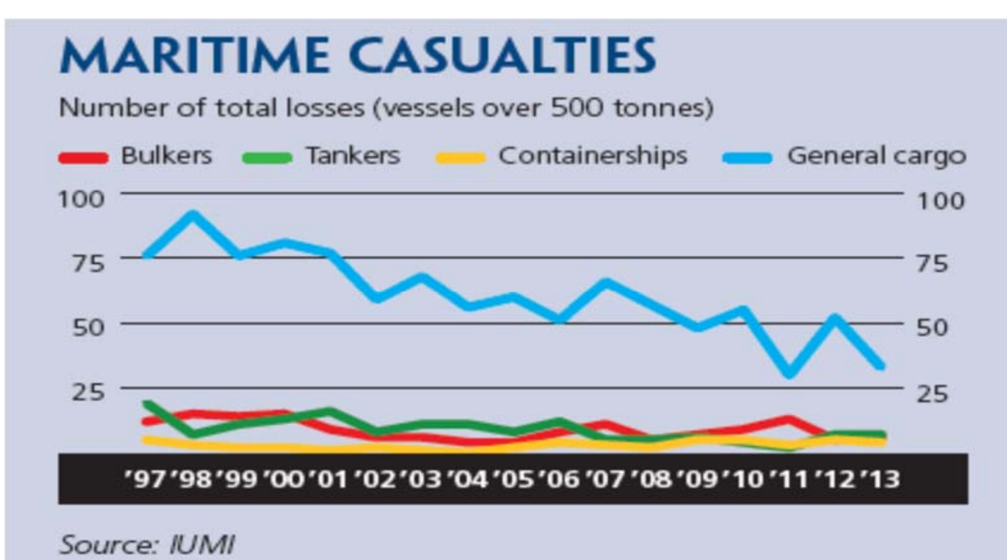

Figure 1.4 Maritime Casualties

According to the report of TSB (2010) statistics, in 2010 nearly 353 accidents occurred in marine industry from 2009 total of 393 and 2005 to 2009 average of 447. During the last 10 years approximately 90%of the accidents in marine industry have been in general shipping field, while the remaining occurred aboard ship. The below figure shows the shipping accidents and aboard ship accidents from 2001 to 2010:

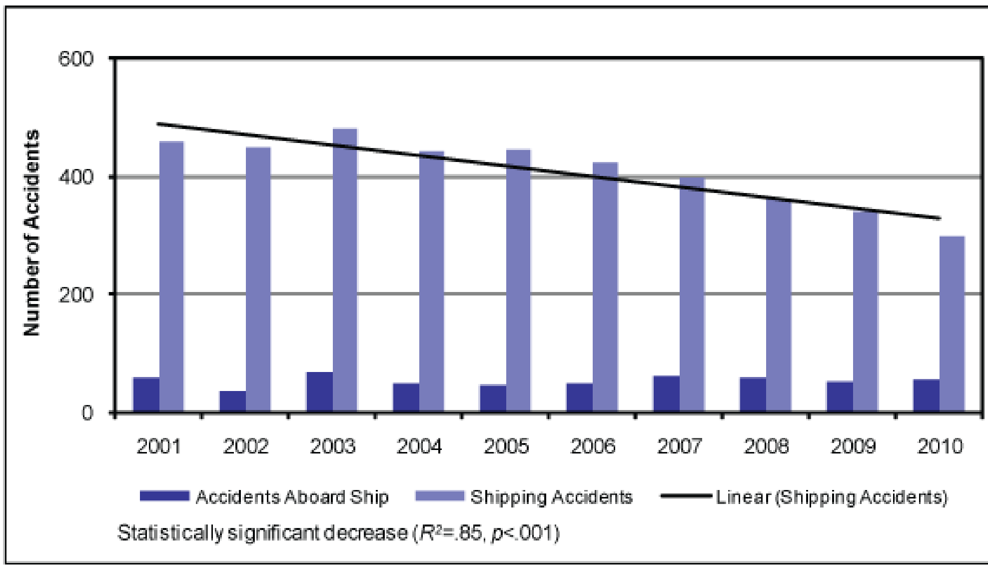

Figure 1.5 Shipping Accidents and Aboard Ship Accidents from 2001 to 2010 Source; TSBC, 2010

From the above graph it can be deduced that accidents in shipping attained a 36 year reduction of 299 in2010 a 12 percent reduction from 2009 total of 341 and a 24 percent reduction from 2005 to 2009 on the average of 393. It can be found from the said graph, that there occurred nearly 52 shipboard incidents, up from 59 in 2009 but reduced gradually from 2005 to 2009 by 54. Most of these accidents occurred on bulk carrier/OBO vessels, bulk/cargo and due to fishing vessels. Another figure below shows the injuries and fatalities occurred in the year 2001 to 2010:

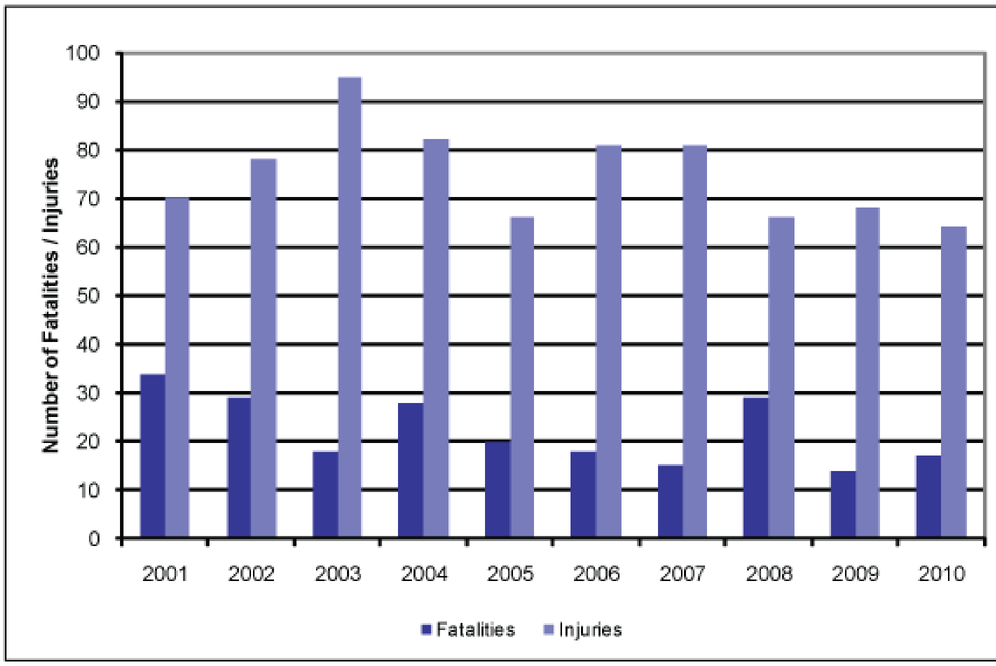

Figure 1.6 Injuries and Fatalities Occurred in the Year 2001 to 2010

Source; TSBC, 2010

From the above figure it may be inferred that the marine fatalities were totally 17 in 2010 reduced from 2009 totaled of 14 and the average of 19 accidents occurred in 2005 to 2009. The accidents occurred due to fishing vessels reported for 7 of 100 fatalities of shipping vessels in 2010. Similarly in 2010 the injuries occurred nearly 64 which decreased from 68 in 2009 and the average of 72 were injured during the year 2005 to 2009. 5 out of 64 injuries outcome from shipboard accidents whereas 11 of them were aboard fishing vessels accidents. The below figure shows the contributing factors for number of accidents in marine industry:

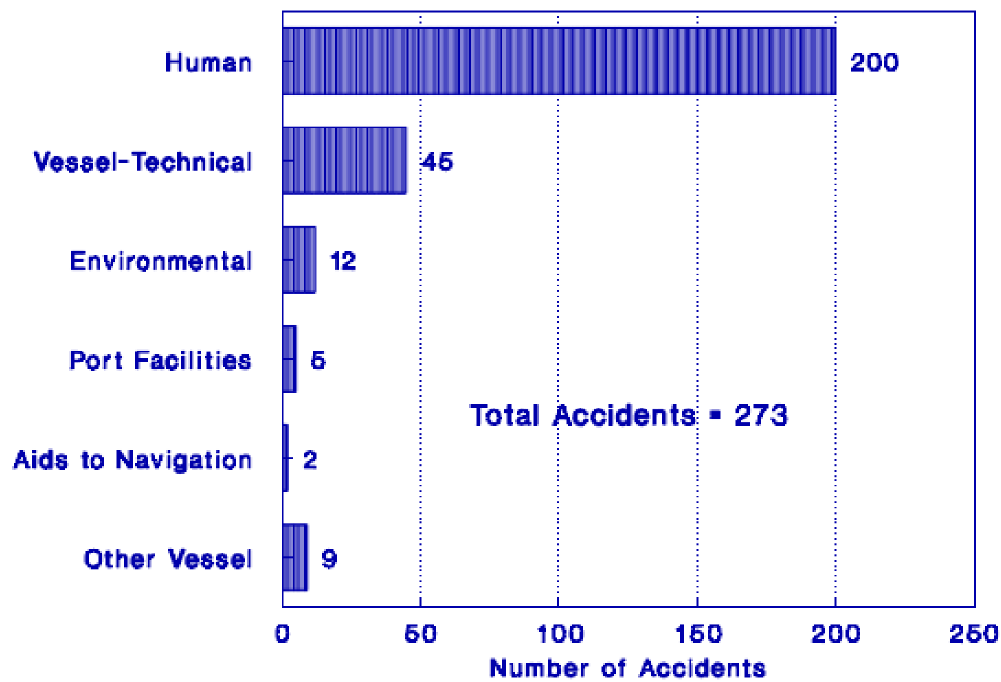

Figure 1.7 Contributing Factors for Number of Accidents in Marine Industry

Source; TSB, 2013

From the above figure it can be understood that a preliminary investigation was conducted in transportation of safety board comprising of a 273 accidents for which the most essential factor contributing to the accidents was recognized in the above figure. Another figure highlights human factor reasons for accidents in marine industry:

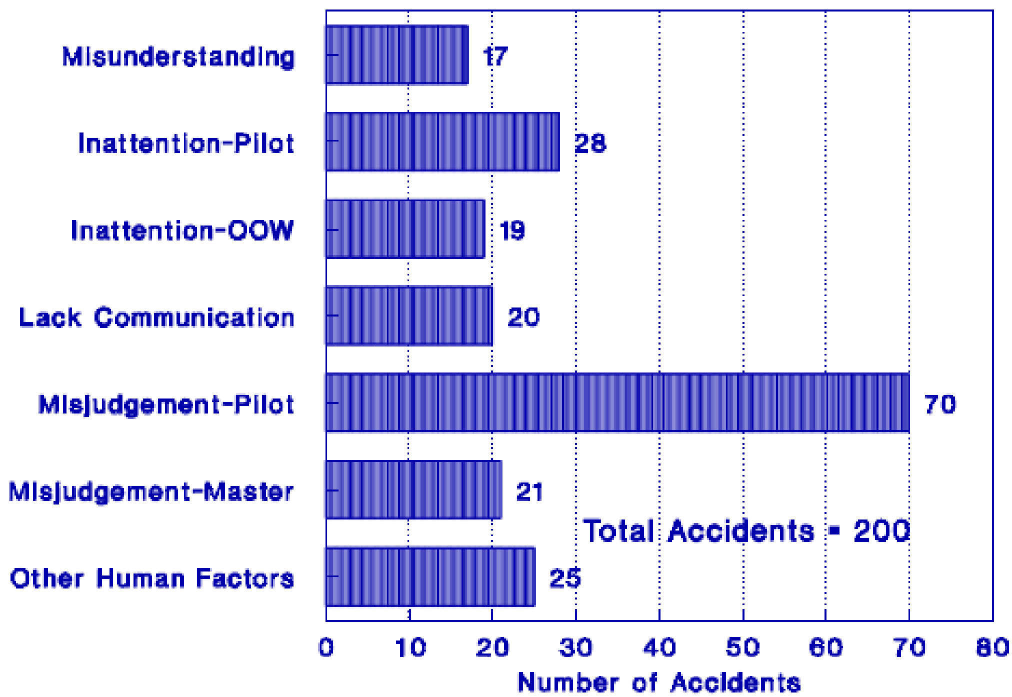

Figure1.8 Human Factor Reasons for Accidents in Marine Industry

Source: TSB, 2013

According to TSB (2013) statistics from the above figure it may be understood that 200 accidents were recognized as human error related, 42 percent (i.e. 82) accidents involved misunderstanding between master and pilot, lack of communication between officer of the watch and pilot or inattention by OOW or pilot. In addition to that 46 percent (i.e. 91) accidents involved misjudgment by master or pilot and breakdowns in teamwork or communication on bridge happens to be involved in several occurrences in marine industry. The greater number of human factors recognized as being related with pilots may not be surprising as in entire 200 accidents the vessels were under the pilot supervision at the time. As an outcome of its preliminary investigation the transportation of safety board determined to learn the practices or conditions which leads to such accidents with a view to recognize deficiencies in safety in marine industry.

1.3 Maritime Training

2015 is a big milestone for the maritime industry. It is a known fact that the majority of the world's seafarers work on board ships which are registered with an administrative authority that is different from the nationalities of the seafarers. International Maritime Organization (IMO) being the overall authority for the globalized maritime workforce have brought out under the Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) certain regulations which highlight the need of training.

The STCW 2010 ‘Manila’ amendments are currently being brought in phases and all this is expected to be in place by end of 2017. As it is, the IMO enforced and instructed all the member countries to ensure that all new seafarers are trained according to new standards with effect from 1st July 2013.

There are different methods to train employees, but it is important to match the training method to the situation. It is imperative that each of the training method used is assessed by engaging the course participants in a feedback process. This aims to ensure that the trainees do get the required knowledge and skills as planned. Then the results from the most sought after take the results from the most popular and most effective methods to design a specific training program.

		Degree of Formality	
		Informal	Formal
Degree of Interaction	Personal	Self-training	E-Learning
	Interpersonal	Peer	Instructor-led

Figure 1.9 Methods of Training

Source: “Methods of training in the workplace by James Danziger &Debora Dunkle”

Different methods are available to train employees, but looking at the training need and the other situations, a suitable method to be adopted to get the best outcome of the training. Any training has to be evaluated to see if the trainees have learnt as planned. Thereafter these results must be taken into consideration to design a specific training programme which may be effective. The simulator based training is one of them and also very widely used and popular method around the world now. All training methods should to be evaluated to find if they are suitable for the situation/organisation/people being trained.

Depending upon the situations, training may be imparted using various methods. The different methods of imparting training are as below.

- Lectures/Class room
- On the Job Training (OJT)
- Learning based on technology and the following method are included;
    - ✓ Training using computer based programs
    - ✓ Training utilising Interactive multimedia e.g. CD-ROM
    - ✓ Use of interactive video DVD or CD.
    - ✓ Training offered using web
- Simulator Based Training
- Coaching/Mentoring
- Training based on Group Discussions & Tutorials
- Role Playing sessions
- Playing Management Games
- Outdoor Training
- Films
- Training based on Case Studies

Training Evaluation

To understand whether the training programme had the desired results or not, the training programme needs to be evaluated. How do you find out that the training imparted was effective? Even if the trainees may be seen leaving the class room and apparently looking satisfied. They also may have given good remarks and high scores on feedback sheets. It may not necessarily be interpreted that the course participants learned from the training programme. It may also be difficult to guess that they may apply what they have learnt. Of course, on face value it may be taken that course participants enjoyed themselves for the time spent in the training session with some of old friends or shipmates. It has been observed and recommended by the experts in the field that only a well-planned, targeted and systematic training evaluation process will help you answer the million dollar question, “Did the participants learn”

There are many models and different ways to evaluate training. The Four-Level Model approach is regarded and used more often to evaluate training programmes and also is used to design new programmes. This process focuses on four levels of training outcomes which are as below:

- Reactions,
- Learning,
- Behaviour and
- Results.

The important issue guiding this type of training evaluation is to determine whether the training had any impact on the participants in terms of their reactions, learning, behaviour, and organizational results.” The training effectiveness matrix used for this study is established on Donald L. Kirkpatrick’s 1959 four-level approach to training evaluation. The four levels being:

- Customer satisfaction (internal and external) – level one,
- Learner performance – level two,
- Training process performance – level three, and
- Returned value – level four evaluations.

The Kirkpatrick model of evaluation provides a good platform to evaluate the training programmes. Kirkpatrick defined the four levels of training evaluation as given below;

Level 1—Reaction

Level 2—Learning

Level 3—Behaviour

Level 4—Results

1.4 Simulators

- What I hear, I forget. What I see, I remember. What I do, I understand. *(Confucius, 451 B. C.)*
- Tell me and I forget. Teach me and I remember. Involve me and I learn. (Benjamin Franklin)

- What we have to learn to do, we learn by doing. (Aristotle)

1.5 What is a Simulator?

Simulation and use of simulators in training has long been utilised in various industries. Medical, defence, aviation, engineering and scientific fields are a few to mention here where the use of simulators is being made as a tool of training.

A simulator, in the simplest way, may be defined as a machine with a similar set of controls designed to provide a realistic imitation of the operation of a ship, vehicle, aircraft, or other equipment. Simulation is essentially a virtual replication of the operation of a system over time. A model imitating the key characteristics or behaviours of the selected physical or abstract system or process developed to achieve the act of simulation. The model is a representation of the system itself, whereas the simulation is a replica of operation of the system over time.

There are three basic attributes that every simulation should have. If all three attributes exist, then you can easily call something a simulation. However, if even one attribute is missing, then it's not considered as a simulation.
These three attributes as mentioned below, are required for every simulation;
A simulation:

a) Imitates something real, but
b) It is not real, and
c) It may be altered by its users (hence instructor plays an important role)

According to Sauvé et.al, (2007) in their article distinguishing between games and simulations: A systematic review. "Simulation is defined as a simplified, dynamic and accurate model of reality that is a system used in a learning context. Through its model, judged by its fidelity and its similarity to the reality it represents, a simulation is distinguished from a game that makes absolutely no reference to reality. These attributes of a simulation are essential to its use in addressing educational objectives and to allowing learners to study complex and real phenomena, which is not the case with a game."

Safahani (2014) has stated that simulation refers to the imitation of actual situation,, state of process or affairs. The simulation act usually entails enacting some major behavioral characteristics of a chosen abstract or physical procedure. Simulators are utilized in several various fields and the use of them in training has proliferated every day, the marine/offshore industry being no exception to the rule.

Simulators offer a superb platform for learners to perform something in virtual world. In the marine & offshore industry there are several good examples of simulators such as engine-room simulators, specific cargo handling simulators and bridge/navigation/communication simulators. These simulators provide the fresher's an opportunity to perform tasks virtually, which otherwise would have been expensive, time-consuming and risky, had they been done in real time. Repetition of wrongly carried procedures corrects errors which would have cost a ton should they have been carried out in real-life situations

.

According to Cieutat, Gonzato and Guitton (2001) numerous training simulators are available in maritime industry, globally. This training/learning initially was restricted to the use of simulators for Radar training for quite a while, before the other simulators were accepted. Nowadays designing a simulator for ships is becoming formidable venture, as would have been designing a flight simulator in the past. A trainee needs to have the complete feeling of being onboard a real vessel with the use of all instruments and systems required for its navigation and operation of a ship; like meteorological environment, a console of controls, a steering system ,a sonar and radar and in addition marine chart visualization software Procedures have also to be practiced in monitoring, operating and maintaining the systems onboard.

Detailing a training simulator in precise aspects brings to the fore the importance of replicating the navigational environment on board the ship. Attention needs to be paid to factors which may lead a pilot or navigator to difficult situations especially unexpected currents and severe sea conditions. It is accounted that the major accidents of maritime are caused by wrong reaction of navigators during difficult situations. The major challenge of designing a training simulator in maritime industry is to regenerate sea conditions from calm to very severe, as near as possible to actual phenomenon.

Looking at the history of shipping over the past forty years one cannot help but notice a quantum leap and phenomenal diversity in technology, procedures followed on board, as also specialization in types of cargoes carried. Categories which once were limited to Passenger vessels, General cargo carriers, dry bulkers, double skinned tankers, and OBO's, today have been extended to container vessels of several sizes, specialized chemical carriers, gas carriers, car carriers, Off-shore activities and what have you!! The net result being, personnel having to familiarize themselves with behavioral characteristics of diverse vessels, operating specialized equipment designed to cater to the specialized trade, communicating and establishing logistics in an environment where every minute costs, not forgetting performing diverse tasks single-handedly, which would in the past been performing leisurely by several persons. Summarily, the advance in deployment of simulators could be understood as follows:

To begin with and a few decades back, Radars and ARPA were the technological big-wigs on board, and along came those simulators, along with the basic ship-handling simulator, which gave the potential Captain a feel at handling vessels of different sizes.

Communications were next to transform; out goes the Morse code, in with Satellites, voice and digital communications. Simulators were designed to get the 'new feel'. Safety procedures were revised, and casualties reduced with group efforts in search and rescue.

Oil!! The Liquid Gold came next. Finding it, tapping it and conveying to facilities for processing became another industry, as also a source of employment. Mistakes could prove hazardous and expensive, and along came simulators catering to practice of this profession.

Propulsion has advanced, with new machinery designed for better efficiency and economy. Backup systems have been put in place to cope with almost every aspect of redundancy. Training established to cope with new procedures. The potential advance is unlimited with no virtual end in sight.

According to Cross (2011) more and varied kinds of simulators are accessible to a big number of training providers as a basis for quality equipment for the purpose of training. Maritime simulator training initiated as ship and radar simulations due to technological advancement and complexity of these new training aids and the requirement to movements of research vessel and reactions in a very economical way as compared to using a real ship for this purpose. The ship handling and radar simulators are the most widely used and well known type of simulators but it is really good to know what different kinds of equipment and activities have become good tools for a system of maritime training simulator. This also need that latest technology simulators may be installed and used for training.

Veritas (2010) has indicated other types of marine simulators which can be used in the industry namely GMDSS equipment trainer/communication procedure, navigation equipment trainer, Navigational equipment and Automated radar simulator, radar simulator, inland waterways simulator, dynamic positioning simulator, propulsion plant trainer, ship handling simulator without/with image generation/motion platform, crane handling simulator for safe and efficient transfer of material, fisheries simulator, rescue and search management trainer, cargo handling trainer, vessel traffic management simulator, oil spill management trainer, drilling technology ,trainer for ballast control , steam generation plant trainer, simulator for dredging ,trainer for refrigeration plant, electrical power trainer and simulators and trainers for various offshore activities.

Van Maanen and Sarvaas (2009) have described technology as progressive; new systems related to the industry as well as built-in techniques of simulation are being made available with regularity.

1.6 Simulation in India and Global Maritime Industry

Like other fields of training, use of simulation in the marine industry is influenced by multiple factors which obviously include technological, financial, suitability and training needs of the time. Some of these factors are as discussed in the following lines;

- Due to technological advancements different types of ships may be simulated together in one simulator; hence simulation technology is available for multiple ships operations at a reasonable cost.
- Familiarization with modern equipment fitted on-board ships is possible by using simulator.
- In purpose built simulators, a trainee can feel and learn ashore the activities he is expected to undertake on-board the ship, before joining a ship.
- Real life simulation; complete range of the system fitted on-board ship can be simulated with purpose built equipment and scenarios.
- Training sessions may be planned as per the availability of the simulators considering time and space factors.
- A student can run and speed up his ship on simulator as per training requirements without worrying about fuel cost or time constraints (Thereby learning a lesson to save fuel when needed in real voyages).
- Training scenarios including and beyond ship's safety are possible, like close quarter situation, excessive turns and high speed manoeuvring.
- Conditions and environment in a simulator can be repeated again and again to improve the learning outcome of training; unlike ships where all situations are new ones and no repetition is available.
- Simulation gives chance to apply the theoretical concepts to demonstrate their practicality; for example, operation in shallow water effect area or modification of the entering / leaving harbour route plan can be tested on simulators.
- One can choose his area of operation for maximum training value and increasing confidence and morale of the trainees. For example, trainees

can learn and practice two different areas/channels/related operations in same day training schedule, which is not possible in real life.

- Different types of ships are available on simulators for practicing and operation by the trainees. They can actually feel the difference between behaviour of different size general cargo ships and crude carriers i.e. VLCCs.
- The exercises, learning and performance on simulators can be recorded and played back to the trainees for carrying out analysis, providing feedback and pointing out mistakes done during the exercise, thus making this a unique learning opportunity.
- A trainee can change over the exercise or run the exercise at a pace suitable and demanded by training requirements and time constraints.
- The set environmental conditions in simulators are known and repeatable. This makes it possible that performance in these conditions can be graded and assessed with uniformity.
- The instructor/student has a facility so that exercises can be stopped and delayed so that particular learning points may be emphasised by the instructors.
- For propulsion and auxiliary machinery, where UMS operations are almost a requirement, it is frequently difficult for the staff to achieve sufficient familiarity with even routine operations. Many voyages may bring out some of the peculiar fault conditions one has not experienced before. By using simulators one can train the ship's staff to go through these experiences.
- By using a simulator, for training OOW and bridge team, one can manipulate weather conditions and visibility with day / night operations for real time experiences and training.
- It is possible to develop situations using simulators which are much more complex and grave when compared with real ship operations. Such situations are difficult to create on-board ships and when they occur, it's difficult to handle the same.

- With the simulators, it is possible to design tailor made courses, e.g. introduction of ships operation to new comers or specialized course for Pilot operations.

1.7 Global Maritime Simulator Training Practices

With the indications provided within STCW 1978, to use simulators as a means to demonstrate competence. In the marine simulator world there have been on-going efforts in the past for classification of simulators being used in the maritime and offshore industry, which can now possibly be applied. According to Stephen J Cross, “The revision of the International Maritime Organization’s (IMO) training Convention (Standards of Certification, Training and Watch keeping for Seafarers STCW 95) has had a considerable impact on the types and extent of training and education and subsequently on the training equipment used”.

The maritime and offshore industry world over have been using the following types of simulators to train the seafarers;

- Ship handling or
- Bridge Simulator
- Simulator for engine room operations
- Ballast control and cargo simulators
- Communication simulators
- Global Maritime Distress Safety System(GMDSS) simulator
- Vessel Traffic System (VTS)
- Dynamic Positioning
- Anchor Handling
- Tug/Escort
- Crane & Winch
- Crisis/Security
- Trainer sand simulators for search and rescue,
- Simulator for Oil spill management,
- Propulsion simulator,
- Simulator for Steam plant

- Electrical power generation, distribution simulator,
- Dredging ship trainer,
- Offshore process simulator,
- Drilling technology simulator
- Simulator and trainers for Refrigeration plant ,
- Cargo handling simulator ,
- Simulator for Ballast control system,

(Source: IMO, STCW 2010, Kongsberg, SJ Cross)

History of Simulators

1959	Radar Simulator.
1965	Radar and Navigation Simulator.
1967	Simulator for Ship Handling
1976	Liquid Cargo Handling Simulator.
1980	Engine Room Simulator.
1992	GMDSS Simulator.

Table 1.2 History of Simulators- Source (Muirhead, 2003)

Classification of simulators in details.

Single Task	**Multi-Task**	**Full Mission**
Work Station with single instrument • Radar / ARPA • GPS / SATNAV • Rules of the Road	(limited fidelity) (medium cost) • Systems with control accessories • Bridge (with helms, engine control, limited visuals, equipment) • Engine Room (with simulated panels) • GMDSS Simulator • Liquid Cargo handling simulator (LCHS)	(high level of fidelity) (higher cost facility) • Ship handling including berthing capability • Main engine and auxiliary operations • Visual navigation with full manoeuvring • Emergency response training • Teamwork management

Table 1.3: (Source: Muirhead, 2003)

The configuration of simulators will depend upon its use and application and may be delivered in the following configuration/s;

- Stand Alone simulator
- Instructor Led Simulators
- Task Specific simulator
- Multi task simulator
- Full Mission simulator

1.8 Stand Alone Simulator

The Stand-alone Simulator permits exploring the entire range of functions of a simulated system. Of course it does not have the facility for the instructor to have online access to the stand alone simulator. However the instructor can pre-plan the tasks/exercises which the student then can perform.

For example, a Stand-alone KPOS DP Simulator from Kongsberg can be used to conduct varied operations, test the operational condition, and imitate the vessels characteristic response to different environmental conditions for on board training based on varied weather forecasts. The Stand-alone KPOS DP Simulator can also define desired operational situations, save and recall sets of simulator set-up data, be programmed with the voyage commence position, course, sea water depth, the vessel's draught ballasting, simulated environmental conditions e.g. wind speeds, waves and current, status of the thruster's power bus and generator switches – basically use all the operational modes and functions of the simulated vessel/system. Other features of the standalone simulator depending on the version purchased are pipe-lay operations, simulation of the mooring system, single and multiple risers, simulation of anchor winch operations, simulation of a break in one or more of the anchor lines, simulation of failures in the thrusters (by disconnecting thrusters).

Another example of standalone simulator is Transas ERS SOLO which is a stand-alone engine room simulator. This solo ER simulator has all the functionality of the other simulators which are networked but it doesn't have real controls and online instructor functions. All the controls are simulated. The instructor can perform various settings but this possible only when the simulator is offline. The simulation includes vessels power plant, propulsion system, including a two stroke engine or a four stroke engine. This simulator can effective provide low cost training solution for initial training and also mid-career refresher training for engineering officers onboard or ashore.

1.9 Instructor Led Simulators

Most STCW compliant marine training simulators are required to have an instructor station. The instructor, using the settings on the instructor station can monitor the trainees' action and decisions while they learn using the simulators. The instructor station may also be utilised as an effective tool to carry out action review and end of the exercise review and feedback. Most simulator suppliers of the marine field have provisions of supplying an instructor station, which can provide access to various kinds of simulators.

The configuration of the Instructor Station consists of displays on which the outside view and navigation screens of the trainee are duplicated in real-time. With the Exercise Manager component, the instructor can also carry out a range of tasks:

• Prepare an exercise. Select a training environment, and add one or more vessels in it, using the easy
drag-and-drop interface. Set the weather conditions and time of the day.

• Save exercises for later use

•The NAUTIS Instructor Station has both a 3D bird's eye view of the environment and a 2D chart view.

•Assign trainees that are logged into the exercise to one of the vessels

•Start, pause, record or stop the exercise.

During training/an exercise, the instructor can perform the following actions in real-time:

•Change the weather, visibility and time of day

• Show a trail of all the ship movements

• Shift any of the vessels to a different position

•Add new target vessels or other structures, and set their position, speed and direction, or add them to a complex track

• Change the track of the target vessels, structures and helicopters etc.

For an example an Instructor-Led simulator course curriculum may include some or all of the below mentioned features

- Orientation Courses
  - ✓ Course Purpose
  - ✓ Course Overview
  - ✓ Administrative Requirements
  - ✓ Safety Information
  - ✓ Operational Profile
  - ✓ OSV Familiarization
- Firefighting& Damage Control/

- ✓ Basic Damage Control
- ✓ Safety Precautions and Hazards
- ✓ Damage Control Organization
- ✓ Damage Control Communications
- ✓ Firefighting Fundamentals
- ✓ Portable Firefighting Equipment
- ✓ Battle Damage Repair
- ✓ Compartment and System Isolation
- ✓ Portable Dewatering Equipment
- ✓ (CO_2) Carbon Dioxide Fixed Flooding System
- ✓ Fire main System
- ✓ (PPE) Personnel Protective Equipment
- ✓ Fire Alarm and Detection System
- ✓ Damage Control and Firefighting Familiarization
- ✓ Firefighting (MFFT) Simulator

1.10 Task Specific Simulator

A task specific simulator is used to simulate and impart training for a particular task. For example if only PPE training needs to be imparted on a certain group of employees and the company doesn't want to invest in an expensive simulator, a task specific simulator for PPE can be used. Many simulator suppliers have a product line of task specific simulators.

1.11 Multi Task Simulators

A multitasking simulator can be used to impart training for a group of complex tasks/activities. An example of Navigation simulator as given below shows that a plenty of tasks may be simulated by using a relatively complex simulator; an example below is that of navigation courses;

- Navigation Courses

  - Introduction to Navigation
  - Compasses
  - The Nautical Road
  - Dead Reckoning, Piloting, and Electronic Navigation

- Ship's Bridge and Equipment
- Dynamic Positioning System
- Navigation Simulation
- Navigation Shipboard Familiarization Training

1.12 Full Mission Simulator

A full-mission simulator (FMS) replicates for an example, the mission environment the aircraft will operate in. Based on inputs from experienced pilots, available handling characteristics of actual aircraft taken from the logged data of actual flights. The simulator creates motion, sounds, visual topographical scenes, instrument layout and all other systems in order to emulate a virtual flight training environment. Trainee aircrew will have a platform on which to develop an expertise in landing, take off, day and night flights, formation flying, and weapons delivery besides cockpit familiarization in normal, adverse and emergency situations. To broaden the training horizon several full-mission simulators are integrated to work with other simulated systems to create distributed mission operations environment so that services such as military forces may train as they fight – so to speak.

Similarly the FMS for a marine tasks for an example Kongsberg's Polaris simulator which is capable of simulating a total shipboard bridge operation situation, including the capability for advanced manoeuvring in restricted waterways. Advanced tugging with ship-to-ship interaction, ice, effects of tug/winches etc. A further option this type of simulator may include interface to a full mission Engine Room Simulator (ERS). This will enable a total training capability.

Figure 1.10 An Example set up of Full Mission Bridge Simulator(Courtesy: Bibby Ship Management)

1.13 Training Evaluation

Training evaluation is considered a critical component of analysing, designing, creating and setting up an effective training curriculum. To understand whether the training programme had the desired results or not, the training programme needs to be evaluated. How do you know your training was effective? Even if the participants leave the training room looking happy and they also give high scores on an evaluation or feedback sheets, it may not necessarily mean that the course participants learned or if they can apply what they learned to their job. Of course, it may be taken that course participants enjoyed themselves for the time spent in the training session with some of old friends or shipmates. Only a systematic, targeted approach to training evaluation will help you answer the question, did participants learn?

There are many models and different ways to evaluate training. The Four-Level Model approach is most often used to evaluate training and development programs (Kirkpatrick, 1994). It focuses on four levels of training outcomes: reactions, learning, behaviour, and results. The major question guiding this kind of evaluation is, "What impact did the training have on participants in terms of their reactions, learning, behaviour, and organizational results?"

Listed below is the four-level approach to training and evaluation, a work of Donald L. Kirkpatrick in 1959 (Appendix A) used for the study in evaluating the effectiveness of training

- Customer satisfaction (internal and external) – level one,
- Learner performance – level two,
- Training process performance – level three, and
- Returned value – level four evaluations.

The Kirkpatrick model of evaluation provides a good platform to evaluate the training programmes.

1.14 Kirkpatrick's Model - Four Levels of Evaluation

Donald L. Kirkpatrick described his approach to training evaluation in a chapter titled 'Evaluation' in three editions of the Training and Development Handbook; (1987, 1976, 1967). In these chapters he stated 'nearly every one would agree that a definition of evaluation would be the determination of the effectiveness of a training programme' (1987, p.302). His four steps have since become commonly known in the training field as: Level One, Level Two, Level Three, and Level Four Evaluation. The table below indicates these four levels of evaluation. Following the table is a brief description with suggested guidelines in evaluation of training at each level, as discussed by Kirkpatrick in the 1987 edition of the Training and Development Handbook.

Levels	When to find?	What to know?
1. Reaction	Upon completion of the course	Did they like it? How well did participants like the programme or course?
2. Learning	Upon completion of the course	Did they learn it? What principles, facts, skills and techniques were earned? What attitudes were changed?
3. Application/ Behaviour	After training	Did they use it? What changes in job behaviour resulted from the programme?
4. Results	After training	Was a tangible business result achieved? Did the tangible results of the programme result in cost reduction, improvement in quality /quantity, etc.

Table 1.4: Four Levels of Kirkpatrick

1.15 Level One: Reaction

Kirkpatrick defines this first level of evaluation as determining "the extent of liking a particular training programme by the trainees"; "measuring the feelings of trainees"; "measuring customer satisfaction". Kirkpatrick set the following guidelines for evaluating reaction:

- Determine what you want to find out.
- Use a written comment sheet covering those items determined in step 1.
- Design the form so that the reactions can be tabulated and quantified.
- Obtain honest reactions by making the forms anonymous.
- Encourage the trainees to write in additional comments not covered by the questions that were designed to be tabulated and quantified.

Kirkpatrick also suggested that evaluating the reactions of trainees may not be sufficient alone. It should be complemented by talking to the programme coordinators, training managers, and wherever possible other qualified observers' may also form the team to evaluate the course. This combined approach is more likely to give better results to evaluate the effectiveness of a training programme the first level.

1.16 Level Two: Learning

According to Kirkpatrick learning may be defined as an amendment in attitude with having acquired knowledge and skills. The guidelines as defined by Kirkpatrick for evaluating learning are as follows:

- Aim to measure the learning of each trainee.
- A before-and-after approach may be used so that relating the learning to the programme becomes easy.
- Though difficult in a marine environment, Kirkpatrick recommends that whenever practical the amended attitudes of a trained group through having acquired knowledge and skills should be compared with a controlled group that has not received training.
- Kirkpatrick also emphasised that where practical, a statistical analysis of the evaluation results be utilised to evidence that learning can be proved in terms of correlation with thelevel of confidence that trainees exhibit.

In addition to conventional methods of written, oral and practical hands on examinations a programme if meticulously designed could be used to make a fair and objective evaluation of learning, while the training session itself is in progress. Evaluation techniques could also be based on assessing the level of skill transferred to a trainee following a practical and oral examination in a role-playing situation.

1.17 Level Three: Behaviour (The Transfer of Training) Lacuna

Realizing that a lacuna may exist between skills acquired during training and actual application of those skills while on the job Kirkpatrick recommends that the following five criteria must be met for change in behaviour to occur:

- Desire to change
- Know-how of what needs be done and how to go about it
- The right job climate
- Help in applying what was learned during training
- Rewards for changing behaviour

Kirkpatrick outlines the following guidelines for evaluating training programmes in terms of an improvement of skills:

1. A systematic assessment of an "on the job" performance prior to and after training should be made.

2. The assessment of the "on the job" performance should preferable be conducted by one or more assessors from amongst the following:

    - The trainee
    - The trainee's supervisor or superiors
    - The trainee's junior (if any)
    - The trainee's peers or other personnel thoroughly familiar with the trainees past performance

3. A statistical analysis of the pre and post knowledge and skills of individual trainees should be compiled in order to determine the effectiveness of the training programme.

4. The post-training appraisal should be conducted a few months after the training so that the trainees have an opportunity to practically apply the knowledge and skills acquired during training. Subsequently further appraisals may be conducted to add to the validity of the study.

5. A group not having received training should be used.

Kirkpatrick observed that keeping a statistical analysis of a trainee's improvement in knowledge and skills subsequent to training involves a laborious and time consuming process. It however is worthwhile if training programmes, as a result are going to increase in effectiveness and their benefits of such programmes are made clear to clients. Kirkpatrick also recognizes that not many training managers have the background, skill, and time to engage in extensive assessments, in such cases he suggests they call upon specialists, researchers, and consultants for advice and help.

1.18 Level Four: Results (The Benefits of Training to Business)

Most training programmes are aimed at improving human/organisational performance. Based on the premise that most training programmes are designed to cater to achieving a reduction in cost, an increase in production both in terms of quality and quantity, an improvement in efficiency of the work force, a reduced turnover in manpower, improved morale in the work force, reduced grievances both from the work force and clients Kirkpatrick observed that "it would be best to evaluate training programmes directly in terms of results desired". On account of the several complicating factors involved that make it hard to evaluate some kinds of programmes in terms of results he recommends that training managers evaluate the programmes in terms of reaction, learning, and improvement in skills prior to considering tangible business results. He also cautions that due to the difficulty in the separation of variables — that is how much of the improvement is due to training as compared to other factors, it is very difficult to measure results that can be attributed directly to a specific training programme.

From Kirkpatrick's experience with Level Four evaluations, he surmises that in order to measure results, evaluations conducted through a personal interview is preferable over evaluations conducted through written questionnaires. Furthermore assessments pre and post training can provide some evidence (not necessarily proof) that the results achieved are directly attributed to the training although other factors might have influenced the result.

A variety of training programmes may use the three evaluation patterns listed below.

(1) Written exams: Written examinations may be utilised to evaluate each of the training programmes. However, such examinations are best suited to measure knowledge and rarely a development in skills.

(2) Oral exams: Oral examinations can be used to evaluate each of the training activities; however, they are more appropriate for settings, which include hands-on training activities. Oral examinations are the best

evaluation methods to measure communication skills, and to test attitudes as well as higher levels of knowledge; and

(3) Performance exams: Hands-on-the-job, simulated or otherwise may be used to evaluate skills, as they are best suited to measure actual performance to job specific needs.

For this study, the primary data was collected using questionnaire specially designed and based on Kirkpatrick's' model.

1.19 Epilogue

This chapter discussed the brief introduction about marine industry, the seafarers and marine accidents. Highlighting the need of maritime training and use of simulators in maritime training, the chapter also covers various types of simulators used in training of seafarers. The importance of evaluating training and various methods of evaluating training are also covered. Various methods of training evaluation are briefly described. The evaluation method base on Kirkpatrick's model is highlighted and the four levels therein are explained.

CHAPTER 2

2 Literature Review– Introduction

This chapter reviews work related to effectiveness of seafarer training using maritime simulation done by several researchers. This chapter has discussed benefits, challenges and types of maritime simulator the importance of seafarer training using simulation, issues faced by seafarers and effectiveness of seafarer training through simulation and finally future scope of maritime simulation in seafarer's training.

2.1 An Overview of Maritime Simulator

According to IMO (1994) "the development in electronic industry has strongly impacted the application and development of simulators for marine related objectives of training. Several varied kinds of simulators are becoming accessible to vast number of users as a foundation for quality training needs". A simulator can be explained as a device that equivalents real world perspectives. The process of using simulation identifies entire classic advantages such as risks related with actual systems operation, avoidance of damage in case of an accident and or injury and avoidance of high costs. ,. Simulators are known to be repeatable and can simulate rapid activities. Rooij and Van (1992) have described that simulation is a practical following in real time of marine handling, navigation and radar, ballast/cargo, propulsion or other ship system incorporating an interface applicable for innovative use by the candidate or trainee either outside or within the operating surrounding and complying with standards of performance.

Maritime simulator is a platform or device which simulates the operations predicted on-board merchant vessels and in operational activities. Marine simulators offers real life training of operation, comprehensive effects of environment and produce different faults in system assuring training using team procedures using visuals for higher realism.

According to NTS (2011) “Maritime simulators can be utilized to handle the complete environment of maritime industry. The fidelity of simulators can differ from 360 degrees complete mission simulator to a desktop workstation”. In the Deck officer’s education, simulators are used to manage skills according to Standards for Training, Certification and Watch keeping (STCW) Convention. Advanced operations of ship like maneuvering in ports, with tug support close to platforms involving interaction with other stations of land and ships can be handled on a bridge simulator. Marine simulators are used for fairways and harbor design as well as for ship modeling. For marine industry the simulator is required to simulate for different types of vessels depending on the specific operation carried out by the vessel..

2.1.1 Benefits of Maritime Simulator

According to Tanker Operator (2007) “the benefits of maritime simulator are obvious however there are some barriers. It permits a seafarer to acquire essential competence, underpinning skills and knowledge to qualify as an officer in a similarly small time period.” Simulation driven assessment and training based on computer enhances training to be provided in marine industry. To enhance the number of expert seafarers it is essential to establish an extensive training, examination, education and certification system.

All maritime training has been concentrated on technical skills of individual in ship handling and navigation. Now it is identified that this knowledge must be accompanied by management and leadership skills. The major benefit of having simulator training to seafarers is to lower the hazards of accidents. Dankjaer (1992) has stated that “the maritime simulators were the result of new development in and automation which made new requests on maritime training and education". STCW1978 Convention became out dated due to the major reason of qualification based on paper. Trainee was needed to undergo the instructions of classroom and then sit in some written exam. Fact exists that modifications were requested and new competency tests and the way it can be revealed by a trainee. It is acknowledged widely that most of the casualties or accidents at marine industry are affected by human error. Simulators are the best source to reveal the seafarer's competency individually as well as when comprising a group working onboard ship. Muirhead (2003) has mentioned that "inexperienced marine professions are likely to make judgment mistakes early in maritime training.

The effects of such mistakes could be expensive and at times catastrophic". In such situations the maritime simulator is considered a very helpful and beneficial tool. Learning using simulators could be an experience wherein the trainee could make mistakes and learn without having to worry about the consequences. The idea while running the exercises is mainly to learn so that under similar situations onboard, the mariner is now prepared in advance to initiate an action which he/she has practiced in a not so demanding environment.

At the end of exercise, the simulators can also give the all-important feedback to enhance the onboard performance of the trainee. Simulators also help the trainees to carry out some of the activities by simulation, which in real life cannot be carried out and learnt by practically doing it onboard a ship or in real working environment. Activities like break down, maneuvering in critical conditions, emergency procedures or geographical places which may be difficult to practice onboard are available readily on maritime simulators. The simulators, when used properly assisted by experienced and well trained instructors, can be a very useful tool in acquiring the knowledge for safe operations.

The trainees get the much needed confidence by handling the simulated scenario by themselves and preparing them to undertake their tasks roles and functions. This should result in acquiring better capabilities without exposing themselves to real hazards.

Chaturvedi (2006) has described that "the distinct opportunity of facing a real life crisis in safe surroundings of a simulator has several benefits for training experts versus typical classroom process or even methodologies of on the job training". The simulation surroundings permits individual to be exposed to circumstances which the seafarer may rarely have the chance to face in real life where he is capable to integrate the technical knowledge with practical skills application and perhaps most essentially where seafarer has to feel the experience and engage essential soft skills to handle the situation effectively.

Benedict (2000) has stated that "to acquire maximum advantage it is essential that individual who faces maritime simulation programme has to move through an internal realization process, change and acceptance". To ensure this, the environment, surroundings and an ambience of understanding each other and that of trust is required to be developed between participant and facilitator. In soft skills terms a carefully designed exercise of simulation can support in evaluation of a range of skills involving command clarity, leadership, abilities of communication, situational awareness, tasks prioritization, efficient delegation, capability to plan ahead, techniques of problem solving, anger and stress management, communication abilities and response to unexpected emergencies and situations.

Another benefit mentioned by Kongsberg (2011) is that "maritime simulator is beneficial in educating best personnel. A maritime simulator provides a much structured process of enhancing greater competence levels compared to conventional training". During simulation training one can freeze and separate every sub system to perceive and gain knowledge, carry out difficult operations repeatedly and enhance attitudes by training on difficult operations requiring composite decision making. Through the use of progressive assessment systems maritime simulation training can help to separate areas needing development and assist the improvement of tailor made practices for day to day as well as critical operations. In this way, maritime simulation will concentrate on the process to ensure that the seafarers acquire the best so that the safety of operations is ensured.

2.1.2 Challenges of Maritime Simulator

According to Fisher and Muirhead (2006) “the offshore industry has numerous challenges to produce and develop new simulator designs. To exist in the market, competitive organizations must develop quality simulators”. In face of enormous worldwide pressures of pricing, shipping industry turn to technological innovation to set up a niche and remain ahead. One of the major challenges of maritime simulator is the burden of finance that ship owners have on the budget of training and the computer software related to simulation depend on this simulators aspect for their occurrence.

Leading manufacturer of these programs of simulation are Kongsberg, MarineSoft, Sindel, SSPA, Seagull, Transas and Poseidon. In Indian scenario Applied Research International (ARI) is doing very well and has supplied quite a few marine/offshore simulators in India and also to many other countries.

The high end simulator software not being affordable to many ship owners and training providers has compelled the leading manufacturers of simulators to develop relatively less expensive systems in parallel. These computer based software / simulators have the entire simulation components but the major Man Machine Interface (MMI) element and the sense of job on real ship is not experienced. This makes them less acceptable for high end training or for the training of senior seafarers. It can be seen from the market that the desk top simulators without the MMI are best suited for basic training purposes. To simulate the higher levels of environmental and other variables, this needs to be upgraded by adding MMI and the required features.

Similarly Kongsberg (2010) stated “competence is a challenge in maritime simulation because for offshore vessel operators and owners, competency is the key to reliability, economy and safety”. Safety lowers the risk hazards to ship personnel and reduces the hazards of harm to surroundings and the environment. Reliability reduces the ever increasing cost of being off hired. Well trained and competent personnel contribute to the economy and efficiency of marine operations. Onboard training using original equipment presents numerous challenges such as developed hazards to ship equipment and ship personnel. Restricted access to costly properties of marine and greater cost of offshore training are affecting customers to turn highly to maritime simulation technique as a cost efficient substitute. Thus by using currently available solutions of maritime simulation, personnel competence can be accomplished in a protective way with larger flexibility of scheduling and scale economies.

Rudrakumar (2004) has pointed out “another challenge of maritime simulator is fidelity problems. The fidelity problems in maritime simulator were the effects of visuals produced in ship handling simulators.” The effects of visuals were far from original in display lacking in movement of objects and sound system were very poor. The shipping industry simulation providers must take proper steps to assure fidelity and it must be undermined completely by effects of visuals having more artificiality.

Of course, thing have changed since then for better due to the technological advancements. This has helped the producers of the simulation equipment to make use of technology to cater to the requirements of fidelity. Simulation these days, can offer 360 degree views of panorama of ultra-realistic images in both night and day modes with different weather conditions and visibility. All these issues in a way may be handled by On the Job Training (OJT) and with effective sound and visuals so that maritime simulators can sink comfortably into a mood of actual performance on the ship’s bridge at high seas. Bailey, Ellis and Sampson (2008) have mentioned another challenge of maritime simulator training as the introduction of new techniques onboard many vessels. Such technique is introduced and designed with the purpose of developing safety and supporting in operation, navigation and maintenance of vessels. However improper utilization of such technique may lead to or unfamiliarity which can cause major accidents and dire consequences. The introduction of new technique often poses a challenge to operational personnel who are familiar with other ways of performing these tasks and often get too used to that particular way. Occasional accidents may be anticipated in such situations. However well delivered and well-designed maritime simulation training as well as efficient handovers and available technical data are important in reduction of accidents.

2.2 Types of Maritime Simulator

Various types of simulators are used to train seafarers for general types of job often they are engaged in. Also simulators are used to train them for not so often taken activities and skills like steering gear failure, firefighting, black out or loss of ships power, search and rescue(SAR). IMO and the flag states have formulated guidelines for various training needs using simulators. There seem to be no consensus on the characteristics of these simulators like sensitivity, fidelity, interface, response time and also the ability to simulate diverse environmental conditions. Baker et. all (ABS) Washington, observed that “Mechanisms whereby simulators can be subjected to inspection and assessment to ensure that they train adequately, and accurately measure mariner skill acquisition, will benefit safety”.

Muirhead (2006) has mentioned that “there are numerous kinds of simulators in use for assessment and training of seafarers and their number is ever increasing”. Over the time it has become critical to draw a clear guideline for classifying and differentiating between their need and competencies. Simulators may be classified into three types based on their tasking namely single task, full mission and multi task. Under these three types there are major simulators which are in use for seafarers training to prepare them for effective work onboard ships. The different types of maritime simulators used are ARPA/RADAR simulator, Ship handling simulator, GMDSS simulator, engine room simulator, AIS Simulator, Liquid cargo handling simulator, ECDIS simulator, and dredging simulator. Each type of simulators is described in detail below:

2.2.1 ARPA/Radar Simulator

According to IMO (2001) "radar is a support to navigation and when used properly will offer information of value to protect navigation". However several severe collisions have existed as an outcome of misinterpretation of data offered by radar. To offer facilities for officers and skippers in charge of a navigational watch to appreciate how ARPA and radar can be used safely to avoid collisions in marine industry, their risks of failing and limitations. According to Barber (2005) "ARPA (Automatic Radar Plotting Aid) is a system that retrieves data from raw information of radar and presents radar data analysis. It automates the plotting operation traditionally performed on plotting screen or paper or repeater head by grease pencil or lead". The ARPA/ Radar simulator must involve more than one station each with separate engine and helm controls. In addition for describing ARPA, the simulator must be capable of simulating more than 20 targets of ships simultaneously.

2.2.2 Ship Handling Simulator

Hays (2006) have mentioned that "ship handling is a demanding task of operator particularly when large submarines or tankers must be performed in limited waters". Simulated exercises of ship handling were efficient in developing performance as real world experience. Similarly Webster (1992) has stated that the ship handling simulator encloses huge number of facilities, the hardware and other simulation capabilities. These simulators may be categorized into two different types; namely fast type simulator and real time simulators. The real time simulator has a controller. Barber (2005) has mentioned that navy ships acquire the advantages of ship handling simulation training services from ship handling simulators in the leading areas of fleet concentration. The training offered by these simulators is important for safe navy ships operation. This training is received by personnel of ships to study, maintain and develop proficiency in skills of ship handling to sharpen their procedures of safe navigation and to lower the probability of groundings and collisions.

2.2.3 GMDSS Simulator

According to Patterson and Biagi (2003) “Global Maritime Distress and Safety System (GMDSS) simulator controlled by computer enhances instructors to present students with real time radio and different inputs simulating the range of GMDSS equipment used on the bridge of ship”. The simulator allows instructors to recreate different search and rescue and complex scenarios and to evaluate and record how mariners perform. In this way mariners can practice the GMDSS procedures and follow quality international procedures for responding to various situations, such as Distress, Urgency and Safety. . According to STSTC (2014) the Global Maritime Distress and Safety System Simulator offers navigators of ship with general skills and knowledge in use of GMDSS radio equipment. This lowers falsealerts; it also familiarizes search and rescue procedures, thus saving human lives.

2.2.4 Engine Room Simulator

Cwilewicz, Tomczak and Pudlowski (2002) have mentioned that “engine room simulators are utilized in academics of maritime as a valuable property for process of education for more than 30 years”. The engine room simulators are suggested by Standard of Training, Certification and Watch keeping 95 International Maritime Organization Convention. Olanrewaju (2013) has described that “the Engine room simulator comprises of engine control room, machinery space and a lab for computer workstation. This machinery space is provided with stations of local operation to offer proper controls and indicators for control of local power plant”. The engine control room is provided with leading control console of engine, main switchboard console and diesel generator control console to permit trainees to perform machinery and valves throughput in the engine room. Realistic engine room alarms and sounds are simulated in engine control room to offer aural cues. Engine room simulator is only a teaching aid to create various scenarios to help an individual in team work.

2.2.5 AIS Simulator

Weintrit (2011) has mentioned that "AIS stands for Automatic identification system which is an automated system of tracking vessels. It is used for vessel traffic services and on vessels for recognizing and locating vessels by exchanging data electronically with other nearby ships or vessel traffic service stations". Automatic identification system consists of a standard very high frequency transceiver with a positioning system such as GPS receiver or LORAN-C that can offer data supplements The Automatic Identification system offers numerous data such as distinct identification number of a vessel, namely MMSI (Maritime Mobile Service Identification Number) position, speed, course and rate of turn can be shown on a screen or an ECDIS. Popovich, Schrenk and Korolenko (2007) have stated that nowadays automatic identification systems is used to warn and detect about feasible collisions of maritime navigation which is a suitable solution for well-maintained ships but relatively costly and difficult to handle for pleasure boats and small ships.

2.2.6 Liquid Cargo Handling Simulator

According to MPRI Simulations Group (2008) "the liquid cargo handling simulator to be used to offer training in entire perspectives of managing of huge amount of liquid cargoes, the models utilized should be capable of generating greater realism". This is accomplished by the utilization of certain advanced techniques of mathematical modeling for chemical and physical properties together with the behavior of gases and liquids involved within closed system. Tarasov et al (2012) has mentioned that "appropriate ship crews training in decision making, emergency response and operational procedures is essential to avoid expensive errors during operations of liquid cargo transfer. Cargo handling simulators are modern ways of training expert personnel of gas carriers and liquid cargo tankers to carry out their functions effectively and safely". The liquid cargo handling simulators involve vast number of ship systems such as ballast systems, cargo systems, tank heating systems, tank stripping systems, oil discharge monitoring equipment, tank washing systems, gas detection systems, dry air and inert gas systems, insulation space nitrogen systems and deck wash and spray and fire systems.

2.2.7 ECDIS Simulator

According to NAUTIS (2014) ECDIS stands for Electronic Chart Display and Information System. The ECDIS simulator training is a system of simulation training applicable for use in assessment, familiarization and competence training in the use and operation of Electronic Chart Display and Information System equipment. This is in accordance with the standards of STCW (Standard of Training, Certification and Watch keeping) for training based on simulator.

The system has been constructed to follow with international maritime organization standards for Electronic Chart Display and Information System to be used on board merchant vessels. Nielson (2005) has mentioned that the ECDIS simulator is helpful to examine nautical alarms during route supervision and route planning as well as sensor alarms. They will be capable to assess the influence of sensors performance limits on protective use of Electronic Chart Display and Information System. They will be capable to assess errors, ambiguities and inaccuracies caused by inappropriate management of data.

2.2.8 Dredging Simulator

According to STCG (2014) dredging simulator is of huge importance for the development of dredging engineering technique of waterway, rivers, harbor, lakes, etc. The work of dredging simulator is to bring the ship into proper position and maintain it there assure an appropriate tempo of cleaning cutter arm, deciding proper number of cutter head revolutions and assure optimal production and proper ratio between sand and water.

Mourik and Braadbaart (2006) have described that during dredging projects execution there is the time nor the right conditions or patient to fiddle out best settings of system probably resulting in underperforming system or even reluctance to make use of it. The dredging simulator provides proper environment to hinder the behavior of dredge crew and perform several initial testing using conditions as critical as appears realistic. The simulator provides surroundings to attempt within some limits newly developed component within a complete dredging surroundings and it is an essential technological step ahead.

2.3 Importance of Seafarer Training

According to Albayrak and Ziarati (2010) seafarer onboard training is very essential for entire seafarers of different kinds and plays an essential role in training and education of cadet officers. However the opportunities of onboard ship training provided by shipping firms have been reduced essentially and due to commercial pressures it resulted in reduced levels of manning together with ever developing automation level and the quality on board has changed essentially for the worse.

Holland (1997) has mentioned that the process of socialization experienced on ship would likely impact identification of an individual if the seafarer fits the surroundings well. This also influences intentions of a seafarer if he/she would like to continue to be part of this profession after the training /graduation is finished. Selecting the career from here onwards is an individual decision. Keeping in view the technological advancements and other development Schroder et al (2002) have mentioned that humans are the crucial player of marine operations and design.

The developing assortment of mission specific ship and maritime operations and kinds of craft fitted with developed technologies and equipment rely heavily on the crew performance on board the ship. Safety of the people onboard, the machinery, the environment and the cargo has been a matter of concern for most of the ship owning companies and the responsibilities get passed on to the ship staff eventually. Maritime industry around the globe has been carrying out studies and developed systems and technologies for issues related to humans in noncommercial or commercial world. They have also addressed human health and safety related to the seafarers working onboard ships and offshore installations to develop safety culture and lower accidents in maritime. Felicia, Cristina and Geanina (2010) have mentioned that the major purpose of training and development has been to assure that seafarers can achieve their jobs effectively. The traditional way of learning performance of human beings in maritime industry is through the reports of accidents or even better through examination of accidents. Nearly 80 percent of accidents of maritime are affected by human error or human factors. Better quality training is an essential need to assure seafarers to attain greater operation standards. A well maintained seafarer is the most essential asset which a ship owner must have on board. Maritime industry must attain the needs for which they are responsible directly. Having well managed seafarers is very important to any maritime industry who desires to mention that responsibility will be viewed by community as having competitive and quality operation.

2.3.1 Issues Faced by Seafarers

Singh (2012) has stated numerous issues faced by marine industry which made the lives of seafarers at sea extremely critical. The processes in which numerous problems are being managed by authorities of maritime have led to aggravation of issues which required to be solved as soon as possible. One of the problems faced by seafarers in maritime industry is lack of appropriate training in seafarer training huge emphasis must be given to onboard training including shipyard personnel and marine equipment manufacturers. Training which is generally imparted by shore based professionals who may have been experts and as a seafarer but it seems that such experts may not be able to transfer the knowledge. The training imparted may be hit hard if the same is being imparted by the trainers who have no experience on the similar situations or using similar technology and equipment.

Matheson et al (2001) has stated another problem faced by seafarers is health. Among physical risks described were accidents in bad cases leading to colleague's death but more frequently harm to limbs. Minor injuries or accidents specifically falls, trips, burns and cuts were regarded as commonplace by certain seafarers or an inevitable part of job when the sea was rough. Less training and long hours of working had developed the hazard of accidents. Proper healthcare is not often provided immediately for small injuries. The seafarers have to wait until they reach another port before they could acquire proper treatment for their injuries. Other physical risks involved are loss of blood circulation in hands, engine room's noise, moving from a cold country to hot country, chemical risks, radiation and prolonged exposure to artificial light causing eyesight problems and asbestos exposure hazards. Some seafarer's lives have been affected seriously by accidents at times they are forced to end their sea career due to such accidents. Thomas et al (2003) has mentioned some other issues faced by seafarers are stress, fatigue and workloads. Thomas discuss that separation from family is the major cause for stress. Lowering the levels of manning, ever increasing burden of paperwork and rapid port turnaround have been represented as the causes for fatigue.

Cockroft (2000) recognizes another issue such as practices of hiring, restricted development of career, working conditions and safety, welfare and pay at harbor port and at sea as difficult areas of marine labor management. In MAIB (2005) it has been mentioned that institutions such as ILO (International Labor Organization), IMO (International Maritime Organization, Maritime unions, WHO (World Health Organization), shipping firms, federations of shipping, port states, classification universities and societies, flag states and marine insurers have developed norms and regulations intended to reduce on board ship accidents. Thus seafarer training is regarded as an essential factor to limit the issues related to human beings and the revised version of Standard of Training, Certification and Watch keeping for seafarers must be adopted by international Maritime organization to set up a reduced standard of training for seafarers suitable to colleges of maritime globally for lack of control over training standards of seafarer. Thus according to Baldwin et al (1991) "Seafarer training is an essential problem in relation to maritime industry's overall safety".

As design of ship and technical standards has developed still there exist accidents similar to structural failure of vessels. Till now accidents related to mistakes of human beings have not been lowered to acquire larger proportion of whole accidents occurring at sea. To handle the underlying issues of such human mistakes training plays a major role for seafarers.

2.3.2 Studies Related to Seafarer Training Through Simulation

Cwilewicz, Tomczak and Pudlowski (2003) conducted a study based on the application and development of computer based training programs in maritime engineering. The author stated that all leading technical universities have presented computers as a valuable and essential vehicle for the development of education process. Several teachers from university are being involved in development of different kinds of innovative CBT (computer based training)_ programs for application in learning/teaching process of university. Under the Convention 78/95 STCW (Seafarers Training, Certification and Watch keeping) it is highly suggested that the training programs based on computer be used for maritime engineering.

For example, the University of Gdynia Maritime uses computer for, design and development of components. The main purpose of this study is to present and describe certain experiences similar to effective and development use of simulators based on computer for teaching. The basic features of simulator such as self-training, faults scenario creation and assessment of highly efficient processes in marine training are discussed and presented in this study.

Ali (2006) conducted a study on simulator instructor with requirements of STCW and reality. Maritime simulator is constantly changing seafarers in service training and Convention of Standard of Training, Certification and Watch Keeping was acquired to develop seafarer's competency globally.

One of the leading new improvements in the concept of new convention was the competency based training concept whereby the trainee was to demonstrate the desired competency The author feels that the tables of competency must be utilized as components for seafarers training by instructors as well as by the trainees for demonstrating their competency. This put huge liabilities on instructors of simulators in the global Maritime Educational Training Institutes and Centers for quality assessment and training when using simulators. According to the study of***Ali (2008)*** like other training fields use of simulation in marine industry is owing to numerous factors enclosing financial, training and technological requirements of the time. The simulators training value is accepted well, as simulators are closer to actual equipment. The traditional seafarer training concept was based on theoretical study in classroom followed by on board ship practical training. This topic experience profound modifications in 80s because of practice and economic issues developing from new era of offshore industry. A perfect simulator is far away from experiences of the actual ship. Instructor is essential and is liable to link the experience of simulator with experience of real ship through visualization. This study investigates how the simulator training is evaluated using Kirkpatrick's model.

Xi (2011) has conducted a study on maritime training for navigation of seafarers in ice covered water. As worldwide energy demand increases there has been active development in sourcing of natural gas, oil and other natural resources in resource rich areas of the Arctic Ocean. As an outcome it is expected that there will a development in number of ships that will navigate in these ice-covered waters in upcoming years. For international shipping Arctic is identified as an essential area that needs particular attention to factors of human therefore the operational procedures training for seafarers becomes highly essential. Although the Guidelines of International Maritime Organization for Ships performing in Ice Covered Waters of Arctic region sets out equipment, construction, environmental and operational supply with special deliberation for hazards of navigating ice covered waters but still does not have adequate practical processes for training institutes.

This research discusses the effective methods and requirements for strengthening maritime training for navigation of seafarers in ice covered waters. The author has discussed the feasible implementation of current arrangement as well as guidelines of maritime training. Some suggestions concerning the approaches and contents of maritime training for seafarers are stated in this study particularly problems on developing/improving the training efficiency.

Unlugencoglu, Yildiz and Turan (2011) conducted a study on engine room simulator and importance of applied maritime education. The equipment of marine industry are improving every year including several advanced techniques. Engine room simulators is among the one which have been developed to attain the maritime training demands with techniques which is efficient for developing operational skills and management experiences of officers and engineers in emergency circumstances. Marine Engine Room Simulator includes simulation with assistance of leading auxiliary and engine systems in engine room. The systems and machines that have been simulated are diesel generators, main engine, steering gear, pumps, valves, heat exchangers, boiler, purifiers and other similar parts. The systems and machine's operating conditions in simulation is accurately similar with real ones.

Therefore with the method of simulation the engineers acquire skills and knowledge at management level. In this study the significance of applied education of engine room simulator, capabilities and purpose of engine room simulator and skills and knowledge of future seafarers who have to use technology and have skills of teamwork are investigated. The outcomes of the study is that the Engine room simulator application in maritime education leads to good understanding of equipment procedures, marine engineering systems and outcomes in developed safety and lowers the human error risk in maintenance and operation of marine equipment.

Zizic, Krcum and Gudelj (2011) proposed a study on safety of maritime with more encouragement on best use of simulators. Higher professional level is important for marine engineers to perform safety and equip merchant vessel properly with advanced automation system. According to International Standards and Regulations ships are equipped to accomplish a safe navigation. Safe and efficient performance in such surroundings needs highly qualified individuals and greater extent of team coordination.

Therefore the seafarers training for better skills and for updated information became an essential problem. Nowadays marine engineers must have vast number of professional skills and knowledge from work with hand components to the use of computer techniques. In order to accomplish competence standards, the requirements of trainee should be evaluated and trained continuously. Simulation is a strong tool of training because it permits trainer to control the practice schedule systematically within a controlled and safe environments of learning. Simulation training was perceived to be based on computer and simple concentrating largely on assessment and acquisition of individual technical skills. Trainees perform from basic through advanced levels of skills and use navigational equipment, to developed scenarios that need simultaneous utilization of numerous instruments to navigate through a safe path and eliminate collisions. This study presents certain models which are helpful for design of optimal system of power management as well as for simulation that include load shedding and system redesign.

According to the study of ***Baylon and Santos (2011)*** Maritime Education Training must be developed in terms of equipment and facilities, learning methodologies, design of curriculum, instruction quality. The significance of MET cannot be perceived specifically with present scenario of global market and implementation of revised STCW Code and Convention.

Nearly 80 to 90% of accidents in marine industry are due to mistakes of human beings. Hence it is essential that seafarers be trained and educate well, handle risks properly, able to follow orders, solve issues easily and must be emotionally and psychologically happy to assure secure, clean, safe and effective operations for safety of life at sea. This study discusses two major challenges in MET namely implementation of revised version of STCW (Standard training, certification and watch keeping Code) and worldwide market demand and supply scenario. The role of different stakeholders to train, hire and retain seafarers for safe performance of their vessels. The author concluded that MET would assure secure, clean, safe and effective life operations at sea to avoid accidents in marine industry.

Baldauf, Schoder-Hinrichs, Benedict and Tuschling (2012) proposes a study of training based on simulation for maritime security and safety. Crisis management, Emergency response and crew resource are one of the essential parts in maritime training of engineers and nautical officers. The best way to acquire corresponding skills and accomplish experience is practice runs on specifically configured simulators which indicate conditions of complex shipboard situations. Simulators are well identified as advantageous for training of maneuvering and handling of a vessel using a real time simulated and well maintained simulator using real time bridge procedures. The author has presented World Maritime University's MARiSa (Maritime Risk and System Safety) on dealing with the implementation, integration and development of modules based on simulation into course schemes and training units. This study presents the basic security and safety training simulator concept and explores research study similar to training scenarios implementation.

Felsenstein, Benedict and Baldauf (2013) conducted a study on maritime safety and security challenges based on 3D simulation training. The best way to gain essential skills and to meet experience are runs of practice on simulators which are specially designed and configured for this type of training considering the technologically advanced vessels and complex operations these vessels are engaged in. Examples are , actions after the emergency alert. Marine security and safety on board ships relies very much on well qualified crews. That is why exercising and training procedures of emergency response as well as effectiveness in reliable management are extremely essential. The facilities of simulation are important for both training and exercising but also for technological and research improvement. This study aims to evaluate the effectiveness of the training imparted to the seafarers using these advanced technology simulators.

2.3.3 Effectiveness of Seafarer Training Through Maritime Simulator

According to Butter (2000) the advent of PC, data presentation and collection, integrated electronic navigation systems and satellite communication have generated a change in traditional role of crew of ship in machinery tool and bridge operations. Reduced crew onboard ships and rapid turnaround time in ports has put additional burden on seafarers to have proper competencies. Modifications in size speed and design of the vessels demands new techniques on education and training of seafarers. Environmental and economic consequences of huge vessels request of a greater crew training level to handle the vessel efficiently. Pretty (1995) has mentioned that the reduction of manning may hinder the accessibility of extra trained manpower to develop watch keepers strength in heavy traffic and adverse weather conditions. In order to handle efficiently with the scene of changing operation new approaches are required in maritime training. Nowadays handling and navigation of new generation vessels in all situations and environments is an essential facet in competence of watch keepers and masters in modern ships. Most of these skills are evaluated and acquired on maritime simulation without danger to life or risk to ship. The maritime simulator offers both the conditions and circumstances to expose seafarer in such experiences.

Sampson and Tang (2011) have stated that training using simulators is considered as an essential factor by seafarers in relation to knowledge acquisitions for new on board application and equipment. Most such trainings are not optional and is needed to be attended when the seafarer is expected to handle or operate that equipment. Most cases the seafarer may not be involved in the need or identification of the training required. It has been observed that most seafarer end up paying for their own training. A few percentage out of them may get compensated for the fees they paid, when they join a company which may have adopted a policy to reimburse the fee paid for a particular type of training. Whereas there are employers who pay for the training of the seafarers they employ. In such a scenario, the training may have a mixed impact on the seafarer's learning and development process.

According to Kongsberg (2009) high quality maritime simulation training is very much important for effective seafarer training. Demand for high quality and effective maritime training will develop every year. The major applications for simulation such as decision assistance, mission planning, procedure and training will always be essential for marine industry. Simulation under greater realistic situations indicates a cost effective and protective training substitute. This is due to unlimited possibilities offered by maritime simulation. The outcome can be accomplished in a much effective and safer way which in turn generates greater quality seafarers and crews of ship. Thus it can be inferred that maritime simulation has demonstrated its effectiveness and is without doubt the future of seafarer training.

2.3.4 Future Scope of Maritime Simulator

Chislett (1996) has mentioned that the use of simulator in marine education training has carried out substantial increase in present years and there is every representation that this trend will last well into next century. Along with the development in use there has been quick advance in capability of marine simulator. This has been primarily due to developments in computer technology. The training acquired by instructors of simulators is different and does not occur to conform to any identified standard. Some nations need that instructors of simulator acquire formal grant to teach the courses of maritime simulator while other nations have no such formal needs. Glen (2005) has mentioned that recruitment of instructors is based on certification of professional mariner, accumulation of sea time and teaching courses of simulator under the monitoring of previously approved instructor of simulator.

It is obvious that most of the instructors of simulator are hired directly from industry and are trained within a loosely structured system of mentoring after which they acquire experience while providing courses of marine simulator. In order to make much efficient use of simulators in marine training it is essential to offer instructors with programs of marine training which will develop their capability to provide the training.

Ali (2006) has mentioned that at the time of revised version of Standard of Training, Certification and Watch keeping Convention only ARPA and Radar maritime simulator was made compulsory for seafarers. One of the leading obstacles was the accessibility of facilities of simulator particularly in developing nations. However the International Maritime Organization Compendium of Institutes of Maritime training reveals that a developing number of Maritime Educational Training Institutes and Centers have the facility of basic kinds of simulators like engine room simulator, GMDSS simulator and navigation simulation. This implicit that after a failure of decade from acquiring Standard of Training, Certification and Watch Keeping Convention the scenario of world has changed totally with respect to accessibility of marine simulator for the purpose of training. In future the convention can be designed with new statistics with the problem of compulsory maritime simulator based training for seafarers at different levels.

Theme Based Literature Review

The literature was divided based upon the following themes.

2.4 Thematic tabulation of Literature Review

For thematic tabulation purposes the literature review has been divided in to the following categories;

1. Maritime accidents
2. Maritime training
3. Simulators
4. Effectiveness of training
5. Methods of evaluating effectiveness
6. Cross industry examination-Simulator based training

2.4.1 Maritime Accidents

Literature Review

Segment	Author(s)/ Title/Year	Inference	Remarks/Gap
Maritime Accidents	MAIB UK; Marine Accident Investigation Branch- Annual Report; **1988**	In the year 1988, 220 accidents/causalities were reported, the size of UK fleet: 1072.	The number of accidents per 1000 vessels was 205.
	MAIB UK; Marine Accident Investigation Branch- Annual Report; **1999**	In the year 1999, 159 accidents/causalities were reported, the size of UK fleet: 1035.	The number of accidents per 1000 vessels was 154.
	MAIB UK; Marine Accident Investigation Branch- Annual Report; **2000**	In the year 2000, 139 accidents/causalities were reported, the size of UK fleet: 1050.	The number of accidents per 1000 vessels was 132.
	Insurance ADVOCATE(EBSCO); Blame for Crane Accidents Put on Uninspected Equipment, Unskilled, Unlicensed Operators.**2001**	Losses can be traced to lack of training	Training required Simulators can help!
	MAIB UK; Marine Accident Investigation Branch- Annual Report; **2001**	In the year 2001, 139 accidents/causalities were reported, the size of UK fleet: 1047.	The number of accidents per 1000 vessels was 133.
	MAIB UK; Marine Accident Investigation	In the year 2002, 129 accidents/causalities were	The number of accidents per

	Branch- Annual Report; **2002**	reported, the size of UK fleet: 1210.	1000 vessels was 107.
	MAIB UK; Marine Accident Investigation Branch- Annual Report; **2003**	In the year 2003, 145 accidents/causalities were reported, the size of UK fleet: 1343.	The number of accidents per 1000 vessels was 108.
	Marine Insurance; (EBSCO); Ship Disasters hit Insurance rates; The Journal of Commerce, Jan **2003**	Oct-Dec, 2002 three months losses more than one billion USD. Lloyd's underwriters show Sep to Oct, 2002 @750 Million USD losses.	Penalty is much higher than the investment in the training of seafarers.
	MAIB UK; Marine Accident Investigation Branch- Annual Report; **2004**	In the year 2004, 144 accidents/causalities were reported, the size of UK fleet: 1406.	The number of accidents per 1000 vessels was 102.
	Oil Spill INTELLIGENCE REORT; Bow Mariner Investigation; March **2004**	Investigation records include Vessel Particulars, Safety Management System, Fire Control Plan, Inert Gas System Operations Manual, and copies of the crew's licenses and training certificates.	Crew training an important aspect
	Baker &Seah; Maritime Accidents and Human Performance:	Role of the human element in accident causation and consequence mitigation.	Percent of Human Error related in causing

	the Statistical Trail **2004**		accidents: 84%
	MAIB UK; Marine Accident Investigation Branch- Annual Report; **2005**	In the year 2005, 196 accidents/causalities were reported, the size of UK fleet: 1406.	The number of accidents per 1000 vessels was 136.
	Michael L Barnett ; Searching for the Root Causes of Maritime Casualties – Individual Competence or Organisational Culture? **2005**	Total number of accidents is declining, human error continues to be a dominant factor in 80 to 85% of maritime accidents.	Design of more effective training courses through a better understanding of the nature of the skill requirements of situational awareness
	Oil Spill INTELLIGENCE REORT; Jet Lag Contributes to Grounding; Feb, **2005**	Report concludes that the helmsman's error was possibly due to fatigue effects	Training could make things better
	MAIB UK; Marine Accident Investigation Branch- Annual Report; **2006**	In the year 2006, 130 accidents/causalities were reported, the size of UK fleet: 1480.	The number of accidents per 1000 vessels was 88.
	Oil Spill INTELLIGENCE REORT; USCG Completes Athos I Spill Investigation; Jan **2006**	No violation of rules	Accident due some external material hit the ship
	MAIB UK; Marine Accident Investigation Branch- Annual Report;	In the year 2007, 116 accidents/causalities were reported, the size of UK	The number of accidents per 1000 vessels was

	2007	fleet: 1518.	76.
	Oil Spill INTELLIGENCE REORT; MV CoscoBusan Report Released, Jan, **2008**	Crew not conversant with English.	Good teamwork after oil spill
	Cieutat et al; A new efficient wave model for maritime training simulator, **2008**	Many types of training simulators in marine, marine simulators comparable to aviation simulators.	Maritime simulators a learning tool to learn how to react in critical situations. Transas and Kongsberg two major suppliers.
	MAIB UK; Marine Accident Investigation Branch- Annual Report; **2008**	In the year 2008, 131 accidents/causalities were reported, the size of UK fleet: 1578	The number of accidents per 1000 vessels was 83
	Pazara et.al; Reducing Maritime Accidents Caused by Human Factors Using Simulators in Training Process ;**2008**	Emphasis on improving ship stability and design of equipment to reduce casualties and increase productivity.	About 75-96 % of accidents caused by human error. To reduce accidents, focus on human errors, training is one way
	MAIB UK; Marine Accident Investigation Branch- Annual Report; **2009**	In the year 2009, 127 accidents/causalities were reported, the size of UK fleet: 1564	The number of accidents per 1000 vessels was 81.

	MAIB UK; Marine Accident Investigation Branch- Annual Report; **2010**	In the year 2010, 141 accidents/causalities were reported, the size of UK fleet: 1520	The number of accidents per 1000 vessels was 93
	MAIB UK; Marine Accident Investigation Branch- Annual Report; **2011**	In the year 2011, 115 accidents/causalities were reported, the size of UK fleet: 1521.	The number of accidents per 1000 vessels was 76
	Steve Clinch; Marine Accident Investigation Branch - Annual Report; **2012**	The MAIB continues to be regarded as one of the world leaders in its field	Total number of reported accidents in UK ships – 133, Crew injured-186, Deaths 3
	Steve Clinch; MAIB Annual Report; **2013**	1332 Accidents (Casualties and Incidents) were reported to MAIB, involved 1459 vessels. 70 of these Accidents involved only non-commercial vessels, 420 were occupational accidents that did not involve any actual or potential Casualty to a vessel. There were 842 Accidents involving 927 vessels that involved actual or potential	Marine Incident-336, Less Serious Casualty-488, Serious Casualty-82, Very Serious Casualty-21

		Casualties to ships.	
	Allianz Global Corporate & Specialty ;Safety and Shipping Review; **2013**	World losses in shipping industry in review: by location, type and cause An annual review of trends and developments in shipping losses and safety . 2012 in Review-Trends and developments affecting shipping safety	• Shipping losses continue downward trend • 27% decrease in 2012 on previous 10 year average • Losses centered on South China and South East Asia region • Foundering most common cause of loss • Despite industry initiatives, challenges remain Need for training emphasized
	Philip Graham; IMUI Canada; **2014**	Total loss of vessels >500 GT has shown a downwards trend from 1997 to 2013	The losses and accidents were due to various reasons, weather contributed the maximum.

Table 2.1 Maritime Accidents

2.4.2 Maritime Training

Literature Review

Segment	Author(s)/ Title/Year	Inference	Remarks / Gap
Training			
	Kayten et.al., Assessment of simulator-based training for the enhancement of cadet watch officer performance; **1982**	discover what types of watchstanding skills might be trained on a simulator and how much simulator training would be necessary to promote the acquisition of these skills such that performance by simulator-trained cadets might equal that of cadets trained at sea	Training/simulato r training provided better results.
	Esbensen et.al., The Importance of crew training and standard operating procedures in commercial vessel accident prevention; **1985**	Assess the equivalence of varied amounts of simulator experience to simulator applicable skills assumedly acquired during the first one year of cadet sea time	Training/simulato r training provided better results.
	Betsey et.al; Youth Employment and Training Programs: The YEDPA Years; **1985**	Targeting, Recruiting, training and Retaining Youths	No reliable evidence on the effectiveness of occupational skills training provided in a nonresidential setting for out-of-school youths.

	Druckmanet.al; Enhancing Human Performance: Issues, Theories, and Techniques; **1988**	Wide range of techniques that have been proposed to enhance human performance.	Scientifically sound evaluation procedures; Various learning techniques; pointing to importance of training.
	Mary R. Brooks; Seafarers in the ASEAN Region(ed), **1989**	Much of training to meet ship board technological development	Training becomes a requirement, lots of training schools, private as well as government.
	Edmond M.J. Corten; ESCAP Involvement and Seafarers Training, **1989**	The United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) involvement in seafarer's training	Importance of training for all ranks onbaord important for safe operations.
	Bjorklund et.al; Effects Of Maritime Simulator Training On Performance; **1994**	This study assesses the effect of maritime simulator training on the performance of experienced shipmasters	Captains with a low level of competence did not improve their performance during the simulator-based training.
	Druckman et.al; Enhancing Organizational Performance; **1997**	Explore the utility and effectiveness of various techniques to enhance human performance	Society functions thru organizations. Organisational

			efficiency depends on the people. Training improves efficiency.
	Yang et.al; Applying Collision Avoidance Expert System to Navigation Training Systems as an Intelligent Tutor ; **2001**	Recent huge maritime casualties and their environmental impacts, especially the stranding of EXXON tanker in Alaska, showed that human error in ship navigation is one of the primary causes leading to accidents.	From the training operation, it can be pointed that CAES is effective to provide the necessary decision-making support to help trainee to master navigation skills and learn how to handle ship in complex encounter situation.
	ILO, Maritime Labor Conventions and Recommendations: **2002**	Highlights training and employment relationship	Training creates employability
	Deniz et.al; Computer – Based Training For Sea – Going Engineers ; **2002**	Successes of achieving the tasks assigned, are based on the level of the personnel's knowledge and skills.	Training help in improving knowledge and skills. CBT has demonstrated a number of significant

			advantages. Objectivity in the evaluation and assessment
	Colin Barrow; Introduction to E-Training and Development; **2003**	Training process, is closely correlated with economic development.	E-training and development enables organizations of any size and in any part of the world to enjoy the benefits of a skilled and well-trained workforce.
	Danziger&Dunkle – **2004**	Training methods chosen by organisations. Work related computing in various forms. Training divided in Formal, Informal, Personal and Inter personal segments and further classified as	Self-training, E-Learning, Peer training and Instructor-led training. Most trainings can make use of simulation
	United Nations: Report of the Second Regional Forum on Maritime Manpower Planning, Training ...**2004**	Degrees and normal qualifications not enough	Need for training' Seafarers trained to meet international standards, safety
	RégisKalaydjian; French Marine-related Economic Data; **2005**	Maritime training budget – accounted for Govt. and private	Importance of maritime training

		contribution	
	Asghar Ali ; Role And Importance Of Simulator Instructor; **2006**	Traditional concept of seafarers' training was based upon theoretical teaching in class room followed by the practical training onboard ships.	Simulator training had obvious advantages of being economical, safe and redundant. But it had its own implications.
	Michelle L. Hoffman ; St. Petersburg's Maritime Service Training Station, **2006**	The USMSTS, Florida	Importance on maritime training. Classroom, on the job, specialized training ships
	IMO Publication: Specialized Training for Oil Tankers, **2006**	Facilities among others included CBT, Computers, and Simulators	Simulators not mandatory but recommended by STCW 1995
	Tracy Garcia; Development Effectiveness Training-Global DOTS Training; **2007**	The training emphasizes the critical role that investment staff plays in tracking results throughout the project cycle.	DEU has committed to continue to provide more field training.
	Olaniyan&Ojo; Staff Training and Development: A Vital Tool for Organisational Effectiveness; **2008**	Training essential for facilitating productivity, safety.	Methods of Training and Development Highlighted
	Chia Lin Sien; Training of Seafarers in ASEAN	Government, private and seafarers union	Training needs emphasised,

	region;		surplus seafarers, many more training centre
	IMO Model Course 1.26; Restricted operator's certificate for the Global Maritime Distress and Safety System (GMDSS)	The IMO ECDIS Model Course (1.27) has been revised to ensure that navigators understand ECDIS in the context of navigation and can demonstrate all competencies contained in and implied by STCW 2010. The new publication is entitled Model Course (1.27) 2012 Edition and is now available from the IMO (www.imo.org).	Standards for ECDIS training
	Grechet al; Human Factors in the Maritime Domain, **2008**	Maritime training improvising use of simulators	Simulators contribute a lot to maritime training as technology and complexities increase.
	S.J.Cross; Transfer Of Learning: A Competence Based Programme Requirement; **2009**	Many studies into transfer of teaching, training and learning have been conducted over the past years.	Simulators are seen to be powerful tools as intensifier and accelerator of maritime training efforts.

	Albayrak&Ziarati; Training: Onboard And Simulation Based Familiarization And Skill Enhancement To Improve The Performance Of Seagoing Crew, **2010**	The International standards for merchant navy education and training (MET) currently in place were introduced in 1995 [IMO STCW-95]. Rapidly improving maritime technology,	Education and training of seafarers is still a very complex issue when compared to other disciplines, which requires variousconsiderations to be taken into account for a well balanced MET programme.
	Stephen J. Cross; Quality MET through Quality Simulator Applications, **2011**	IMO training Convention (Standards of Certification, Training and Watch-keeping for Seafarers (STCW 95) has had a considerable impact on the types and extent of training	specific personnel competences in the shipping industry will require Specific types of training equipment. Simulators are better than equipment for training.
	IMO Model Course 1.27; At the IMO's 43rd meeting of the STW Sub Committee in May 2012, the initial Model Course 1.27 (2000 Edition): Revised **2012**	The IMO ECDIS Model Course (1.27) has been revised to ensure that navigators understand ECDIS in the context of navigation and can demonstrate all	Part D – Instructor manual – guidance for instructors – learning objectives in Parts A, B and C

		competencies contained in and implied by STCW 2010. The new publication is entitled Model Course (1.27) 2012 Edition and is now available from the IMO (www.imo.org).	Simulator exercises – guidance functions and task groups and expected outcomes.

Tables 2.2 Maritime Training

2.4.3 Maritime Simulators

Literature Review

Segment	Author(s)/ Title/Year	Inference	Remarks/Gap
Simulators			
	Webster et.al; Ship handling Simulation: Application to Waterway design; **1992**	The nation's ports and waterways are vital links in national, regional, and local intermodal transportation and economic systems. The safety of vessel operations in these waters is equally important.	choosing a simulator facility with suitable capabilities to address the design problem effectively, of having confidence in the results, and of integrating simulation results into the waterway design process
	National Academy Press Washington, D.C. Minding the Helm:: Marine Navigation and Piloting By Division on Engineering and Physical Sciences, Commission on Engineering and Technical Systems, Marine Board; **1994**	Safety of vessel navigation and piloting practices have been called to national attention. Ship handling, positioning, work practices, and communications in piloting waters have been identified as key causal factors in these accidents.	Applying the Aviation model to marine transportation. Consistent and thorough approach to professional development is needed. training and performance standards for professional mariners
	Jesse et. Al; The Value Of Simulation For Training ; **1994**	Examine the utility of simulation for training at the individual, unit, and joint force levels of	The procurement of simulators for training costs about $1.1 billion per year

		readiness and to propose guidelines for the development of new technology relevant to training.	(average of FY 91-97); Most expensive simulators for aviation.
	Simulated Voyages: Using Simulation Technology to Train and License Mariners; **1996**	The professional performance of merchant mariners, marine pilots, and towing vessel operators has been brought to public attention by major marine accidents and the resulting loss of life, oil spills, and damage to marine ecosystems.	Research results reported in the literature and anecdotal evidence suggest that simulator-based mariner training can be used to improve the development of knowledge, skills, and abilities and that such training transfers to and improves the safety of actual operations.
	M.S. Chislett; Marine Simulation and Ship Manoeuvrability: **1996**	Use of simulators & qualification requirements of users, potential role of simulators in training.	Simulators used for training and certification
	Hansen et.al; Taking Flight: Education and Training for Aviation Careers; **1997**	Civilian aviation is a key part of the transportation system. Training a must to make the required manpower available for future needs.	Five training pathways, military training, foreign hires, on-the-job training, collegiate training, and “ab initio” (from the beginning) training. All have simulator

			training as one of the important options.
	National Academy Press; Simulated Voyages: Using Simulation Technology to Train and License Mariners By Marine Board, Commission on Engineering and Technical Systems, Division on Engineering and Physical Sciences; **1996**	Wide range of marine simulators in use worldwide. • Simulators can be used to train regardless of weather. • Instructors can terminate training scenarios at any time. • Training scenarios can be repeated. • Training scenarios can be recorded and played back. • Training takes place in a "safe" environment	Simulation can become an effective training tool to improve mariner professional competence.
	Hansen et al; Taking Flight: Education and Training for Aviation Careers, **1997**	Most training programmes in aviation industry make use of simulators	Simulators presence in Aviation training
	Harraldet.al; Using system simulation to model the impact of human error in a maritime system; **1998**.	Human error is cited as the predominant cause of transportation accidents.	The expansion of maritime simulators provides another opportunity for the capture of descriptive human error data. Berenji (1997) has demonstrated that aviation simulator training sessions can be used to create

			human error databases.
	Stewart Technology Associates; July **2001**	New era in simulation, jack-up simulators and Ballast control	New segment of maritime simulators, well received by the market
	Cieutat et. al; A new efficient wave model for maritime training simulator;**2001**	To simulate ocean environment (stream and ocean waves) on a real maritime simulator. Conscious of the main phenomena modifying the behaviour of the ship propagation, future pilots can learn how to react in critical situations.	Various depths and waves simulated for better learning.
	Barnett et.al; Shipboard Crisis Management: A Case Study; **2002**	Providing solution to the problems of risk of	Use of simulators a long history in maritime training.
	WijarnWangdee; Bulk Electric System Reliability Simulation And Application-**2005**	Sequential simulation can be used to reasonably represent most contingencies and the complex operating characteristics inherent in a bulk electric system.	Simulation a good way to understand bulk electric system
	Stefan Kluj; A Diagnostic Simulator Applied to Engineering Training; **2005**	Mathematical model based simulation can simulate the parameters better.	The diagnostic simulator is based on the mathematical model of the high power, medium speed, four-stroke

			diesel engine and is particularly suited for diagnostic engineering education.
	David Gatfield; Using Simulation To Determine A Framework For The Objective Assessment Of Competence In Maritime Crisis Management; **2005**	Behavioural markers can be used as a basis for an objective assessment framework for the assessment of competence in crisis management within the domain of a merchant vessel engine room control room.	Non-technical skills of maritime crisis management can be better learnt by simulation.
	Capt. Simon Pelletier; The Role Of Navigation Simulator Technology In Marine Pilotage Training; **2006**	Pilots were strongly motivated by their own professional requirements to invest in the best simulator technology available	Enhanced benefits of training on simulators.
	Committee on Modelling and Simulation for Defence Transformation, National Research Council ; Defence Modelling, Simulation, and Analysis: Meeting the Challenge Committee on Modelling and Simulation for Defence Transformation,	Modelling, simulation, and analysis (MS&A) is a crucial tool for military affairs. While DoD's reliance on MS&A, in some form, dates back to World War I.	Research recommended in various other aspects of simulation in defence applications.

	National Research Council ; **2006**		
	Davidovitch et.al; Simulation-based Learning in Engineering Education: Performance and Transfer in Learning Project Management; **2006**	Simulations are recognized as an efficient and effective way of teaching and learning complex and dynamic systems for engineering education.	Using simulators as a teaching tool is widespread, both in academic areas and in business areas
	Perez et. al; An Overview of the Marine Systems Simulator (MSS): A Simulink Toolbox for Marine Control Systems; **2006**	Marine simulators use mathematical model.	These simulators cab simulate vessel, state of the sea, and speed etc.
	Britannia News; Simulators with a mission to train, JUNE **2007**	Full mission maritime training simulators better tools to impart specific training, highlighting Realism.	Single task, Limited Task, Multiple task and full mission simulators in use in the market.
	Sinha et.al; Importance of Virtual reality simulators In interventional radiology: The ImaGiNe--S CIRSE 2008 experience ; **2008**	The limitations found in the Hardware during this study are In the process of being addressed. The "feel" from real world data Is now incorporated into the Existing model.	The role of virtual Reality in Interventional Radiology is positive. ImaGINe--S may be used to train core skills and procedure steps.
	Murthy et. al; The Impact of Simulation	Simulation training in call centres follows a three	Unlike role-play, simulation

	Training on Call Centre Agent Performance: A Field-Based Investigation; **2008**	step process, namely, "paced observation," "modularized practice with feedback," and "integrated practice with feedback."	training incorporates behaviour modelling enhancements.
	Maanen et. al; Opportunities for improved training using innovative maritime simulators; **2009**	Simulation technology has come of age. Bulky and expensive machines replaced with computer base simulators.	function areas: Bridge Operation Machinery Operation Radio Communication Cargo handling Class A (full mission) Class B (multi-task) Class C (limited task) Class X (special task)
	Bron&Uitterhoeve; Full 6-Dimensional Modeling: A New Approach For Full-Mission Simulations, **2009**	6-D model is better capable of predicting the complex behaviour of a small vessel encountering large forces than the traditional model	Simulators developing new concepts in marine training
	Zhang et al; The Marine Safety Simulation based Electronic Chart Display and Information System; **2011**	The navigation safety Simulation in ECDIS is important to marine traffic, so route plan and route monitoring are two key navigational functions.	Route plan and route monitoring are important aspects of using ECDIS simulator for training.

	Benedict et.al; New levels of Integrated Simulation Interfacing Ship Handling Simulation Safety Training; **2011**	Simulators have proved beneficial for ship handling training in real time on well equipped bridges.	Full mission simulators enables the trainees to simulate the entire ship system and presents challenges to both officers and crew.
	P. Zalewski; Path Following Problem for a DP Ship Simulation Model; **2011**	Ship's motion can be simplified to a 3 degrees-of-freedom (DOF) model.	Simulators uses advance concepts like Kalman filter and fuzzy controllers.
	J.Kornacki; Simulating Method of Ship's Turning-basins Designing; **2011**	The simulating method is more and more often used to the defining parameters.	Manoeuvring the vessel in a basin polar method may be applied.
	L.K.Kobylinski; Capabilities of Ship handling Simulators to Simulate Shallow Water, Bank and Canal effect, **2011**	Safe navigation of ships in restricted areas requires special skills of seafarers. Full Mission Bridge Simulators can help to learn these required skills.	Simulator training in ship handling becomes more and more popular and some pilots organizations require now refreshing such courses every five years.
	Stephen J. Cross ; Quality MET through Quality Simulator Applications; **2011**	The revision of the International Maritime Organization's (IMO) training Convention (Standards of Certification, Training and Watch keeping for	With increase of the simulated performance and importance of the simulated environment, there is a deceleration of

		Seafarers STCW 95) has had a considerable impact on the types and extent of training and education and subsequently on the training equipment used.	relevant transfer to the real life task.
	Ellen Thomseth; More Effective and Efficient Training with Simulation; **2011**	Best available evidence suggests that high-fidelity medical simulations facilitate learning, when training is conducted under the ''right conditions.''	Hospital's opinion that Simulation training will translate into improved quality of care and increased patient safety
	Adam Weintrit(ed); Navigational Systems and Simulators: Nautical Institute, London-**2011**	Compilation various works in marine systems and simulation	Different types of simulators in use in marine training.
	Honey and Hilton ; Learning Science Through Computer Games and Simulations; **2011**	Scientific and technological competence is vital to the nation's future.	Teachers spark students' interest by engaging them in investigations,helping them to develop understanding of both science concepts and science processes.Computer simulations and games have great potential to catalyze this new approach
	Lindberg et al; Towards	A main objective of	The coupling of

	Real Time Simulation of Ship-Ship Interaction; **2012**	the work is to improve and enable more accurate (realistic) and much faster ship-wave and ship-ship simulations than are currently possible.	simulation with visualization should improve the visual experience such that it can be perceived as more realistic in training.
	Dr.Oladokun S. Olanrewaju; **2013** Olanrewaju, O. S. (2013). Risk Based Design for Safe Development of Reliable and Environmentally Friendly Inland Water Transportation System. Xlibris Corporation.	Simulation an important feature, most simulators based on mathematical model. Maritime simulators similar to aviation simulators.	Use of simulation is quickly becoming indispensable
	Hui et al; Modeling and Simulation of Working Process of Marine Diesel Engine with a Comprehensive Method; **2013**	The working process of marine diesel engine is simulated by combining mean value engine model and volumetric model. It reflects some average parameters such as effective pressure, effective power and engine speed, as well as reflects real-time explosion pressure, maximum temperature in cylinder and indicator diagram.	The new model developed can be used in marine simulator to satisfy training requirements.

Tables 2.3: Maritime (Simulat

2.4.4 Effectiveness of Training

Literature Review

Segment	Author(s)/ Title/Year	Inference	Remarks/Gap
Effectiveness of training	Mathieu et.al; Influences Of Individual And Situational Characteristics On Measures Of Training Effectiveness;**1992**	Investigate issues related to training effectiveness.	Relationship among Kirkpatrick's (1976) training criteria than has previously been assumed and hypothesized that reactions to training would moderate the relationship between individuals' training motivation and learning scores.
	Tannenbaum et al; Factors That Influence Training Effectiveness: A Conceptual Model And Longitudinal Analysis; **1993**	Training effectiveness should yield dividends in terms of improved understanding of crucial training variables, and improved training outcomes.	Kirkpatrick's typology has helped guide numerous research and training evaluation efforts, and is probably the most frequently cited framework for understanding training effectiveness.
	NIOSH USA; A Model for Research on Training Effectiveness; **1999**	Study Variables as below; • Independent Variables Dependent Variables Modifying Variables	Stage 1: Formative Research Stage 2: Process Research Stage 3: Outcome

		Intervening Variables Confounding Variables	Research Stage 4: Impact Assessment
	Fred Nickols; Evaluating Training- There is no "cookbook" approach; **2003**	Trainingis an intervention, as a solution to some problem other than equipping people to do their jobs.	To properly evaluate training requires one to think through the purposes of the training, the purposes of the evaluation, the audiences for the results of the evaluation, the points or spans of points at which measurements will be taken, the time perspective to be employed, and the overall framework to be utilized.
	Arthur et.al; Effectiveness of Training in Organizations: A Meta-Analysis of Design and Evaluation Features; **2003**	To assess whether the effectiveness of training varied systematically as a function of the evaluation criteria used.	Training method used, the skill or task characteristic trained, and the choice of training evaluation criteria are related to the observed effectiveness of Training programs.

	Shane&Lafferty; Effectiveness of Training and Development, **2004**	Art and a science approach, begin at the top	Effective training helps development
	Ooi et al ; The Determinants Of Training Effectiveness In Malaysian Organizations; **2007**	Paper attempts to identify the significant determinants of training effectiveness.	Instructor competence and training type are the primary contributors to training effectiveness.
	Lee&Li; The moderating effects of teaching method, learning style and cross-cultural differences on the relationship between expatriate training and training effectiveness; **2008**	Expatriates who perceived higher levels of fit between their learning styles and instructor teaching method, perceived lower cross-cultural differences and perceived higher demand for training tended to achieve higher training effectiveness.	Moderating effects of the fit between learning and teaching and the perceived cross cultural differences on the relationship between expatriation training and training effectiveness.
	Scaduto et. al; Leader influences on training effectiveness: motivation and outcome expectation processes; **2008**	Examine the influence of one aspect of the social environment of work – exchanges with the direct leader on training transfer.	training effectiveness and leader influence on training transfer
	Giangrecoet al; Trainees' reactions to training: an analysis	3000 trainees from a range of Italian companies	Kirkpatrick's model highlighted. Factors that affect

	of the factors affecting overall satisfaction with training; **2009**	participating in a large-scale regionally-funded training programme involving over 300 different training courses.	their overall level of satisfaction with the training they have received
	Vic Nanda; An innovative method and tool for role-specific quality-training evaluation;**2009**	Many training evaluation models are in use in the industry; however, the model that is the most widely adopted was first proposed by Kirkpatrick in 1959 (Kirkpatrick, 1998). Kirkpatrick's training evaluation framework comprises four levels at which training can be evaluated.	Paper provides an automated approach for tailoring of training evaluations to accommodate different learning needs of the audience
	Developing an Effective Maritime Education and Training System-TUDEV Experiment; DEMİREL & MEHTA; **2009**	Maritime education and training (MET) is to supply manpower for the shipping industry.Balancing and matching academic studies and on board training.	Learning institutions and industry.
	Giangreco et al; Trainees' reactions to training: shaping groups and courses forhappier trainees; **2010**	The extensive use of training demands more extensive evaluations of its real effects.	Kirkpatrick model has received much criticism, we cannot ignore that, in its simplicity, it provides information

			and benefits for both trainers and trainees in terms of the potential impact on organisational climate, self-esteem, quality of relationships and motivation of workers (Meyer and Allen 1997; Alvesson 2000).
	Robson et. al; A systematic review of the effectiveness of training & education for the protection of workers, **2010**	Out of total 22 studies carried out by different authors, all outcome timing and types were tabulated	Most timings were in Intermediate and short time frames and outcome varied between Behaviour and knowledge. Majority of interventions were that of Printed material, Simulated work, Video, computers
	Aurelie Landry; Suggested evaluation approach for health and safety training; **2011**	Examine the links between a process and the effects produced	Develop knowledge about training-related activity and intervention-related activity in order to identify suitable evaluation indicators

	Sheeba Hameed; A Study of Effectiveness of Training and Development Programmes of UPSTDC – An Analysis; **2011**	An effective training is an investment in the human resources of an organisation.	No uniform policy, UPSTDC rarely plans training, need to evaluate existing skill base to identify gaps, formulate training programmes and plans, and develop performance assessment criteria based on job descriptions.
	The U.S. Office of Personnel Management Training Evaluation Regulations; Training Evaluation Field Guide; **2011**	• How well did the training meet the development needs identified? • How well did the learners master the training content? • How well did the learning transfer to the work setting? • How well did the training contribute to the achievement of the agency's mission?	Field guide is based on the Kirkpatrick Four Levels,
	Kaur&Jayaraman; Effectiveness of Training in Indian Banks:	Training imparted in banks provided higher benefits of increased motivation and increased	Focus of training and development programs in public sector and private

	Some Evidences from the Punjab Region; **2012**	awareness in practical banking among public sector bank officials,	sector banks varied significantly
	Ramakrishna et al; Effectiveness Of Training And Development Programmes- A Case Study Of Canara Bank Employees In Kurnool District; **2012**	More proactive role in shaping the employees to fight out the challenges.	Banks need to develop training and evaluate the same for effectiveness. Training provided is "Good"
	Punia& Kant; A Review Of Factors Affecting Training Effectiveness Vis-À-Vis Managerial Implications And Future Research; **2013**	Training effectiveness usually is determined by assessing some combination of the criteria presented in Kirkpatrick's (1967) hierarchical model of training outcomes	Trainees' attitude a great factor, emotionally intelligent leaders inspire workers.

Tables 2.4 Effectiveness of Training

2.4.5 Methods of Evaluating Effectiveness of Training

Literature Review

Segment	Author(s)/ Title/Year	Inference	Remarks/Gap
Methods of evaluating effectiveness of training			
	Alliger & Janek; Citation Search on Kirkpatrick levels, **1989**	55 Articles reviewed, 8 dealt with training evaluation, no reported study of correlation between all levels of Kirkpatrick model	Research contributed literature to effectiveness of Kirkpatrick's model
	Keller & Watkins; What works and what doesn't. Evaluation beyond Kirkpatrick; **1996**	Four level approach by Kirkpatrick incomplete	Should include strategic and tactical planning,
	Phillips, J.J.; ROI: the search for the best practices. Training and Development; **1996**	Exploring best practices	5th Level added to Kirkpatrick's model
	Philips JJ; How much is the training worth? **1996**	Add fifth level to Kirkpatrick's model	ROI model..just one level added to four levels of Kirkpatrick
	Thackwray, Bob; The Effective Evaluation of Training and Development in Higher Education, **1997**	Highlights Kirkpatrick's model against CIRO and other models for training evaluation	Kirkpatrick's model more suitable and acceptable

	Bassi& Russ-Eft; Assessment, Development, and Measurement; **1997**	Hamblin's model compared to Kirkpatricks model. Kaufmann et all; Five level model ; new twist to Kirkpatrick's model	One more level "Human Good" /Economic outcomes. Fifth level/; societal outcome of training
	Lachenmaer & Moor; Using business performance to evaluate multimedia training in manufacturing, **1997**	Various models to evaluate training compared with Kirkpatrick's model	Shortened Kirkpatrick model used effectively to evaluate multimedia training in a manufacturing environment.
	Combs & Falletta; The Targeted Evaluation Process: A Performance Consultant's Guide to Asking right questions and getting the results you trust; ASTD **2000**	Measures outcome not process.	Emphasises Targeted Evaluation Process(TEP)
	Rauemi; Te Papa National Services-Training Evaluation; **2001**	What do you want your training activities to achieve? Evaluation objectives must be SMART. • Specific? • Measurable? • Achievable? • Results-oriented? • Time-bound?	Pre and post training evaluation plan. • peer assessment and feedback • community surveys • service questionnaires • return on investment. The

			questions asked, indicate to Kirkpatrick's model
	Colin Barrow; Introduction to E-Training and Development; **2003**	Key Concepts and Thinkers	Kirkpatrick highlighted among others
	IAEA, VIENNA ; Means of evaluating and improving the effectiveness of training of nuclear power plant personnel; **2003**	A number of performance indicators that can indicate effectiveness of how the training was in each of the training settings.	more focused evaluation includes both student reaction and student learning to identify effectiveness indicators. (Kirkpatrick's model)
	Michael Brannick; Measures of Learning Effectiveness; **2003**	CEOs value training because they believe it strengthens the organization and serves as a retention tool, not many are clear on how to measure the return on the investment (ROI).	organization needs to use ongoing assessment to establish learning outcomes. Ability to measure ROI.
	Carolyn Nilson; How to Manage Training, **2003**	Kirkpatrick's model preferred	Kirkpatrick's model used
	William W. Lee Diana L. Owens; Multimedia-Based Instructional Design,	Kirkpatrick's model compared with ROI- Used Kirkpatrick	Kirkpatrick's model used

	Second Edition, **2004**		
	Mohamed E Ibrahim ; Measuring Training Effectiveness; **2004**	94 trainees at two locations of a training institute in UAE	Significant positive reactions to the training program. (Reaction etc..points to Kirkpatrick's model)
	Beckmann et.al; Evaluating the Effectiveness of Reclamation's Training and Development Programs; **2007**	Smile sheets, end of course, participants satisfaction used. Rarely evaluation is conducted to determine increased competencies.	Don Kirkpatrick's and Jack Phillips' 5 levels of evaluation are the industry's recommended evaluation models.
	Kaye Thorne and David Mackey; Everything you ever needed to know about training ; **2007**	Chapter 9. Evaluation of Training; 'bottom line' benefit to the organization – are based on the Kirkpatrick model	Kirkpatrick's model preferred
	Sharon M. Foreman; Kirkpatrick Model: Training Evaluation Practices in the Pharmaceutical Industry; **2008**	Kirkpatrick model used for training evaluation in pharmaceutical industry	Kirkpatrick model effective in pharmaceutical industry training evaluation.
	Giangreco et.al; Trainees' reactions to training: an analysis of the factors affecting overall satisfaction with training; **2009**	Evaluating an important, aspect namely trainees' immediate reaction to training.	Points to Kirkpatrick's first level "Reaction". Most companies generally not capable of fully evaluating training.

	Victor Wang; Assessing and Evaluating Adult Learning in Career and Technical Education; **2009**	Effective evaluation; answers: Does the programme meet its goals and objectives?	Kirkpatrick model among the best and more suitable
	Chimote, N; Training programs: evaluation of trainees' expectations and experience; **2010**	purpose of this study is to find out the effectiveness of a training program from the perspective of the trainees.	Kirkpatrick model used for effectiveness.
	Mani V; Evaluating effectiveness of executive training. International Bulletin of Business Administration ; **2010**	The executive training effectiveness evaluated.	Training evaluation and measuring effectiveness an important aspect.
	Giangreco et.al; Trainees' reactions to training: shaping groups and courses for happier trainees; **2010**	The extensive use of training demands more extensive evaluations of its real effects.	Critics of the Kirkpatrick cite no progressive importance between level 1 to 4. lack of a proven cause and effect relationship.
	Sandy Leong; How to develop a Talent For Training A very practical guide for trainers, **2010**	Kirkpatrick's model preferred	Kirkpatrick's model used

	Rama Devi & Shaik Evaluating training & development effectiveness - A measurement model; **2012**	According to Brown G. Kenneth & Gerhardt W. Megan (2002), evaluation should include procedures that ensure alignment of a training activity with the organization's strategy.	Among these widely accepted framework is four stage training evaluation model proposed by Kirkpatrick (1959).
	Mohamed & Alias; Evaluating the Effectiveness of a Training Program Using the Four Level Kirkpatrick Model in the Banking Sector in Malaysia ; **2012**	Employee training and development is becoming an increasingly important function of human resource management. Every training program must be evaluated since there is no alternative way of ensuring that investments on training are worthwhile without doing evaluation	Using the Kirkpatrick's four levels of evaluation model, this paper specifically examines: (i) the reactions of the employees to the training programs; (ii) the level of employee's learning; and (iii) the employee's transfer of training.
	Keziah Rachel Cherian; Impact of	Evaluation is important to successful training.	Kirkpatrick's model and others used for

	Training and Development Programs Conducted in Organizations; **2012**		evaluating training.
	Suman Singh; Developing Training Evaluation Methods For ACC Limited; **2013**	Most trainers are familiar with formal methods of evaluation after a training program.	Kirkpatrick's model an important tool for evaluating training. ACC did not evaluate the training programmes.
	Jennifer S. Boman ; Graduate Student Teaching Development: Evaluating the Effectiveness of Training in Relation to Graduate Student Characteristics; **2013**	Training increased self-efficacy of the Teaching Assistants.	This research used a pretest/posttest design to evaluate changes in TAs after a two-and-a-half-day information and skills program.
	Alyahya and Norsiah; Evaluation Of Effectiveness Of Training And Development: The Kirkpatrick Model; **2013**	Evaluation of training effectiveness is the measurement of improvement in the employee's knowledge, skill and behavioural pattern within the organization as a result of training program.	Review the model of training effectiveness: Kirkpatrick's Model
	Kraiger et al; The Willey Blackwell Handbook of The Psychology of	ASTD survey ; 91 percent US companies use Level 1, 50 percent Level2 and 8 percent Level 4 (O'Toole	Level 4 used only in organisations where training and development are

	Training, Development and Performance Improvement, **2014**	2009) CIRO model by Warr e. all, compared to Kirkpatrick's CIPP (Context, Input, Process, Product) model Phillip's Five Level model compared to Kirkpatrick's model Holton's(1996) HRD Evaluation and Research Model	aligned. Have measurable output. Measurement before and after training. Educational applications Fifth level added - ROI

Tables 2.5 Methods of Evaluating Effectiveness of Training

2.4.6 Cross Industry Examination-Simulator Based Training

Literature Review

Segment	Author(s)/ Title/Year	Inference	Remarks/Gap
Simulation in corporate world	Schrieber, A. N. (Ed.). (1970). Corporate Simulations Models. College on Simulation and Gaming of the Institute of Management Science, Providence, RI, and Graduate School of Business Administration of the University of Washington.	Decision support system outlines their principal characteristics and presents case studies of successful systems.	Corporate simulation enhances decision making capability.
	Salinger, M., & Summers, L. H. (1983). Tax reform and corporate investment: A micro-econometric simulation study. In Behavioral simulation methods in tax policy analysis (pp. 247-288). University of Chicago Press.	This paper develops a methodology for simulating the effects of alternative corporate tax reforms on the stock market valuation and investment plans of individual firms.	Helps in understanding stock market evaluation
	Codella, C., Jalili, R., Koved, L., Lewis, J. B., Ling, D. T., Lipscomb, J. S., ...& Turk, G. (1992, June). Interactive simulation in a multi-	A multi-user Virtual World has been implemented combining a flexible-object simulator with a	Flexibility of the system stems from the initial design decision to separatestyle from content makes

	person virtual world. In Proceedings of the SIGCHI conference on Human factors in computing systems (pp. 329-334). ACM.	multisensory userinterface, including hand motion and gestures, speech inputand output, sound output etc.	learning better.
	Woerner, J., Laengle, T., &Woern, H. (2002). Corporate planning and simulation of plant production facilities in the virtual world. In Proceedings of the 18th International Conference on CAD/CAM, Robotics and Factories of the Future, ISPE, INESC Porto, MSE Unit, Porto, Portugal (pp. 109-116).	A digital representation of complete production facilities will provide a lot ofnew features and possibilities in plant production.	Simulation helps understanding planning applications.
	Bos, N. D., Shami, N. S., &Naab, S. (2006). A globalization simulation to teach corporate social responsibility: Design features and analysis of student reasoning. Simulation & Gaming, 37(1), 56-72.	increasing need for business students to be taught the ability to think through ethical dilemmas faced by corporations conducting business on a global scale.	Learner can actively work through problems related to both ethics and corporate social responsibility.
Simulation for the Process Industries	http://www.gses.com/chemical-process-simulation accessed on 15 Jun 2014	The worldwide chemical processing industry is a keystone of the global economy.	chemical companies to improve performance through comprehensive

			simulation, training and engineering services.
	http://www.rheinmetall-defence.com/en/rheinmetall_defence/systems_and_products/simulation_and_training/index.php accessed on 15 Jun 2014	Simulators can be used under all weather conditions and around the clock.	Simulators spare real-world equipment from wear-and-tear and exposure to the elements, as well as enabling training in extreme situations that would be virtually impossible to practice in the field.
Simulation in Defence Forces	Baijal, R., Jha, V. N., Sinha, A., & Sharma, S. K. (2006). Simulator based spatial disorientation training in the Indian Air Force. Ind J Aerospace Med, 50(2), 1-6.	Spatial Disorientation (SD) prevention strategies need to focus on four major categories: education, training, research and equipment.	Post training, the SD awareness increased significantly. Realism of illusions in the simulator was foundto be satisfactory by 15% of pilots and good to excellent by 85%. Overall experience in using simulators in training very good.
	Holcomb, J. B., Dumire, R. D., Crommett, J. W., Stamateris, C. E., Fagert, M. A., Cleveland, J. A.,	Evaluation of trauma team performance using an advanced human patient simulator for	Human patient simulation (HPS) has been used since 1969 for

	... & Mattox, K. L. (2002). Evaluation of trauma team performance using an advanced human patient simulator for resuscitation training. Journal of Trauma and Acute Care Surgery, 52(6), 1078-1086.	resuscitation training for the medical/paramedical staff.	teaching purposes.
Simulation in Healthcare Industry	Sutherland, L. M., Middleton, P. F., Anthony, A., Hamdorf, J., Cregan, P., Scott, D., &Maddern, G. J. (2006). Surgical simulation: a systematic review. Annals of surgery, 243(3), 291.	Skill practice by surgeons can be done on simulators.	Surgical simulation with or without computers is a good aid to learning as it doesn't need a patient.
	http://www.ansys.com/ Accessed on 15 Jun 2014	To analyzepotential nuclear plant accidents. While the likelihood that any of these events would ever happen is extremely small, the analyses are an important component of ongoing research	Simulation improves hearing aid performance while saving time and money by quickly iterating through design alternatives.
	http://www.cooperindustries.com/content/public/e	The CYME software provides powerful	The CYME software provides powerful

	n/power_systems/solutions/power_system_simulation.html Accessed on 15 Jun, 2014	capabilities that support the detailed modeling of any distribution, industrial or transmission network of any scale and complexity	capabilities that support the detailed modeling of any distribution, industrial or transmission network of any scale and complexity.
Simulation in Power Industry	http://www.gses.com/power-plant-simulation accessed on 15 Jun 2014	For more than 40 years, GSE has been developing next-generation, custom training simulation technologies.	Simulation training strongly complements the value of on-the-job and classroom training by presenting a means of "hands-on" learning

Tables 2.6 Cross Industry Examination-Simulator Based Training

2.5 Epilogue

This Chapter has summarized the use of maritime simulator to predict seafarer training effectiveness. This study has mentioned the important benefits, challenges and types of maritime simulator to reduce the accidents in sea and develop efficiency and provide the marine engineers the essential confidence and experience in their work. This study has also discussed the importance of seafarer training and the issues they faced in marine industry. Several studies have been provided by various authors based on effectiveness of seafarer training through simulation. Thus maritime simulator training can be used to develop the proficiency level in those aspects or tasks in which marine experience proves to be deficient or ineffective. This cost in time is similar and the simulator can offer the chance for seafarer and mariner to develop their skills in some navigation and seamanship tasks over a small time period. It can be inferred that maritime simulators cannot replace the actual experiences of ship it being no alternative for depth of skills made feasible through the operations of ship in real surroundings over a time period.

This chapter also reviews work related to effectiveness of seafarer training using maritime simulation done by several researchers. This chapter has discussed benefits, challenges and types of maritime simulator the importance of seafarer training using simulation, issues faced by seafarers and effectiveness of seafarer training through simulation and finally future scope of maritime simulation in seafarer's training.

CHAPTER 3

3. Research Methodology

3.1 Introduction

Based on the literature review, the research gap, research problem, research questions and research objectives were formulated as below.

3.2Research Gap

For more than 40 years, researchers have lauded the benefits of simulation (Wolfe and Crookall, 1998), very few of these claims are supported with substantial research (Miles et al., 1986, Butler et al., 1988).

How to evaluate the training effectiveness of simulators is still a major challenge (Feinstein and Cannon, 2002; Hayes

The researcher could not locate any significant information/research work on the effectiveness of marine training using simulators in India.

3.3 Research Problem

Based on the objectives of the research, having reviewed the environment of the marine/offshore industry, relationship between variables and the consequences of the same the research problem is as defined below;

Research Problem: Maritime/Offshore industry has seen a number of failures due to safety issues and human errors resulting in huge losses.

Background & Need for the research: The marine and offshore market is booming with activities. More and more vessels, ranging from general use to much specialised applications are being added to the existing fleet. To safely man these vessels and to carry out the operations with least down time and maintaining highest standards of safety, it is the need of the hour that we have very high standards of training procedures in place. To ensure that these training standards are implemented, the training simulators are already contributing a lot.

3.4 Research Questions

This study aims to find answers to the following research questions:

- What different types of simulators are in use in maritime training in India?
- What is the effectiveness of the seafarer's training using simulators & how to evaluate the same?
- Are the simulators a motivating tool for learning?
- Is there a change in knowledge, attitude and skill levels after training?
- Is the knowledge acquired being used in work place?
- Does the organisation get benefitted by the training imparted?

3.5 Research Objectives

The objectives of the research are as below:

- To find out different types of simulators being used in maritime training.
- To measure the effectiveness of seafarer's training using maritime simulators by;
    i. Identifying the favourable and unfavourable perceptions of the trainees for all the factors of simulator training as motivating aid to learning.
    ii. Identifying the favourable and unfavourable perceptions of the trainees for all the factors of the change in knowledge, attitude and skills.
    iii. Identifying the favourable and unfavourable perceptions of the trainees for all the factors of the knowledge acquired and the same being used on the job.
    iv. Identifying the favourable and unfavourable perceptions of the employers/organisation for all the factors of benefits they get by employing seafarers trained on simulators.

3.6 Research Methodology

Research methodology is the section that gives the details of the methods and tools taken in hand to analyze the data collected and to find the solution for the problem defined. The aim of the research methodology is to find the appropriate techniques of paradigm, design of research, sampling techniques, data collection methods and the validating parameters that are followed in the study and finally the ethical principles taken in the study. The section in addition, will explain the hypothesis testing.

According to Kothari, "research in general, refers to a search for knowledge. Research may also be defined as a scientific and systematic search for relevant information on a particular topic". Many authors also agree to define research as a way of investigating a problem scientifically. The Advanced Learner's Dictionary of Current English has also defined research in its own way. As per the dictionary the meaning of research is a careful investigation to get new facts about any branch of knowledge. Research methods may be defined as those techniques which are utilised to conduct research. We can simply observe that research methods, research techniques are the methods a researcher uses while carrying out research operations.

Systematically solving a research problem, using various research techniques, is the simplest way to define research methodology. Research methodology can easily be explained as a systematic way of studying how to carry out research in a scientific way. Researcher needs to know the steps that are generally adopted for carrying out his research, based upon the research problem and the objectives set for the same. Thus it makes it necessary for the researcher to know both the research methods/techniques and the methodology.

3.7 Research Paradigm

Research, in common refers to the search for knowledge and it can also be defined as the scientific and systematic study for the information on the particular theme. Research is the careful investigation of the new facts and branch of the knowledge.

A research model can be defined as an outline of methods, standards and attitudes. Researchers will make their investigation using the values and beliefs defined in the research model (Krauss, 2005). Research paradigms are widely considered as of two types. They are (1) Positivism and (2) Interpretivism (Kothari &Prakasam 1990).

The term positivism can be also determined as the quantitative investigation. It is purposeful in character. Positivism is carried out with the help of numerical data, statistics and figures. On the contrary, Interpretivism is called as qualitative method of research. It is biased in nature. This investigation will be handled by the investigator with the help of text analysis and interpretation.

3.8 Research Paradigm Adapted

A mixed paradigm will be used in this study. The investigator makes use of both the Interpretivism and positivism paradigms. Interpretivism is the type followed in the study because the author has compiled the descriptive information for finding the difficulty proposed in the work. In addition, positivism will also be taken for the collection of primary data through surveys.

The study will attempt to investigate the effectiveness of seafarer's training using simulators in maritime and offshore sector in India. The effectiveness of training imparted by using simulators in maritime sector worldwide has been a matter of interest and more so in India and nothing significant has been done in this regard. Hence, the research aims to the study of the role of simulators in the maritime industry and to measure the effectiveness of the seafarer's training using maritime simulators.

For the purpose of this research the Kirkpatrick's model has been suitably adapted. Questionnaires have been accordingly prepared and tested for the suitability for Indian scenario.

3.9 Research Approach

A method that is followed by the investigator is called as the research approach (Gliner and Morgan, 2000). Research process may be divided in two major approaches. They are qualitative and quantitative research approaches (Teddie&Tashakjori 2003).

3.10 Research Steps Flowchart

The flowchart below illustrates the research steps.

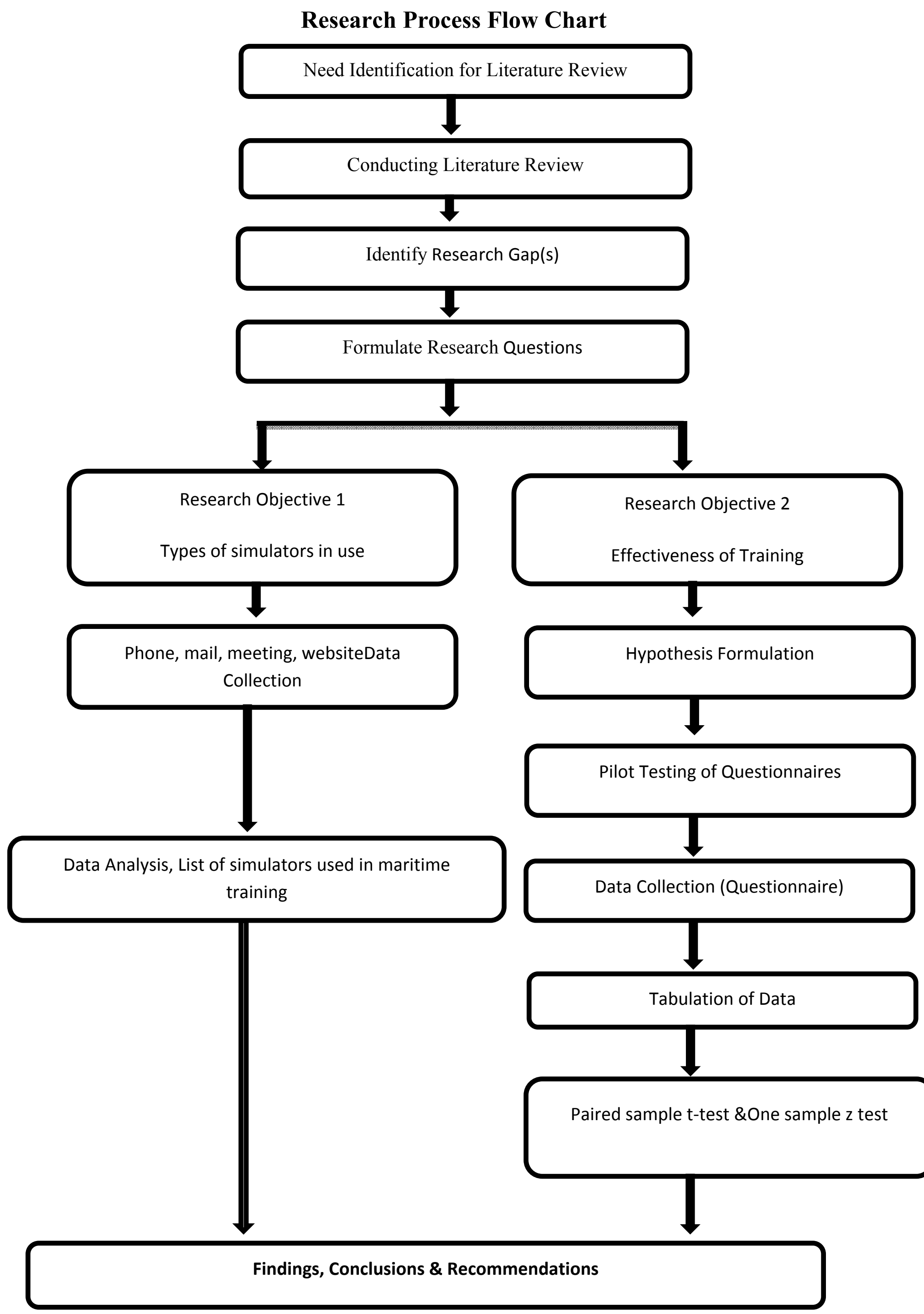

Figure 3.1 Research Steps

3.11 Research Design

Research design may be defined as the arrangement of a different way for collection of data, analysing the data mainly to match relevance to purpose of the research. Practically, the research design is considered as the conceptual procedure and structure under which research is taken up. This procedure certifies the basic procedure on how to collect measure and analyse the data for the research. According to Webb (1966) research design is a procedure in where an investigator can really change the research questioning development into research examination process to acquire an answer for the issues. The process will be varied according to the investigator's perspectives.

Research design is of two major segments. They are exploratory and conclusive research types. The conclusive research type will be divided into descriptive and causal research design types. Other kinds in research plan method are popularly used are experimental research and the non-experimental research type.

Research Design can be split into the following:-

- The sampling design and
- The observational design.

3.12 Definition of Variables

Perception of the training usefulness: According to Sharp (2007) it is the organized activity targets on the imparting of the information and the instructions that will help to improve the performance of the person to help him/her in attaining the required level of knowledge and skill.

- Efforts to gain knowledge & skills: It is the hard work and effort taken by the person in the aim of getting the experience or knowledge about the work (Sharp 2007).
- Self-efficacy of person: It is defined as the individual's belief about himself/herself and capability to fulfil the work or the deal with many challenges in life.

- Application of the knowledge received: It is the use of the knowledge and experience in the required place or time (Carter 1997).

3.13 Hypothesis Formulation

Based upon Kirkpatrick's model, suitably adapted to marine training evaluation, the researcher intends testing if the trainees rate the simulators in marine training a motivating aid to learning? Is there a change in the knowledge, attitude and skills of participants after the training? Whether the knowledge thus acquired during training is being used by the seafarers on the job? The trained seafarers are employed by the organisations; do these organizations get benefitted by employing seafarers trained on simulators? The following null hypotheses were formulated;

3.13.1 Main Hypotheses

Hypothesis #1

H1 $_0$: There is no significant difference in the perception of the trainees for all the factors of simulator training as motivating aid to learning. **(H_0: $\mu = 3$).**

H1 $_a$: There is a significant difference in the perception of the trainees for all the factors of simulator training as motivating aid to learning. **(H_1: $\mu \neq 3$).**

Hypothesis #2

H2 $_0$: There is no significant difference in the perceptions of the trainees for all the factors of the change in knowledge, attitude and skills. **(H_0: $\mu = 3$).**

H2 $_a$: There is a significant difference in the perceptions of the trainees for all the factors of the change in knowledge, attitude and skills.**(H_1: $\mu \neq 3$).**

Hypothesis #3

H3 $_0$: There is no significant difference in the perceptions of the trainees for all the factors of the knowledge acquired and the same being used on the job. **(H_0: $\mu = 3$).**

H3 $_a$: There is a significant difference in the perceptions of the trainees for all the factors of the knowledge acquired and the same being used on the job.**(H_1: $\mu \neq 3$).**

Hypothesis #4

H4 $_0$: There is no significant difference in the perceptions of the employers/organisations for all the factors of benefits they get by employing a seafarer trained on simulator. **(H_0: $\mu = 3$).**

H4 $_a$: There is a significant difference in the perceptions of the employers/organisations for all the factors of benefits they get by employing a seafarer trained on simulator. **(H_1: $\mu \neq 3$).**

For testing each hypothesis, sub hypotheses were developed. The sub hypotheses formulated for each level are as below;

3.13.2 Sub-hypotheses

Sub-hypotheses for Hypothesis #1

Out of the total twelve questions for level 3, it was decided to choose the most relevant to indicate the knowledge and skills acquired during training is being used by the seafarers on the job. A total of eight questions were picked up and analyzed by formulating hypothesis.

Sub-hypotheses 1.1:

H1.1 $_0$: The use of simulator to the subject training is not pertinent.

H1.1 $_a$: The use of simulator to the subject training is pertinent.

Sub-hypotheses 1.2:

H1.2 $_0$: The simulator training was not presented in an interesting way.

H1.2 $_a$: The simulator training was presented in an interesting way.

Sub-hypotheses 1.3:

H1.3 $_0$: The audio-visual aids used in simulator were not effective.

H1.3 $_a$: The audio-visual aids used in simulator were effective.

Sub-hypotheses 1.4:

H1.4 $_0$: The simulation facilities were not suitable.

H1.4 $_a$: The simulation facilities were suitable.

Sub-hypotheses 1.5:

H1.5 $_0$: There was no good balance between presentation and simulation.

H1.5 $_a$: There was a good balance between presentation and simulation.

Sub-hypotheses 1.6:

H1.6 $_0$: I feel that the simulator training will not help to do the job better.

H1.6 $_a$: I feel that the simulator training will help to do my job better.

Sub-hypotheses 1.7:

H1.7 $_0$: The simulator use did not meet all needs of the course.

H1.7 $_a$: The simulator use met all needs of the course.

Sub-hypotheses 1.8:

H1.8 $_0$: The simulator does not relate directly to job responsibilities.

H1.8 $_a$: The simulator relates directly to job responsibilities.

Sub-hypotheses 1.9:

H1.9 $_0$: The overall impression of the simulator was not good.

H1.9 $_a$: The overall impression of the simulator was good.

Sub-hypotheses for Hypothesis #2

Out of the total fourteen questions for level 2, it was decided to choose the most relevant to indicate the change in knowledge, attitude and skill levels of the trainees. Five questions indicating that the trainees' level of knowledge and skill are improved were picked up and analysed by formulating hypothesis.

Sub-hypotheses 2.1:

H2.1 $_0$: The skills/knowledge imparted was not applicable to job.

H2.1 $_a$: The skills/knowledge imparted was applicable to job.

Sub-hypotheses 2.2:

H2.2 $_0$: This simulator course did not help do job better.

H2.2 $_a$: This simulator course helped do job better.

Sub-hypotheses 2.3:

H2.3 $_0$: The class room training did not help to do job better.

H2.3 $_a$: The class room training helped to do job better.

Sub-hypotheses 2.4:

H2.4 $_0$: The course training did not improve confidence levels.

H2.4 $_{a}$: The course training improved confidence levels.

Sub-hypotheses 2.5:

H2.5 $_{0}$: The simulator did not improve confidence levels.

H2.5 $_{a}$: The simulator improved confidence levels

Sub-hypotheses for Hypothesis #3

Out of the total twelve questions for level 3, it was decided to choose the most relevant to indicate the knowledge and skills acquired during training is being used by the seafarers on the job. A total of eight questions were picked up and analyzed by formulating hypothesis.

Sub-hypotheses 3.1:

H3.1 $_{0}$: Participant did not have the opportunity to use the knowledge and/or skills presented in this course.

H3.1 $_{a}$: Participant had the opportunity to use the knowledge and/or skills presented in this course.

Sub-hypotheses 3.2:

H3.2 $_{0}$: Participant did not use the knowledge and/or skills presented in this course, to good extent.

H3.2 $_{a}$: Participant used the knowledge and/or skills presented in this course, to good extent.

Sub-hypotheses 3.3:

H3.3 $_{0}$: There is no increase in confidence using knowledge and skills as a result of this course.

H3.3 $_{a}$: There is an increase in confidence using knowledge and skills as a result of this course.

Sub-hypotheses 3.4:

H3.4 $_{0}$: Participant did not have a good access to the necessary resources to apply the knowledge and/or skills on the job.

H3.4 $_{a}$: Participant had a good access to the necessary resources to apply the knowledge and/or skills on the job.

Sub-hypotheses 3.5:

H3.5 $_{0}$: As a result of this course, performance on the course objectives has not changed for good.

H3.5 $_a$: As a result of this course, performance on the course objectives has changed for good.

Sub-hypotheses 3.6:

H3.6 $_0$: Participant did not receive help, through coaching and/or feedback, with applying the knowledge and/or skills on the job.

H3.6 $_a$: Participant received help, through coaching and/or feedback, with applying the knowledge and/or skills on the job.

Sub-hypotheses 3.7:

H3.7 $_0$: As a result of this course, overall job performance has not improved.

H3.7 $_a$: As a result of this course, overall job performance has improved.

Sub-hypotheses 3.8:

H3.8 $_0$: The simulator training did not help do job better.

H3.8 $_a$: The simulator training helped do job better.

Sub-hypotheses for Hypothesis #4

Out of the total eight questions for level 4, it was decided to choose the most relevant to indicate that the organisation employing seafarers trained using simulators get benefitted. A total of seven questions were picked up and analysed by formulating seven sub hypotheses as given below;

Sub-hypotheses 4.1:

H4.1 $_0$: There are no benefits realised by the organization after the employee attended the course.

H4.1 $_a$: There are benefits realised by the organization after the employee attended the course

Sub-hypotheses 4.2:

H4.2 $_0$: After the training employees' actions have not improved safety of vessel operations.

H4.2 $_a$: After the training employees' actions have improved safety of vessel operations.

Sub-hypotheses 4.3:

H4.3 $_0$: After the training employees' employees' actions have not improved the safety of people onboard.

H4.3 $_a$: After the training employees' employees' actions have improved the safety of people onboard.

Sub-hypotheses 4.4:

H4.4$_0$: After training the employees' actions have not improved safety of own vessels/vessels & other installations.

H4.4$_a$: After training the employees' actions have improved safety of own vessels/vessels & other installations.

Sub-hypotheses 4.5:

H4.5 $_0$: There is no good change in the attitude of the employee after training.

H4.5 $_a$: There is a good change in the attitude of the employee after training.

Sub-hypotheses 4.6:

H4.6 $_0$: There is no good change in the behaviour of the employee after training.

H4.6 $_a$: There is a good change in the behaviour of the employee after training.

Sub-hypotheses 4.7:

H4.7 $_0$: The contribution of the employees/s trained on simulators did not result in better performance of the organisation.

H4.7 $_a$: The contribution of the employees/s trained on simulators resulted in better performance of the organisation.

3.14 Sampling Design

A sampling design is a process which specifies the probability for every possible sample of being selected. There are different ways of sampling design; some of the often used methods are as listed below;

- Simple random sampling
- Systematic Sampling
- Stratified Sampling
- Cluster Sampling
- Alternative ways of Sampling include convenience sampling, quota sampling, purposive sampling and snowball sampling.

The observational design may be divided in to following types, which may useful under different circumstances. From Morse (2003), sampling design is the procedure to define the type of data to be compiled from outsized inhabitants. There are two methods of sample techniques. They are:

1. Non random sampling or Non-probability sampling.

2. Random sampling or probability sampling.

Probability sampling is also called as random sampling and it is the one from which every member of explicit inhabitants has comparable likelihood of being chosen. There are four types of likelihood sampling methods. They are (i) Systematic sampling ii) Clustered sampling (iii) Simple random sampling and (iv) Stratified sampling (Lietz et all 2006)

Denzin (1970) defines, on contrary, non-probability or non-random sample method is the one in where samples are chosen on the basis of their accessibility and individual decision rather than in a random style. The four types of non-probability techniques are (i) Judgmental sampling, (ii) Quota sampling (ii) Snowball sampling and (iv) Convenience sampling.

3.14.1 Sampling Design Adapted

This research makes use of both random sampling methods and convenience sampling method. The study targets the seafarers in India to know the effectiveness of the marine and offshore simulators in training. Simple random sampling will be used since to select the respondents in the random manner. The researcher desires to conduct the study without any bias. The data collection took place between March 2013 to April 2014 from the following training centres.

St. Xavier's Maritime Training Centre Mumbai.

Sir Derek Bibby Maritime Training Centre, Mumbai

Oceans XV Maritime Training Centre, New Delhi

Sir Derek Bibby-Oceans XV Maritime Training Centre, New Delhi

Looking at the above, it may well be observed that the sampling process adopted for the study may also be called convenience sampling.

Greene (2008) clarifies that convenience sampling where used in a study to derive the conclusions from the experts or the professionals of the marine industry. The aim of the study is to find the effectiveness of the simulators currently in use for maritime and offshore training. The study needs to select the respondents for the qualitative sampling in the special departments and hence the study follows the convenient sampling methods.

3.14.2 Target Population

The target population in this research is the candidates (trainees) of the maritime training centers as indicated above attending various courses which make use of simulators in this process.

3.14.3 Survey Sample

Considering the practical difficulties with responses from large survey group/s (population), a meaningful survey sample size had to be determined. An appropriate sample size was calculated with due considerations in mind about the use of simulators by the seafarers in various training courses.

3.14.4 Sample Size Criteria

The following were considered to determine the size of the appropriate sample size;

- The level of precision,
- The confidence level or the risk level, and
- The degree of variability in the attributes being measured

The Level of Precision

The level of precision, also referred to as sampling error, may be defined as the range in which the true value of the population is estimated to be. It is usually expressed in percentage points (e.g., ±5 per cent).

The Confidence Level or the Risk Level

The risk level (confidence) is based on ideas inferred from the Central Limit theorem. The theorem indicates that when a population is repeatedly sampled, the average value of the attribute obtained by those samples is equal to the true population value. Also it assumes that the values obtained by these samples are distributed normally about true value, with some samples having a higher value and some obtaining a lower score than the true population value.

Generally 95% and 99% confidence levels are taken as the two known degrees of confidence for specifying the interval within which one may ascertain the existence of population parameter (e.g. mean). 95% confidence level means if an investigator takes 100 independent samples from the same population, then 95 out of the 100 samples will provide an estimate within the precision set by him. Again, if the level of confidence is 99%, then it means out of 100 samples 99 cases will be within the error of tolerances specified by the precision.

The confidence level of 95% has been chosen for this study.

The Degree of Variability

The degree of variability in the attributes being measured shows the distribution of attributes in the population. In a heterogeneous a population, the sample size is required should be larger, to obtain a given level of precision. In case of less variable (more homogeneous) population, smaller sample sizes works very well. For an example, a proportion of 0.5 (50%) indicates a greater level of variability as compared to either 20% or 80%. This is because 20% and 80% indicate that a large do not or do, respectively, have the attribute of interest. Because a proportion of 0.5 indicates the maximum variability in a population, it is often used in determining a more conservative sample size.

Hence the population proportion chosen for this study is 0.5. As the trainees coming for the simulator based training belong to a considerably homogenous group (The seafarers).

The probable sample size arrived at is 331 participants. Keeping in view the safety margins of approximately 10% the sample size decided is 360 course participants.

3.14.5 Sampling Plan for this Study

It has been planned to collect the data from the participants of the maritime training centers. The study will make use of the research questions to collect the data. The study will make use of the personal visits/emails, Interviews, Survey method, and observation during the training process will be taken.

During the research period, there were 2850 students/officers trained at the four training centres chosen for research. The four training centres are;

- St. Xavier's Maritime Training centre, Mumbai
- Sir Derek Bibby Maritime Training Centre, Mumbai
- Oceans-XV Maritime Training Centre, new Delhi and
- SDB-Oceans XV Training Centre, New Delhi

Out of these 2850 students 1922 were trained using simulators.

Hence N is equal to 1922. A 95% confidence level is considered acceptable and thus we can assume that the statistical of z is equal to 2. The relevant responses to survey is p if we take p is = 0.5 we arrive at a new formula as given below.

3.15 Mathematically Derived Yamane Formula

If we use other values for p, the denominator values will change and this would result in an increase/decrease in the response size as shown in the formulae. Considering this p value of 0.5 has been considered for this study because this offers the maximum possible response rate and thereby confidence and risk values can be maintained.

Placing all these values in mathematical formulae above at a confidence level of 95% and an error value of 5 % we get the final calculations as below:

$$n = \frac{1922}{1 + 1922\,(0{,}05)^2} = 331 \text{ responses}$$

Three hundred thirty one responses would therefore be the lowest acceptable number of responses to maintain a 95% confidence level and a 5% error level. Keeping in view the safety margins, the sample size decided is 350 course participants.

3.16 Data Collection Method

Research information is nothing other than statistics or explanations on which examination or dispute is finished (Merriam 2009). Data may be collected in two types. They are primary data collection and secondary data collection. This research makes use of both of them.

3.17 Method Adapted to Collect Primary Data

Primary data is collected first time and also directly from the respondents by the own effort of the investigator (Hammersley 1992). The standard batch size is either six or twelve, but the batch may have between three to twelve participants. The sample size has been arrived at by using Yamane formula. The estimated sample size is 331course participants. Personal visits/emails, Interviews, for the primary data collection will be utilized. Survey method will be used for effectiveness. Also observation before, during and after training will also be made use of. Interviews/discussions of the participants be recorded for the first research objective. The questionnaire for the second research objective will utilize five point Likert scale. Validation process will be undertaken using Cronbach's Alpha Test.

For this research, the primary data is gathered with the support of open and close-ended questionnaires.

3.18 Method Adapted to Collect Secondary Data

According to Kennewell et all (2007) secondary data is the fact that is already prevails in some manner or other but does not mainly compiled for the first time for the purpose of research conducted at present. Secondary data is often the start point for data collection in as much as it is the first type of data to be collected. Secondary information will be available in progress and can be handled by means of the outside materials. This study makes use of books, journals, research papers and internet related to agile project management in order to collect secondary data. For this research, secondary data is also gathered from the websites of target companies. The magazines and journals from the marine industry were also used to collect the secondary data.

3.19 Instrument Design

In order to study the effectiveness of seafarer's training using simulators, it was decided to design a set of questionnaire for data collection. The data collection was done in four steps as below;

Level 1: To know the reaction of the trainees towards the training imparted.

Level 2: To understand if the learning has taken place and if there is change in knowledge, skill and attitude of the trainees.

Level 3: To know if the changed behaviour due to the training imparted is being used by the seafarers on the job.

Level 4: This crucial stage tries to investigate if the organisation has been benefitted by employing the seafarers trained on simulators.

Set of all questionnaires are attached at Annexure A.

Structured and non-disguised questionnaire were prepared and data collection was carried out from the course participants. The questionnaires were specially designed, to get the information required and are based on a five point Likert scale for each level based upon Kirkpatrick's adapted model.

3.20 Internal Consistency Reliability

To check the internal reliability characteristics the researcher opted to use the most utilised, Cronbach's alpha test. Cronbach's alpha is a reliability coefficient which indicates the degree of positive co-relation with each other. If the Cronbach's alpha is closer to 1, the items under test have the higher internal consistency reliability (Kerlinger, 1986). Cronbach's alpha values for these research variables were well above the acceptable values.

The results show that the internal consistency was high and scores for all the questionnaires were between .74 to .94.

Reliability Statistics

Level 1 Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.948	.954	19

Reliability Statistics

Level 2 Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.949	.952	14

Reliability Statistics

Level 3 Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.740	.726	11

Reliability Statistics

Level 4	Cronbach's Alpha Based on Standardized Items	N of Items
.800	.788	7

Figure 3.2 Reliability Statistics

3.21 Pilot Testing

Questionnaires were pretested among experts from the maritime training field. Based on the pretesting advice from the experts, a few items in the questionnaires were improvised or amended accordingly to avoid any ambiguity among survey respondents and finalized for the survey. The experts (marine trainers) included:

- Engineer:2
- GMDSS:3
- ECDIS:4
- DP : 4
- ARPA/ROC:2

The number of questionnaires sent to the experts is as mentioned below;

Level 1: 15

Level 2: 15

Level 3: 15

Level 4: 10

3.22 Data Collection

Personal visits and emails were used for the primary data collection. Secondary data was collected from all possible resources, including the official web site of the Directorate General of Shipping and the training centres conducting simulator based marine training.

Targets: The seafarers getting trained using simulators.

Simple random sampling used select the respondents in the random manner.

The researcher conducted the study without any bias. Data collection was carried out from March 2013 to April 2014 and was limited to the following training centres;

- St. Xavier’s Maritime Training Centre Mumbai.
- Sir Derek Bibby Maritime Training Centre, Mumbai
- Ocean’s-XV Maritime Training Centre, New Delhi
- Sir Derek Bibby-Oceans XV Maritime Training Centre, New Delhi

The following tools are utilised for this research:

- Charts and tables for diagrammatic representation
- Microsoft: Excel, power point and word
- Cronbach's Alpha test
- One sample z-test
- Paired sample t-test

Survey method has been used for measuring the effectiveness of training imparted by using maritime simulators. The course participants were observed before, during and after training. The questionnaires for the purpose was prepared based upon Kirkpatrick’s, served to the specialists in the field for their views and were tested for internal consistency using Cronbach’s Alpha

Test. The final questionnaires were used to collect the data for the following four levels;

- Reaction: To check trainees' perceptions
- Learning: To check knowledge/skills gained
- Behaviour: To check knowledge/skill used on the job?
- Results: To see effects of training on the organization

3.23 Data Analysis & Interpretation

Clark & Creswell (2011) says that the analysis and interpretation of the information involve the purposeful material in the control of the investigator and his biased reaction and needs to derive from the information the inherent sense in their connection to the issue. To evade making ends of the explanation from inadequate or unacceptable data, the last analysis must be predictable in detail. The investigator must decide whether or not the variables selected for the research will satisfy all the terms of the issue and if the sources to be utilized will give the necessary data. The information may be sufficient, dependable and valid to some extent and it do not provide any valuable purpose if not it is cautiously edited methodically classified and tabulated logically analyzed, cleverly interpreted and realistically finished. The analysis will be completed with the assist of graphical or numerical tools. The compiled data has to be evaluated in order to land at a termination (Dane, 2010). The examination of the statistics is followed by elucidation, which is making a finding based on examination of the information gathered. The data investigation and elucidation process helps the investigator to uncover a solution for the study issue recognized and research query proposed.

3.23.1 Statistical Tools Used

The study uses the following numerical tools by means of SPSS application to derive the results.

i. Cronbach's Alpha Test
ii. One sample z test
iii. Paired sample t-test

Cronbach's Alpha Test

This test is considered as an important concept in the process of evaluation of questionnaires. The correct estimation made by the researcher will add validity and accuracy while interpreting the data under investigation. Experience, however, shows that very often alpha has been reported and used without proper understanding and inadequate interpretation.

Nevertheless alpha has frequently been reported in a non-critical way and without adequate understanding and interpretation. It is important that the researchers be extra careful while reporting the alpha values for their studies.

One Sample z-test

A one sample z-test is a type of Univariate analysis. It is used whenever the variable is on Interval scale or Ratio scale. For this study, all the factors i.e. motivating, knowledge, attitude of the trainees and benefits of training to the organisation are on interval scale.

Paired Sample t-test

This test comes under the category of bivariate analysis. The researcher used the two variables namely pre training and post training scores of the trainees. Both the variables are related to each other. The data for both the variables is on ratio scale. Diagrammatical representation makes use of charts and tables.

3.23.2 Software Tools Used

i. Microsoft Excel

ii. Microsoft word

iii. SPSS 20

Microsoft Excel and word is also used in order to derive the results. Graphs will be evaluated for the percentage calculation from the collected primary data in this study.

Srinagesh (2006) says that SPSS is the acronym for Statistical Package for Social Sciences. It is a well-known statistical application used in various scientific sectors. The various very much used and benefited SPSS features are data processing and management, statistical analysis, creating derived data, data documentation, case selection; file reshaping and data compilation and so on. SPSS is basically a comprehensive system which is used for analyzing data.

3.23.3 Strategies for Validating Findings

Henges (2008) clarifies that the results acquired are validated for correctness with the support of two parameters by validity and reliability for any quantitative research. Qualitative research will need some four parameters like credibility, transferability, conformability and dependability. The researcher keeps the parameters in the study alive by collecting the required data which is relevant to the study and the questionnaires are not duplicated while answering and the study in addition is reputed and depended on the sources of data to make the evaluation. The study will be transferred in future for the elaboration of the investigation to other direction.

3.23.4 Ethical Considerations

From the books of White & Carvalho (1997) any research method has to be followed with some basic principles and likewise in this study the investigator maintains the ethical principles very sincerely. The researcher maintains ethics in this study by keeping the responses obtained strictly confidential. Besides, a prior verbal permission was taken by the researcher from the fifteen target companies before conducting the research. This was due to the fact that none was committal in writing considering the nature of data and the information contained therein.

3.23.5 Limitations

- Seafarer’s employment pattern: Seafarers employment pattern does not facilitate the data collection smoothly as some seafarers are employed for a short duration whereas others go for a long tenure onboard.
- Tracking seafarer’s employment after training: It is the market norm that a seafarer working for an Indian company today may be jumping

over to a foreign company tomorrow. Tracking such seafarers for data collection becomes a difficult task.

- Level 3 and 4 – difficulties: Data collection for the levels 3 and 4 are difficult as the seafarer may not be available on emails or phones. In some cases when the seafarer is back home after a long tenure, he is again involved in some or other training and by then he must have lost a track of the previous training.
- Companies unwilling to share info: Most company the researcher interacted, were not very supportive for such researches and data collection. Majority of them refused to discuss about the profitability of the organisation.

3.24 Epilogue

This chapter discussed the research methodology in general and the research methodology adapted for this research. The chapter begins with a brief introduction to research gap, research problem, research questions and research objectives. The steps followed in the research are depicted in the flow chart. The steps include the research design, definition of variables, hypothesis formulation, sample design, the target population, sampling plan and data collection. After the data collection and tabulation, the data analysis and interpretation using software and statistical tools is included. The chapter also includes the ethical consideration s for the study and its limitations.

CHAPTER 4

4. Data Analysis

4.1 Introduction

This chapter presents the data collected for this study, analysis of the data and the findings related to it. After coding and tabulating the data, all necessary assumptions of the tests utilised in carrying out the analysis. The average ratings for all the respondents for the factors are used as an input in regression analysis. The analysis using statistical software package (SPSS) version 20.
The other tools and tests used in carrying out the analysis are as mentioned below;

- Microsoft word, Excel, PowerPoint
- IBM SPSS version 20 – the following tests were conducted;
    - Cronbach's Alfa test
    - One sample z-test
    - Paired sample t-test

4.1.1 Cronbach's Alpha Test

Cronbach's alpha is the measure of reliability (i.e., internal consistency) by far most commonly used test for this purpose. It was originally calculated and presented by Kuder & Richardson (1937) for a study on dichotomously scored data (0 or 1) and later more work was done and thus popularised by Cronbach in 1951,this included more scoring methods. High alpha score (closer to 1) is taken as a good score. Going by experience a high alpha score is the result of high variance. A high variance means that the data is wide spread and this in turn means that the respondents can be easily differentiated.

Internal consistency is an indication of the levels to which all the questions measure the similar concept or construct. Hence this gets associated with the inter-dependence and relatedness of the items being used for the test. In most of the studies internal consistency of the data collected is recommended to be calculated before the data can be tested. This helps in determining the validity of the data. Measurement errors for a test are deployed to estimate the reliability.

If the estimate of reliability increases, the part of test score that is attributable to error will decrease. It may be good to note here that the reliability of a test influences the effect of measurement error over the observed score. This will further indicate that if the items in a test are strongly correlated, this will result in an increased alpha value. It is not necessary that a high coefficient alpha always results in a high level of internal consistency. The fact remains that the alpha score is also affected by the length of the test. If the length of the test is too short, the value of alpha is decreased.

For alpha test to be effective and meaningful, more related items testing the same concept should be added to the test. It is also important to note that alpha is a property of the scores on a test from a specific sample. Therefore it is recommended that researchers should measure alpha each time the test is administered.

4.1.2 Use of Cronbach's Alpha

Good care must be taken while applying the alpha test. If alpha test not used properly, it may lead to certain situations wherein either a test or scale may be wrongly discarded. This will lead to the test not giving trustworthy results. To avoid such a situation, researchers must be having an understanding of the concepts like internal consistency, homogeneity or unidimensionality which are closely related to alpha test. Good use of internal consistency, homogeneity should result in better results. The interrelatedness of a sample of test items depends on internal consistency. Homogeneity is related to unidimensionality. We may call a measure unidimensional if its items are capable of measuring a single latent trait or a construct.

Reliability of data depends upon quality of tests. High quality can evaluate the reliability of data for research study. More often the researchers use alpha as measure of reliability. Alpha may be affected by the length of the test and the dimensionality. At the same time it may be noted that a high value of alpha ($>$ 0.90) may indicate redundancies and this could be an indication that the length of the test may be decreased.

4.1.3 Importance of Alpha Test

Alpha test is considered as an important concept in the process of evaluation of questionnaires. The correct estimation made by the researcher will add validity and accuracy while interpreting the data under investigation. Experience, however, shows that very often alpha has been reported and used without proper understanding and inadequate interpretation.

Nevertheless alpha has frequently been reported in a non-critical way and without adequate understanding and interpretation. It is important that the researchers be extra careful while reporting the alpha values for their studies.

4.2 One Sample z-test:

One sample z-test is a well utilised statistical test to determine if the two population means are different. It assumes that the variances are known and the sample size is assumed to be large. Also it is assumed that the test statistic is normally distributed. The other parameters, generally referred to as nuisance parameters, for example, standard deviation is expected to be known. This helps in executing the z-test more accurately.

Z-test is a statistical test where normal distribution is applied and is more often used, while dealing with data related to large samples ($n \geq 30$.

Where,

n = sample size

4.2.1 *z-test* for Different Purposes

The z-*test* can be categorized differently for different purposes. Common type of z test being used in research are given below:

1. Single proportion z - test; This is used to test a hypothesis for a specific value from the population proportion.
2. z test for difference of proportions; this test is used to test a hypothesis that has two populations having same proportion. Two independent samples are obtained and tested.
3. Single mean z -test: These tests are often utilized to test a hypothesis for a specific value of the population mean. Unlike the t-test for single mean, this test is used if $n \geq 30$ and population standard deviation is known.
4. z test for single variance; this test is used while testing hypothesis against a specific value of variance of population. We can say that the test helps us to ascertain if the sample has been taken from a population which has a specific variance.
5. Equality variance z-test; this test is utilized while testing hypothesis for the equality of variance of two populations. Each sample size is 30 or more.

All the above z – test assume that the samples are drawn from a normally distributed population.

4.2.2 Assumptions for One-Sample z test

Major assumptions on one-sample z-test are based on sampling, measurement and distribution of the population. One-sample z-test is still considered ok it violates the normal distribution. This may indicate that even if some assumptions are violated it doesn't result into serious errors while carrying out the test. This is based on the premise of the central limit theorem that if the sample size is more the data falls into the normal distribution of sample (approximate) even if the population is not normally distributed.

4.3 Paired Sample t-test

When we use t-test for dependent means we may like to know if there is a difference between populations when the data is considered dependent or linked to each other. Dependent t-test or paired sample t-test is used to test

sample means. The hypothesis test is carried out to see whether there is a difference between two means or if they come from two different populations.
The dependent sample t-test compares the mean difference of two sample scores which are generally linked for e.g. before process and after process.
This gives us an opportunity to check whether there is a significant difference in the average value of measurements made before treatment and after treatment of the data.
A normally made null hypothesis will be for e.g. " the difference in the mean value is zero"

4.4 Statistical Tests for this Research

To measure the effectiveness of training, the data (examination results) collected before and after training was analysed using paired sample test. All twelve courses evaluated, and a course summary of all the tests results are as given below;

4.4.1 DP Basic Course

```
T-TEST PAIRS=POSTSCORE WITH PRESCORE (PAIRED)
  /CRITERIA=CI (.9500)
  /MISSING=ANALYSIS
```

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	POSTTRG	78.7391	46	8.26622	1.21879
	PRETRG	29.0217	46	13.89083	2.04809

Paired Samples Correlations

	N	Correlation	Sig.
DP Basic Course	46	.500	.000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	POSTTRG - PRETRG	49.71739	12.10264	1.78444	46.12335	53.31143	27.862	45	.000

Figure 4.1Paired Samples Statistics

There was a significant difference in the scores for Before Training (M=29.02, SD=13.89) and After Training (M=78.73, SD=8.26). Conditions; t (45)=27.86, p = .000

4.4.2 DP Advanced Course

```
T-TEST PAIRS=POSTSCORE WITH PRESCORE (PAIRED)
 /CRITERIA=CI (.9500)
 /MISSING=ANALYSIS
```

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	POSTTRG	79.4872	39	4.69530	.75185
	PRETRG	46.2051	39	9.41214	1.50715

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	POSTTRG & PRETRG	39	.017	.919

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	POSTTRG - PRETRG	33.28205	10.44774	1.67298	29.89529	36.66882	19.894	38	.000

Figure 4.2 Paired Sample Statistics

There was a significant difference in the scores for Before Training (M=46.20, SD=9.41) and After Training (M=79.48, SD=4.69). Conditions; t (38)=19.89, p = .001

4.4.3 DP Technical & Maintenance Course

```
T-TEST PAIRS=POSTSCORE WITH PRESCORE (PAIRED)
  /CRITERIA=CI (.9500)
  /MISSING=ANALYSIS
```

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	POSTTRG	79.26	43	6.547	.998
	PRETRG	38.33	43	12.482	1.903

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	POSTTRG & PRETRG	43	.008	.961

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	POSTTRG - PRETRG	40.930	14.050	2.143	36.606	45.254	19.103	42	.000

Figure 4.3 Paired Sample Statistics

There was a significant difference in the scores for Before Training (M=38.33, SD=12.48) and After Training (M=79.26, SD=6.54). Conditions; t (42)=19.10, p = .001

4.4.4 DP Sea Time Reduction Course

```
T-TEST PAIRS=POSTSCORE WITH PRESCORE (PAIRED)
 /CRITERIA=CI (.9500)
 /MISSING=ANALYSIS
```

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	POSTTRG	81.5000	2	4.94975	3.50000
	PRETRG	32.0000	2	2.82843	2.00000

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	POSTTRG & PRETRG	2	-1.000	.000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	POSTTRG - PRETRG	49.50000	7.77817	5.50000	-20.38413	119.38413	9.000	1	.070

Figure 4.4 Paired Sample Statistics

There was not so significant difference in the scores for Before Training (M=32.00, SD=2.82) and After Training (M=81.5, SD=4.94). Conditions; t (1)=9, p = .070. The reason for this may be the size of N and hence the results are insignificant.

4.4.5 Anchor Handling Course

```
T-TEST PAIRS=POSTSCORE WITH PRESCORE (PAIRED)
 /CRITERIA=CI (.9500)
 /MISSING=ANALYSIS
```

Paired Sample Statistics

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	POSTTRG	80.93	15	7.126	1.840
	PRETRG	38.27	15	11.209	2.894

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	POSTTRG & PRETRG	15	-.225	.420

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	POSTTRG - PRETRG	42.667	14.573	3.763	34.596	50.737	11.339	14	.000

Figure 4.5 Paired Sample Statistics

There was a significant difference in the scores for Before Training (M=38.27, SD=11.20) and After Training (M=80.93, SD=7.12). Conditions; t (14)=11.33, p = .001

4.4.6 GMDSS UK Course

```
T-TEST PAIRS=POSTSCORE WITH PRESCORE (PAIRED)
  /CRITERIA=CI (.9500)
  /MISSING=ANALYSIS
```

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	POSTSCORE	77.2000	20	8.39549	1.87729
	PRESCORE	12.1000	20	3.46258	.77426

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	POSTSCORE & PRESCORE	20	-.229	.332

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	POSTSCORE - PRESCORE	65.10000	9.78667	2.18837	60.51970	69.68030	29.748	19	.000

Figure 4.6 Paired Sample Statistics

There was a significant difference in the scores for Before Training (M=12.10, SD=3.46) and After Training (M=77.20, SD=8.39). Conditions; t (19)=29.74, p = .001

4.4.7 GMDSS India Course

```
T-TEST PAIRS=POSTSCORE WITH PRESCORE (PAIRED)
  /CRITERIA=CI (.9500)
  /MISSING=ANALYSIS
```

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	POSTSCORE	75.3103	29	15.84997	2.94327
	PRESCORE	17.4483	29	7.26826	1.34968

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	POSTSCORE & PRESCORE	29	.119	.537

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	POSTSCORE - PRESCORE	57.86207	16.62984	3.08808	51.53641	64.18772	18.737	28	.000

Figure 4.7 Paired Sample Statistics

There was a significant difference in the scores for Before Training (M=17.44, SD=7.26) and After Training (M=75.31, SD=15.84. Conditions; t (28)=18.73, p = .001

4.4.8 ARPA Course

```
T-TEST PAIRS=POSTSCORE WITH PRESCORE (PAIRED)
 /CRITERIA=CI (.9500)
 /MISSING=ANALYSIS
```

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	POSTSCORE	79.92	25	5.582	1.116
	PRESCORE	15.92	25	8.573	1.715

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	POSTSCORE & PRESCORE	25	.317	.123

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	POSTSCORE - PRESCORE	64.000	8.622	1.724	60.441	67.559	37.116	24	.000

Figure 4.8 Paired Sample Statistics

There was a significant difference in the scores for Before Training (M=15.92, SD=8.57) and After Training (M=79.92, SD=5.58. Conditions; t (24)=37.11, p = .001

4.4.9 ROC Course

```
T-TEST PAIRS=POSTSCORE WITH PRESCORE (PAIRED)
  /CRITERIA=CI (.9500)
  /MISSING=ANALYSIS
```

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	POSTSCORE	80.20	25	2.739	.548
	PRESCORE	16.08	25	7.626	1.525

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	POSTSCORE & PRESCORE	25	-.232	.264

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	POSTSCORE - PRESCORE	64.120	8.681	1.736	60.537	67.703	36.931	24	.000

Figure 4.9 Paired Sample Statistics

There was a significant difference in the scores for Before Training (M=16.08, SD=7.26) and After Training (M=80.20, SD=2.73. Conditions; t (24)=36.93, p = .001

4.4.10 ECDIS UK Course

```
T-TEST PAIRS=POSTSCORE WITH PRESCORE (PAIRED)
  /CRITERIA=CI (.9500)
  /MISSING=ANALYSIS
```

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	POSTSCORE	79.59	34	6.224	1.067
	PRESCORE	43.91	34	14.440	2.476

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	POSTSCORE & PRESCORE	34	-.197	.263

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	POSTSCORE - PRESCORE	35.676	16.814	2.884	29.810	41.543	12.372	33	.000

Figure 4.10 Paired Sample Statistics

There was a significant difference in the scores for Before Training (M=43.91, SD=14.44) and After Training (M=79.59, SD=6.22). Conditions; t (33)=12.37, p = .001

4.4.11 ECDIS (DNV) Course

```
T-TEST PAIRS=POSTSCORE WITH PRESCORE (PAIRED)
  /CRITERIA=CI (.9500)
  /MISSING=ANALYSIS
```

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	POSTSCORE	78.83	36	5.921	.987
	PRESCORE	36.61	36	10.494	1.749

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	POSTSCORE & PRESCORE	36	.095	.583

ECDIS (DNV)

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	POSTSCORE - PRESCORE	42.222	11.551	1.925	38.314	46.131	21.931	35	.000

Figure 4.11 Paired Sample Statistics

There was a significant difference in the scores for Before Training (M=36.61, SD=10.49) and After Training (M=78.83, SD=5.92). Conditions; *t* (35) = 21.93, p = .001

4.4.12 ECDIS Type Specific Course

```
T-TEST PAIRS=POSTSCORE WITH PRESCORE (PAIRED)
  /CRITERIA=CI (.9500)
  /MISSING=ANALYSIS
```

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	POSTSCORE	80.7778	36	7.06343	1.17724
	PRESCORE	55.1667	36	8.83338	1.47223

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	POSTSCORE & PRESCORE	36	-.017	.923

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper			
Pair 1	POSTSCORE - PRESCORE	25.61111	11.40245	1.90041	21.75308	29.46915	13.477	35	.000

Figure 4.12 Paired Sample Statistics

There was a significant difference in the scores for Before Training (M=55.16, SD=8.83) and After Training (M=80.77, SD=7.06). Conditions; t (35) = 13.47, p = .001

4.4.13 Summary of Results – Paired Sample Test

The results of the paired t-test are summarized as below;

Course	**t-value**	***p*-value**	**Inference (α =0.025)**	**Remarks**
DP Basic	27.86	.001	Statistically significant	
DP Advanced	19.89	.001	Statistically significant	
DP Technical	19.1	.001	Statistically significant	
DP Sea Time Reduction	9	.070	Statistically Not significant	Due to small sample size (Only two)
Anchor Handling	11.33	.001	Statistically significant	
GMDSS UK	29.74	.001	Statistically significant	
GMDSS India	18.73	.001	Statistically significant	
ARPA	37.11	.001	Statistically significant	
ROC	36.93	.001	Statistically significant	
ECDIS UK	12.37	.001	Statistically significant	
ECDIS DNV	21.93	.001	Statistically significant	
ECDIS Type Specific	13.47	.001	Statistically significant	

Table 4.1 Summary of Results- Paired Sample Statistics

4.5 Hypothesis Testing

The following four hypotheses were tested using one sample z-test. The results for the hypothesis tests are as below;

Hypothesis #1

H1 $_0$: There is no significant difference in the perception of the trainees for all the factors of simulator training as motivating aid to learning. **(H_0: $\mu = 3$).**

H1 $_a$: There is a significant difference in the perception of the trainees for all the factors of simulator training as motivating aid to learning. **(H_1: $\mu \neq 3$).**

Hypothesis #2

H2 $_0$: There is no significant difference in the perceptions of the trainees for all the factors of the change in knowledge, attitude and skills. **(H_0: $\mu = 3$).**

H2 $_a$: There is a significant difference in the perceptions of the trainees for all the factors of the change in knowledge, attitude and skills.**(H_1: $\mu \neq 3$).**

Hypothesis #3

H3 $_0$: There is no significant difference in the perceptions of the trainees for all the factors of the knowledge acquired and the same being used on the job. **(H_0: $\mu = 3$).**

H3 $_a$: There is a significant difference in the perceptions of the trainees for all the factors of the knowledge acquired and the same being used on the job.**(H_1: $\mu \neq 3$).**

Hypothesis #4

H4 $_0$: There is no significant difference in the perceptions of the employers/organisations for all the factors of benefits they get by employing a seafarer trained on simulator. **(H_0: $\mu = 3$).**

H4 $_a$: There is a significant difference in the perceptions of the employers/organisations for all the factors of benefits they get by employing a seafarer trained on simulator. **(H_1: $\mu \neq 3$).**

Testing Hypothesis

H1 $_0$: There is no significant difference in the perception of the trainees for all the factors of simulator training as motivating aid to learning. **(H_0: $\mu = 3$).**

H_1 (a): There is a significant difference in the perception of the trainees for all the factors of simulator training as motivating aid to learning.**(H_1: $\mu \neq 3$).**

A one-sample z-test was run to determine whether the scores as calculated using Kirkpatrick's model and SPSS, were different from the hypothesized score of 3. The training scores are assumed to be normally distributed.

4.5.1 Sub-hypothesis for Level 1:

Out of the total nineteen questions for level 1, it was decided to choose the most relevant to indicate the motivational aspect of learning for the trainees. Nine questions indicating that the trainees rate simulator as motivational tool in training were picked up and analysed by formulating hypothesis.

Sub hypothesis H1.1:

H1.1 $_0$: The use of simulator to the subject training is not pertinent.

H1.1 $_a$: The use of simulator to the subject training is pertinent.

Sub hypothesis H1.2:

H1.2 $_0$: The simulator training was not presented in an interesting way.

H1.2 $_a$: The simulator training was presented in an interesting way.

Sub hypothesis H1.3:

H1.3 $_0$: The audio-visual aids used in simulator were not effective.

H1.3 $_a$: The audio-visual aids used in simulator were effective.

Sub hypothesis H1.4:

H1.4 $_0$: The simulation facilities were not suitable.

H1.4 $_a$: The simulation facilities were suitable.

Sub hypothesis H1.5:

H1.5 $_0$: There was no good balance between presentation and simulation.

H1.5 $_a$: There was a good balance between presentation and simulation.

Sub hypothesis H1.6:

H1.6 $_0$: I feel that the simulator training will not help to do the job better.

H1.6 $_a$: I feel that the simulator training will help to do my job better.

Sub hypothesis H1.7:

H1.7 $_0$: The simulator use did not meet all needs of the course.

H1.7 $_a$: The simulator use met all needs of the course.

Sub hypothesis H1.8:

H1.8 $_0$: The simulator does not relate directly to job responsibilities.

H1.8 $_a$: The simulator relates directly to job responsibilities.

Sub hypothesis H1.9:

H1.9 $_0$: The overall impression of the simulator was not good.

H1.9 $_a$: The overall impression of the simulator was good.

4.5.2 Test Analysis - Simulators as a Motivational Tool in Training.

The results are analysed using the table below;

Factors	**Hypothesis**	***p*-Value**	**Inference(α=0.025)**
Simulator as motivational tool in training	H1.1 $_{0:\ \text{sim-pertinent}}=3$ H1.1 $_{a:\text{sim-pertinent}} \neq 3$	.001	H_0 – Rejected H_1 – Accepted ($p < \alpha$)
	H1.2 $_{0:\ \text{sim-interesting}}=3$ H1.2 $_{a:\text{sim-interesting}} \neq 3$	.001	H_0 – Rejected H_1 – Accepted ($p < \alpha$)
	H1.3 $_{0:\ \text{sim-audio/video}}=3$ H1.3 $_{a:\text{sim-audio/video}} \neq 3$	.001	H_0 – Rejected H_1 – Accepted ($p < \alpha$)
	H1.4 $_{0:\ \text{sim-facilities}}=3$	.001	H_0 – Rejected H_1 – Accepted

	H1.4 a:sim-facilities $\neq 3$		$(p < \alpha)$
	H1.5 0: sim-ppt balance$=3$ H1.5 a:sim-ppt balance $\neq 3$	.001	H_0 – Rejected H_1 – Accepted $(p < \alpha)$
	H1.6 0: sim-job better$=3$ H1.6 a:sim-job better $\neq 3$	.001	H_0 – Rejected H_1 – Accepted $(p < \alpha)$
	H1.7 0: sim use-trg needs$=3$ H1.7 a:sim use-trg needs $\neq 3$	.001	H_0 – Rejected H_1 – Accepted $(p < \alpha)$
	H1.8 0: sim-jobrespo$=3$ H1.8 a:sim-jobrespo $\neq 3$	.001	H_0 – Rejected H_1 – Accepted $(p < \alpha)$
	H1.9 0: sim-Impression$=3$ H1.9 a: sim-Impression $\neq 3$	.001	H_0 – Rejected H_1 – Accepted $(p < \alpha)$

Table 4.2 Test Analysis Simulators as a Motivational Tool In Training

There is a statistically significant difference between means ($p < .05$) and, therefore, we can reject the null hypothesis and accept the alternative hypothesis.

These results suggest that trainees rate the simulators in marine training a motivating aid to learning.

4.5.3 Level 1- Reaction (Perception Table)

Factors	**Mean**	**Inference/Decision**
Simulator as motivational tool		
The use of simulator to the subject training is pertinent.	4.55	Perceived pertinent by the respondents.
The simulator training was presented in an interesting way.	4.57	Perceived interesting by the respondents.
The audio-visual aids used in simulator were effective.	4.49	Perceived effective by the respondents.
The simulation facilities were suitable.	4.45	Perceived suitable by the respondents.
Good balance between presentation and simulation.	4.44	Perceived balanced by the respondents.
The simulator training will help to do the job better.	4.56	Perceived helpful by the respondents.
The Simulator use met all needs of the course.	4.40	Perceived meeting all needs by the respondents.
The simulator relates directly to the job responsibilities.	4.40	Perceived related to the job by the respondents.
The overall impression of the simulator was "excellent."	4.48	Perceived "overall excellent" by the respondents.

Table 4.3 Level 1- Reaction (Perception Table)

4.5.4 Sub-hypothesis for Level 2:

Hypothesis #2

H2 $_0$: There is no significant difference in the perceptions of the trainees for all the factors of the change in knowledge, attitude and skills. **(H_0: $\mu = 3$).**

H2 $_a$: There is a significant difference in the perceptions of the trainees for all the factors of the change in knowledge, attitude and skills.**(H_1: $\mu \neq 3$).**

A one-sample z-test was run to determine whether the scores as calculated using Kirkpatrick's model and SPSS, were different from the hypothesized score of 3. The training scores were assumed to be normally distributed.

Out of the total fourteen questions for level 2, it was decided to choose the most relevant to indicate the change in knowledge, attitude and skill levels of the trainees. Five questions indicating that the trainees' level of knowledge and skill are improved were picked up and analysed by formulating hypothesis.

Sub hypothesis H2.1:

H2.1 $_0$: The skills/knowledge imparted was not applicable to the job.

H2.1 $_a$: The skills/knowledge imparted was applicable to the job.

Sub hypothesis H2.2:

H2.2 $_0$: This simulator course did not help to do the job better.

H2.2 $_a$: This simulator course helped to do the job better.

Sub hypothesis H2.3:

H2.3 $_0$: The class room training did not help to do the job better.

H2.3 $_a$: The class room training helped to do the job better.

Sub hypothesis H2.4:

H2.4 $_0$: The course training did not improve confidence levels.

H2.4 $_a$: The course training improved confidence levels.

Sub hypothesis H2.5:

H2.5 $_0$: The simulator did not improve confidence levels.

H2.5 $_a$: The simulator improved confidence levels.

4.5.5 Test Analysis - Change in Knowledge and Skill

The results were analysed using the table below;

Factors	**Hypothesis**	***p*-Value**	**Inference(α=0.025)**
Change in Knowledge & skills	H2.1 $_{0}$:$_{s\&k\ to\ job}$=3 H2.1 $_{a}$:$_{s\&k\ to\ job}$ ≠3	.001	H_0 – Rejected H_1 – Accepted ($p < \alpha$)
	H2.2 $_{0}$: $_{job\ better}$=3 H2.2 $_{a}$: $_{job\ better}$ ≠3	.001	H_0 – Rejected H_1 – Accepted ($p < \alpha$)
	H2.3 $_{0}$: $_{CR\ trg\ job\ better}$=3 H2.3 $_{a}$: $_{CR\ trg\ job\ better}$ ≠3	.001	H_0 – Rejected H_1 – Accepted ($p < \alpha$)
	H2.4 $_{0}$: $_{imp\ confi}$=3 H2.4 $_{a}$: $_{imp\ confi}$ ≠3	.001	H_0 – Rejected H_1 – Accepted ($p < \alpha$)
	H2.5 $_{0}$:$_{sim\text{-}confi}$=3 H2.5 $_{a}$:$_{sim\text{-}confi}$ ≠3	.001	H_0 – Rejected H_1 – Accepted ($p < \alpha$)

Table 4.4 Level 2: Change in Knowledge and Skill

There was a statistically significant difference between means ($p < .05$) and, therefore, we can reject the null hypothesis and accept the alternative hypothesis.

These results suggest that there is a change in the knowledge, attitude and skills of participants after the training.

4.5.6 Level 2 Learning - (Perception Table)

Factors	**Mean**	**Inference/Decision**
Change in Knowledge & skills		
The skills/knowledge imparted was applicable to the job.	4.51	Perceived applicable to their job by the respondents.
This course helped to do the job better.	4.42	Perceived helpful by the respondents.
The class room training helped to do the job better	4.39	Perceived helpful by the respondents.
The course training improved the confidence levels.	4.43	Perceived that the course improved confidence levels.
The simulator improvedthe confidence levels.	4.43	Perceived that the simulator improved confidence levels.

Table 4.5 Level 2 Learning (Perception Table)

4.5.7 Sub-hypothesis for Level 3

Hypothesis #3

H3 $_a$: There is a significant difference in the perceptions of the trainees for all the factors of the knowledge acquired and the same being used on the job.**(H_1: $\mu \neq 3$).**

H3 $_0$: There is no significant difference in the perceptions of the trainees for all the factors of the knowledge acquired and the same being used on the job. **(H_0: $\mu = 3$).**

A one-sample z-test was run to determine whether the scores as calculated using Kirkpatrick's model and SPSS, were different from the hypothesized score of 3. The scores were assumed to be normally distributed.

Out of the total twelve questions for level 3, it was decided to choose the most relevant to indicate the knowledge and skills acquired during training is being used by the seafarers on the job. A total of eight questions were picked up and analyzed by formulating hypothesis.

Sub hypothesis H3.1:

H3.1 $_0$: Participant did not have the opportunity to use the knowledge and/or skills presented in this course.

H3.1 $_a$: Participant have had the opportunity to use the knowledge and/or skills presented in this course

Sub hypothesis H3.2:

H3.2 $_0$: Participant did not use the knowledge and/or skills presented in this course, to good extent.

H3.2 $_a$: Participant used the knowledge and/or skills presented in this course, to good extent.

Sub hypothesis H3.3:

H3.3 $_0$: There is no increase in confidence using knowledge and skills as a result of this course.

H3.3 $_a$: There is an increase in confidence using knowledge and skills as a result of this course.

Sub hypothesis H3.4:

H3.4 $_0$: Participant did not have a good access to the necessary resources to apply the knowledge and/or skills on your job.

H3.4 $_a$: Participant had good access to the necessary resources to apply the knowledge and/or skills on your job.

Sub hypothesis H3.5:

H3.5 $_0$: As a result of this course, performance on the course objectives has not changed for good.

H3.5 $_a$: As a result of this course, performance on the course objectives has changed for good.

Sub hypothesis H3.6:

H3.6 $_0$: Participant did not received help, through coaching and/or feedback, with applying the knowledge and/or skills on the job.

H3.6 $_a$: Participant received help, through coaching and/or feedback, with applying the knowledge and/or skills on the job.

Sub hypothesis H3.7:

H3.7 $_0$: As a result of this course, overall job performance has not improved.

H3.7 $_a$: As a result of this course, overall job performance has improved.

Sub hypothesis H3.8:

H3.8 $_0$: The simulator training did not help do job better.

H3.8 $_a$: The simulator training helped do job better.

4.5.8 Test Analysis -Change in Behavior

Level 3 - The results are analyzed using the table below;

Factors	**Hypothesis**	***p*-Value**	**Inference(α=0.025)**
Change in behaviour	H3.1 $_0$: oppor to use k s=3 H3.1 $_a$:oppor to use k s $\neq$3	.001	H_0 – Rejected H_1 – Accepted ($p < \alpha$)
	H3.2 $_0$: act use k s =3 H3.2 $_a$: act use k s $\neq$3	.001	H_0 – Rejected H_1 – Accepted ($p < \alpha$)
	H3.3 $_0$: confiin k s =3 H3.3 $_a$:confiin k s $\neq$3	.001	H_0 – Rejected H_1 – Accepted ($p < \alpha$)
	H1.4 $_0$: resource in k s=3 H3.4 $_a$: resource in k s $\neq$3	.001	H_0 – Rejected H_1 – Accepted ($p < \alpha$)
	H1.5 $_0$: perfo change=3 H3.5 $_a$:perfo change $\neq$3	.001	H_0 – Rejected H_1 – Accepted ($p < \alpha$)
	H3.6 $_0$: coach f b=3 H3.6 $_a$: coach f b $\neq$3	.001	H_0 – Rejected H_1 – Accepted ($p < \alpha$)
	H3.7 $_0$: overall perfo=3 H3.7 $_a$: overall perfo $\neq$3	.001	H_0 – Rejected H_1 – Accepted ($p < \alpha$)

	$H3.8_{0 : sim-job\ better} = 3$ $H3.8_{a: sim-job\ better} \neq 3$	.001	H_0 – Rejected H_1 – Accepted ($p < \alpha$)

Table 4.6 Level 3- Change in Behavior

There was a statistically significant difference between means ($p < .05$) and, therefore, we can reject the null hypothesis and accept the alternative hypothesis. These results suggest that the knowledge acquired during training is being used by the seafarers on the job.

4.5.9 Level 3 Behavior (Perception Table)

Factors	**Mean**	**Inference/Decision**
Change in behavior		
To what extent did you use the knowledge and/or skills prior to attending this course?	3.34	Perceived using the knowledge/skills.
To what extent have you had the opportunity to use the knowledge and/or skills presented in this course?	4.04	Perceived to have good opportunity to use knowledge/skills presented.
To what extent have you actually used the knowledge and/or skills presented in this course, after completing the course?	4.17	Perceived to have used knowledge and skills after completing the course.
To what extent has your confidence in using the knowledge and/or skills increased as a result of this course?	4.33	Perceived increased significantly.
To what extent have you had access to the necessary resources to apply the knowledge and/or skills on your job?	3.99	Perceived to have good access to apply knowledge and skills.
As a result of this course, the performance on the course objectives has changed by.%	4.01	Perceived that performance on course objective has improved.
To what extent have you received help,	3.99	Perceived that help received to

through coaching and/or feedback, with applying the knowledge and/or skills on the job?		apply knowledge and skills on the job.
As a result of this course, the overall job performance has changed by %	4.16	Perceived that job performance improved significantly.
The simulator training helped to do the job better.	4.54	Perceived that simulator training helped to do the job better.

Table 4.7 Level 3 Behavior (Perception Table)

4.5.10 Sub-hypothesis for Level 4

Hypothesis #4

H4 $_0$: There is no significant difference in the perceptions of the employers/organisations for all the factors of benefits they get by employing a seafarer trained on simulator. **(H_0: $\mu = 3$).**

H4 $_a$: There is a significant difference in the perceptions of the employers/organisations for all the factors of benefits they get by employing a seafarer trained on simulator. **(H_1: $\mu \neq 3$).**

A one-sample z-test was run to determine whether the scores as calculated using Kirkpatrick's model and SPSS, were different from the hypothesized score of 3. The training scores were assumed to be normally distributed.

Out of the total eight questions for level 4, it was decided to choose the most relevant to indicate that the organisation employing seafarers trained using simulators get benefitted. A total of seven questions were picked up and analysed by formulating seven sub hypotheses as given below;

Sub hypothesis H4.1:

H4.1 $_0$: There are no benefits realised by the organization after the employee attended the course.

H4.1 $_a$: There are benefits realised by the organization after the employee attended the course.

Sub hypothesis H4.2:

H4.2 $_0$: After the training employees' actions have not improved safety of vessel operations.

H4.2 $_a$: After the training employees' actions have improved safety of vessel operations.

Sub hypothesis H4.3:

H4.3 $_0$: After the training employees' employees' actions have not improved the safety of people onboard.

H4.3 $_a$: After the training employees' employees' actions have improved the safety of people onboard.

Sub hypothesis H4.4:

H4.4 $_0$: After training the employees' actions have not improved safety of own vessels/vessels & other installations.

H4.4 $_a$: After training the employees' actions have improved safety of own vessels/vessels & other installations.

Sub hypothesis H4.5:

H4.5 $_0$: There is no good change in the attitude of the employee after training.

H4.5 $_a$: There is good change in the attitude of the employee after training.

Sub hypothesis H4.6:

H4.6 $_0$: There is no good change in the behaviour of the employee after training.

H4.6 $_a$: There is good change in the behaviour of the employee after training.

Sub hypothesis H4.7:

H4.7 $_0$: The contribution of the employees/s trained on simulators did not result in better performance of the organisation.

H4.7 $_a$: The contribution of the employees/s trained on simulators resulted in better performance of the organisation.

4.5.11 Level 4 – Results (Benefits to the Organization)

The results are analysed using the table below;

Factors	**Hypothesis**	***p*-Value**	**Inference(α=0.025)**
Benefits to the organization	H4.1 $_{0}$: benefit to org=3 H4.1 $_{a}$: benefit to org ≠3	.001	H_0 – Rejected H_1 – Accepted (p < α)
	H4.2 $_{0}$:improv act=3 H4.2 $_{a}$:improv act ≠3	.001	H_0 – Rejected H_1 – Accepted (p < α)
	H4.3 0c imp saf people=3 H4.3 $_{a}$: imp saf people ≠3	.001	H_0 – Rejected H_1 – Accepted (p < α)
	H4.4 $_{0}$: safety of surro=3 H4.4 $_{a}$: safety of surro ≠3	.001	H_0 – Rejected H_1 – Accepted (p < α)
	H4.5 $_{0}$: attitude change=3 H4.5 $_{a}$: attitude change ≠3	.001	H_0 – Rejected H_1 – Accepted (p < α)
	H4.6 $_{0}$:behaviour change=3 H1.6 $_{a}$:behaviour change ≠3	.001	H_0 – Rejected H_1 – Accepted (p < α)
	H4.7 $_{0}$: org performance=3 H4.7 $_{a}$: org performance ≠3	.001	H_0 – Rejected H_1 – Accepted (p < α)

Table 4.8 Level 4 – Results (Benefits to the Organization)

4.5.12 Level 4: Results (Perception Table)

Factors	Mean	Inference/Decision
Benefits to the organization		
What benefits have you, your team, and/or the organization realized so far from the employee after attending the above course?	2.77	Not all perceived that employee's benefitted the organization.
Do you feel that your/employees' actions have improved safety of vessel operations	2.81	Not all perceived that employee's actions have improved safety.
Do you feel that your/employees' actions have improved safety of people onboard?	3.93	Perceived that trained employee's action improved safety of people on board.
Do you feel that your/employees' actions have improved safety of own vessels/vessels & other installations?	2.58	Not all perceived that employees actions have improved safety of own vessel/other vessels and other installations.
Have you noticed any change in the attitude of the employee?	3.34	Perceived that there is change in employee's attitude.
Have you noticed any change in the behavior of the employee?	2.95	Not all perceived that there is a positive change in employeesbehavior.
Has the contribution of the employees/s trained on simulators resulted in better performance of the organization?	3.74	Perceived that trained employee's contribution resulted in better performance of the organization.

Table 4.9 Level 4 (Perception Table)

There was a statistically significant difference between means ($p < .05$) and, therefore, we can reject the null hypothesis and accept the alternative hypothesis. These results suggest that the organisation/s get benefitted by seafarers trained on maritime simulators.

4.6 Analysis

Analysis was carried out by dividing the courses in mandatory and non-mandatory categories.

List of Mandatory Courses

Sr. No	Mandatory Course	Remarks
1.	GMDSS India	
2.	GMDSS UK	
3.	ARPA	
4.	ROC	
5.	ECDIS UK	
6.	ECDIS Type Specific	STCW requirement

Table 4.10 – List of Mandatory Courses

4.6.1 Analysis Based Upon Mandatory Courses

Course	t-value	*p*-value	Inference (α =0.025)	Remarks
GMDSS India	18.73	.001	Statistically significant	
GMDSS UK	29.74	.001	Statistically significant	
ARPA	37.11	.001	Statistically significant	
ROC	36.93	.001	Statistically significant	
ECDIS UK	12.37	.001	Statistically significant	
ECDIS Type Specific	13.47	.001	Statistically significant	

Table 4.11 Analysis based upon Mandatory Courses:

List of Non Mandatory Courses

Sr. No	Non-Mandatory Course	Remarks
1.	DP Basic	Made compulsory by charters
2.	DP advanced	Made compulsory by charters
3.	DP Technical	
4.	DP Sea Time Reduction	optional
5.	Anchor Handling	
6.	ECDIS DNV	

Table 4.12 List of Non Mandatory Courses

4.6.2 Analysis based upon Non Mandatory Courses:

Course	t-value	*p*-value	Inference (α =0.025)	Remarks
DP Basic	27.86	.001	Statistically significant	
DP Advanced	19.89	.001	Statistically significant	
DP Technical	19.1	.001	Statistically significant	
DP Sea Time Reduction	9	.070	Statistically Not significant	Only two samples.
Anchor Handling	11.33	.001	Statistically significant	
ECDIS DNV	21.93	.001	Statistically significant	

Table 4.13 Analysis based upon Non Mandatory Courses

List of – Types of Simulators

Sr. No	Stand Alone Simulator	Instructor Led	Full Mission	Remarks
1.	DP Basic	ARPA	Anchor Handling	
2.	DP Technical	DP Technical	DP advanced	
3.		ECDIS DNV	DP Sea Time Reduction	
4.		ECDIS Type Specific		
5.		ECDIS UK		
6.		GMDSS India		
7.		GMDSS UK		
8.		ROC		

Table 4.14 List of Types of Simulators

4.6.3 Analysis based upon Types of Simulators (Stand Alone)

Course	t-value	*p*-value	Inference(α =0.025)	Remarks
DP Basic	27.86	.001	Statistically significant	
DP Technical	19.1	.001	Statistically significant	

Table 4.15 Analysis based upon Types of Simulators (Stand Alone)

4.6.4 Analysis based upon Instructor Led Simulators

Course	t-value	*p*-value	Inference(α =0.025)	Remarks
ARPA	37.11	.001	Statistically significant	
DP Technical	19.1	.001	Statistically significant	
ECDIS DNV	21.93	.001	Statistically significant	
ECDIS Type Specific	13.47	.001	Statistically significant	
ECDIS UK	12.37	.001	Statistically significant	
GMDSS India	18.73	.001	Statistically significant	
GMDSS UK	29.74	.001	Statistically significant	
ROC	36.93	.001	Statistically significant	

Table 4.16 Analysis based upon Instructor Led Simulators

4.6.5 Analysis based upon: Full Mission Simulators

Course	t-value	*p*-value	Inference (α =0.025)	Remarks
DP Advanced	19.89	.001	Statistically significant	
DP Sea Time Reduction	9	.070	Statistically Not significant	Only two samples.
Anchor Handling	11.33	.001	Statistically significant	

Table 4.17 Analysis Based Upon: Full Mission Simulators

Analysis Based Upon – Duration of Courses

Sr. No	Less than a week	One week	More than a week	Remarks
1.	Anchor Handling	ARPA	ROC	
2.	DP Sea Time Reduction	DP Technical	GMDSS India	
3.	ECDIS Type Specific	DP Basic	GMDSS UK	
4.		DP advanced		
5.		ECDIS UK		
6.		ECDIS DNV		

Table 4.18 Analysis based upon – Duration of Courses

4.6.6 Analysis Based Upon – Duration of Courses (Less than a Week)

Course	t-value	*p*-value	Inference (α =0.025)	Remarks
Anchor Handling	11.33	.001	Statistically significant	
DP Sea Time Reduction	9	.070	Statistically Not significant	Only two samples.
ECDIS Type Specific	13.47	.001	Statistically significant	

Table 4.19 Analysis based upon– Duration of Courses (Less than a Week)

4.6.7 Analysis Based Upon– Duration of Courses (One Week)

Course	t-value	*p*-value	Inference (α =0.025)	Remarks
ARPA	37.11	.001	Statistically significant	
DP Technical	19.1	.001	Statistically significant	
DP Basic	27.86	.001	Statistically significant	
DP Advanced	19.89	.001	Statistically significant	
ECDIS UK	12.37	.001	Statistically significant	
ECDIS DNV	21.93	.001	Statistically significant	

Table 4.20 Analysis Based Upon– Duration of Courses (One Week)

4.6.8 Analysis Based Upon– Duration of Courses (More than a Week)

Course	**t-value**	***p*-value**	**Inference (α =0.025)**	**Remarks**
ROC	36.93	.001	Statistically significant	
GMDSS India	18.73	.001	Statistically significant	
GMDSS UK	29.74	.001	Statistically significant	

Table 4.21 Analysis Based Upon– Duration of Courses (More than a Week)

List of Courses - Attended by Senior/Junior Officers

<table>
<tr><th>Sr. No</th><th>Senior/junior officers</th><th>Remarks</th><th>Junior Officers</th><th>Remarks</th></tr>
<tr><td>1.</td><td>ECDIS Type Specific</td><td rowspan="6">Often a mixed class of senior & junior officers</td><td>ARPA</td><td rowspan="6">All junior officers – STCW requirement.

Senior officers – Revalidation/renewal</td></tr>
<tr><td>2.</td><td>DP Technical</td><td>ROC</td></tr>
<tr><td>3.</td><td>DP Basic</td><td>ECDIS UK</td></tr>
<tr><td>4.</td><td>DP Advanced</td><td>GMDSS India</td></tr>
<tr><td>5.</td><td>DP Sea Time Reduction</td><td>GMDSS UK</td></tr>
<tr><td>6.</td><td>Anchor Handling</td><td>ECDIS DNV</td></tr>
</table>

Table 4.22 List of Courses Attended by: Senior/Junior Officers

4.6.9 Analysis Based Upon Courses Attended by Senior/Junior Officers

Course	**t-value**	***p*-value**	**Inference (α =0.025)**	**Remarks**
ECDIS Type Specific	13.47	.001	Statistically significant	
DP Technical	19.1	.001	Statistically significant	
DP Basic	27.86	.001	Statistically significant	
DP Advanced	19.89	.001	Statistically significant	
DP Sea Time Reduction	9	.070	Statistically Not significant	Only two samples.
Anchor Handling	11.33	.001	Statistically significant	

Table 4.23 Analysis Based Upon Courses Attended by Senior/Junior Officers

4.6.10 Analysis Based Upon Courses Attended by Junior Officers:

Course	**t-value**	***p*-value**	**Inference (α =0.025)**	**Remarks**
ARPA	37.11	.001	Statistically significant	
ROC	36.93	.001	Statistically significant	
ECDIS UK	12.37	.001	Statistically significant	
GMDSS India	18.73	.001	Statistically significant	
GMDSS UK	29.74	.001	Statistically significant	
ECDIS DNV	21.93	.001	Statistically significant	

Table 4.24 Analysis Based Upon Courses Attended by Junior Officers

4.7 Epilogue

This chapter discussed the analysis of the data collected by initially giving out a brief introduction to Cronbach's alpha test, one sample z-test, paired sample t-test and the assumptions made while applying these tests to this research.

Statistical tests adapted for this study, how these tests were applied to evaluate various courses are also discussed. Hypothesis testing by formulating four main hypothesis and their respective sub-hypothesis are depicted. The analysis is carried out based upon the pattern of course attended by different categories of mariners. The results are tabulated to indicate the effectiveness of the training imparted using maritime simulators.

CHAPTER 5

5. Findings and Recommendations

5.1 Findings

This chapter presents findings and recommendations based on the research conducted. Findings are based on literature review and other references available in the area and above all the statistical analysis conducted by the researcher.Training evaluation results summary based on Kirkpatrick'smodel concluded from hypotheses testing is also presented in this chapter. Observations and insight of the researcher is duly incorporated in this chapter. Subsequently recommendations based on the same are listed below. At the end, limitations, unique contributions of the study, and further directions of the research are given.

The primary and secondary data revealed that following types of simulators are in use;

- Engine room
- GMDSS
- ARPA
- Navigation
- Single task
- Multitask
- Full Mission
- Special tasks
- Dynamic Positioning
- Anchor Handling
- Cargo

The training evaluation in marine industry is carried out as routine matter. Feedback is collected at the end of the course. In most cases, the results of the course/s or training/s conducted are presented as the training evaluation. The researcher did not come across any records if any formal evaluation has ever been conducted using the existing evaluation methods and tools. In most cases, the organisations were not ready to share the data.

The data available to the researcher from the literature review indicates that different forms of training evaluation are divided in to two categories as shown below;

The objective based methods:

- Donald Kirkpatrick's 4 levels
- Jack Phillips Return on Investment (ROI)
- Indiana University taxonomy
- Nine outcomes model

The system based evaluation methods:

- CIPP (Context, Input, Process, Product)
- IPO (Input, Process, Output)
- TVS (Training Valuation System)
- E-Learning models

Having gone through the literature and the adaptability of the Kirkpatrick's Model, the researcher decided to use this method adapted suitably for marine industry.

5.2 Effectiveness of Training

Effectiveness of training using maritime simulators was evaluated using Kirkpatrick's model. The study was carried out using the four levels and the results are as indicated below;

5.2.1 Level 1 Findings

Out of the total nineteen questions for level 1, it was decided to choose the most relevant to indicate the motivational aspect of learning for the trainees. Nine questions indicating that the trainees rate simulator as motivational tool in training were picked up and analysed by formulating hypothesis.

The results indicated that;

The use of simulator to the subject training was pertinent

The simulator training was presented in an interesting way

The audio-visual aids used in simulator were effective

The simulation facilities were suitable

There was a good balance between presentation and simulation

Most students felt that the simulator training will help then do their job better

The simulator use met all needs of the course

The simulator relates directly to the job responsibilities.

Overall impression of the trainees about the simulator was good.

5.2.2 Level 2 Findings

Out of the total fourteen questions for level 2, it was decided to choose the most relevant to indicate the change in knowledge, attitude and skill levels of the trainees. Five questions indicating that the trainees' level of knowledge and skill are improved were picked up and analysed by formulating hypothesis. The results indicated that;

The skills/knowledge imparted was applicable to the trainee's job.

This simulator course helped the trainees to do their job better.

The class room training also helped the trainees to do their job better.

The course training improved the confidence levels of the participants.

The simulator improved confidence levels of the trainees to work on real equipment.

5.2.3 Level 3 Findings

Out of the total twelve questions for level 3, it was decided to choose the most relevant to indicate the knowledge and skills acquired during training is being used by the seafarers on the job. A total of eight questions were picked up and analysed by formulating hypothesis.

The results indicated that;

Most students had the opportunity to use the knowledge and/or skills presented in this course.

Trainees used the knowledge and/or skills presented in this course, to good extent.

There is an increase in confidence levels of the students in using knowledge and skills as a result of this course.

Most students had good access to the necessary resources to apply the knowledge and/or skills on the job.

As a result of this course, performance on the course objectives has changed for good.

Trainees received help, through coaching and/or feedback, with applying the knowledge and/or skills on the job.

As a result of this course, the overall job performance of the trainees has improved.

The simulator training helped the students do their job better.

5.2.4 Level 4 Findings

Out of the total eight questions for level 4, it was decided to choose the most relevant to indicate that the organisation employing seafarers trained using simulators get benefitted. A total of seven questions were picked up and analysed by formulating seven sub hypotheses as given below;

The results indicated that;

There are benefits realised by the organization after the employee attended the course.

After the training employees' actions have improved safety of vessel operations.

After the training employees' employees' actions have improved the safety of people onboard

After training the employees' actions have improved safety of own vessels/vessels & other installations.

There is good change in the attitude of the employee after training.

There is good change in the behaviour of the employee after training.

- All four null hypotheses rejected, indicating simulator training found effective.
- Students found simulator training interesting.

- The knowledge, skill and behaviour found to be improved after training
- Students agreed that the acquired knowledge and skill were used on their job
- The companies have shown that the training improved work environment and safety onboard. There was a good change in employee's behaviour and attitude.
- No company wanted to share info about profits.

5.3 Recommendations

The analysis carried out by the researcher is the main basis on which the recommendations are made. Recommendations are also based upon of literature review and other references available in the area of research. The recommendations as a result of the above are;

- The simulators used in marine training are known to have good fidelity and realism. The same can be made use of while mission planning, as well as assessment of existing or new crews.
- Lots of challenging operations can be evaluated, studied and optimised safely in the simulator by using these good features of the simulators.
- Accidents, case studies and events requiring attention of the crew may be simulated and safety and awareness training be imparted using simulators.
- Employees' actions showing less improvement be highlighted and specific training may be planned accordingly.
- Behavioural issues may dealt by engaging the identified trainees using available methods of training in the market.

5.4 Directions for Future Research

This research is limited to evaluating effectiveness of maritime training using simulator, in general. There are other areas which need to be investigated and the training effectiveness in these areas to be evaluated as well. The researcher feels that the below mentioned areas may be taken up for further research in maritime training;

- Engine room
- Navigation,
- Cargo
- Special operations
- Type specific training/operations

Also the research may be taken up for evaluating simulator based training in power and aviation sector.

5.5 Epilogue

This chapter discussed the findings of the study and the recommendations made by the researcher. The findings indicate the various types of simulators in use for training the seafarers. The findings are arranged as per the four levels of training evaluation based on the Kirkpatrick's model of training evaluation. The level one findings indicate that most trainees rate simulator as motivational tool in training. Level two findings indicate that the level of knowledge and skill of the trainees are improved after having attended simulator based training. Level three findings indicate that knowledge and skills acquired during training are being used by the seafarers on the job. Level four findings indicate that the organisation get benefitted by employing seafarers who are trained on simulators.

Profile of the Author

Surender Kumar is a PhD scholar in the branch of Oil & Gas Management from the ***University of Petroleum & Energy Studies, Dehradun.*** *Surender is actively involved in research and teaching. He is an electrical engineer by profession. A Chartered Engineer (UK), a Chartered Marine Engineer (UK), a Fellow of Institute of Marine Engineering, Science and Technology (UK) an Associate Fellow of The Nautical Institute London. He is an MBA in Marketing Management, UGC (NET) qualified and an Accredited Management Teacher from All India Management Association New Delhi.*

*His research interests are in the area of "****Effectiveness of Seafarer's Training Using Maritime Simulators"****. He has attended several National and International conferences/seminars on maritime training and has published two papers in reputed international journals.*

He has more than thirty year so industry experience having exposure in the area of marine, offshore, automation and maritime training.

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Appendix-A.1

Student Feedback Sheet – Level 1 (Reaction)

Student Feedback Sheet – Level 1 (Reaction)

In order to determine the effectiveness of the program in meeting your needs and interests, we need your input. Please give us your reactions, and make any comments or suggestions that will help us to serve you better.

Instructions: Please circle the appropriate response after each statement.

Course: **Instructor:**

(Instructions: Please circle /tick mark the appropriate response after each statement.)
SA= Strongly Agree, A= Agree, N= Neutral, D= Disagree, SD=strongly Disagree

		SA	*A*	*N*	*D*	*SD*
1.	The course subject was pertinent to your needs and interests?	5	4	3	2	1
2.	Facilities provided in class are good?(Seating arrangement, comfort, convenience, etc.)	5	4	3	2	1
3.	The schedule (time, length, etc.)was very good .	5	4	3	2	1
4.	The use of simulator to the subject training is pertinent.	5	4	3	2	1
5.	The simulator training was presented in an interesting way.	5	4	3	2	1
6.	The instructor was an effective communicator.	5	4	3	2	1
7.	The instructor was well prepared/familiar with simulator.	5	4	3	2	1
8.	The instructor demonstrated thorough knowledge of the subject.	5	4	3	2	1
9.	The audio-visual aids used in simulator were effective.	5	4	3	2	1
10.	The hand-outs/Course manual was helpful.	5	4	3	2	1
11.	The simulation facilities were suitable.	5	4	3	2	1
12.	Good balance between presentation and simulation.	5	4	3	2	1
13.	I feel that the simulator training will help me do my job better.	5	4	3	2	1
14.	The Simulator use met all needs of the course.	5	4	3	2	1
15.	The simulator relates directly to my job responsibilities.	5	4	3	2	1
16.	This course relates directly to my job responsibilities.	5	4	3	2	1
17.	I would recommend this course to my colleagues.	5	4	3	2	1
18.	My overall impression of the simulator was "excellent."	5	4	3	2	1
19.	My overall impression of the course was "excellent."	5	4	3	2	1

Your Comments:

Appendix- A.2

Student Feedback Sheet – Level 2 (Learning)

Student Feedback Sheet – Level 2 (Learning)

In order to determine the effectiveness of the program in meeting your needs and interests, we need your input. Please give us your feedback, and make any comments or suggestions that will help us to serve you better.

Course: **Instructor:**

Instructions: Please circle the appropriate response after each statement.

SA= Strongly Agree, A= Agree, N= Neutral, D= Disagree, SD=strongly Disagree

		SA	*A*	*N*	*D*	*SD*
1.	The content of the course matched the stated objectives.	5	4	3	2	1
2.	The difficulty level was neither too difficult, nor too easy.	5	4	3	2	1
3.	Use of simulator matched the stated objectives of the course.	5	4	3	2	1
4.	The simulator exercises and examples were realistic to my job.	5	4	3	2	1
5.	The lecture, discussion, simulation, etc. were useful for my job.	5	4	3	2	1
6.	The skills/knowledge imparted were applicable to my job.	5	4	3	2	1
7.	This course helped me do my job better.	5	4	3	2	1
8.	The simulator training helped me to do my job better	5	4	3	2	1
9.	Course material given is being used as a reference on the job.	5	4	3	2	1
10.	The Instructor explained how each activity related to my job.	5	4	3	2	1
11.	I feel that the simulator training helped me to do my job better.	5	4	3	2	1
12.	This training was worth the time spent away from my job.	5	4	3	2	1
13.	The course training improved my confidence levels.	5	4	3	2	1
14.	The simulator improved my confidence levels.	5	4	3	2	1

What was the weakest part of the course and how could it be improved?

Your Comments:

Appendix- A.3

Student Feedback Sheet – Level 3 (Behaviour)

Student Feedback Sheet – Level 3 (Behaviour)

In order to determine the effectiveness of the program in meeting your needs and interests, we need your input. Please give us your feedback, and make any comments or suggestions that will help us to serve you better.

Please circle/tickmark the appropriate response after each statement.
Course: **Instructor:**

*Choices: **5.** To a very great extent **4.** To a great extent **3.** To a moderate extent*
***2.** To a small extent **1.** Not at all/never/rarely applicable*

1.	To what extent did you use the knowledge and/or skills prior to attending this course?	5	4	3	2	1
2.	To what extent have you had the opportunity to use the knowledge and/or skills presented in this course?	5	4	3	2	1
3.	To what extent have you actually used the knowledge and/or skills presented in this course, after completing the course?	5	4	3	2	1
4.	To what extent has your confidence in using the knowledge and/or skills increased as a result of this course?	5	4	3	2	1
5.	To what extent did you receive the assistance necessary in preparing you for this course?	5	4	3	2	1
6.	To what extent has the content of this course accurately reflected what happens on the job?.	5	4	3	2	1
7.	To what extent have you had access to the necessary resources to apply the knowledge and/or skills on your job?	5	4	3	2	1
8.	As a result of this course, my performance on the course objectives has changed by (%).	5	4	3	2	1
9.	To what extent have you received help, through coaching and/or feedback, with applying the knowledge and/or skills on the job?	5	4	3	2	1
10.	As a result of this course, my overall job performance has changed by (%).	5	4	3	2	1
11.	I feel that the simulator training helped me do my job better.	5	4	3	2	1
12.	What was the weakest part of the course and how could it be improved?	5	4	3	2	1

Your Comments:

Appendix- A.4

Feedback Sheet – Level 4 (Results)

Feedback Sheet – Level 4 (Results)

In order to determine the effectiveness of the program in meeting your needs and interests, we need your input. Please give us your feedback, and make any comments or suggestions that will help us to serve you better.

Mr. _______________________attended ______________ Course with us on____________

Please circle the appropriate response after each statement.

Course: **Candidate:**

Choices: ***5.*** *To a very great extent* ***4.*** *To a great extent* ***3.*** *To a moderate extent*
2. *To a small extent* ***1.*** *Not at all/never/rarely applicable*

1. What benefits have you, your team, and/or the organization realized so far from the employee after attending the above course? 5 4 3 2 1
2. Do you feel that your/employees' actions have improved safety of vessel operations: 5 4 3 2 1
3. Do you feel that your/employees' actions have improved safety of people onboard? 5 4 3 2 1
4. Do you feel that your/employees' actions have improved safety of own vessels/vessels & other installations: 5 4 3 2 1
5. Have you noticed any change in the attitude of the employee? 5 4 3 2 1
6. Have you noticed any change in the behaviour of the employee? 5 4 3 2 1
7. Has the contribution of the employees/s trained on simulators resulted in better performance of the organisation? 5 4 3 2 1
8. What other benefits have you, your team, and/or the organization realized so far from _____________________________ Course.

Your Comments: