Professional Development of Shipboard Engineers and the Role of Collaborative Learning

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Abstract Rapid changes in the ship management pattern characterized by outsourcing of ship operations have had severe implications on shipboard human resources in terms of their declining numbers and competence which in number of cases has been implicated as the contributing cause of accidents. A review of investigation reports of accidents that occurred in ship machinery spaces has indicated that nearly one fifth of all accidents/incidents are attributable, at least in part, to the deficiency in knowledge and skills of shipboard engineering staff. Maritime education and training (MET) is based on the philosophy that the generic engineering and seamanship knowledge supported with basic practical skills imparted to / acquired by the prospective marine engineers during their education and training will be effectively transferred to their specific on job situation. This preliminary study identifies factors that have implications on shipboard engineers' initial and continual learning and to address issues that need further research for developing a suitable mechanism to channelize the natural process of on-the-job learning. Applicability of collaborative learning is discussed with a view to identify issues needing further research to assess its suitability for higher maritime education and training and application on board for professional development of shipboard engineer officers.

Keyword: *Human factors, competence, learning, collaborative learning*

1. Introduction

With steady improvements in design, availability of better materials, advanced construction techniques and production under sound quality control leading to higher reliability and consequent diminished frequency of technological failures, the role of human element in accident causation has become more apparent [1,2,3]. It is a common place to come across statements that human error is responsible for 80% of accidents in most industries, "the fact remains that the most important safety breakthroughs in the 21st century will depend less on technological progress than on recognition of the primacy of human factors [4]. Comprehensive knowledge and understanding, rather than surface knowledge acquired by rote learning, is the platform on which competence is built. Setting adequate standards of knowledge, understanding and proficiency for development of competence is paramount but equally important are the methods to facilitate understanding. Prospective marine engineers are required to transfer their learning to the work situation and this transfer of learning is much easier if the learnt knowledge is more comprehensive [5]. The techniques of knowledge transfer for major part of the curriculum delivery in most maritime education and training institutions conform to behaviourist approach potentiating surface learning through memorising rote. The prevailing assessment methods where incentive is to pass examinations at the end of various courses, with a few exceptions of practical training courses, also support this form of surface learning. Prospective marine engineers with such learning are deprived of long lasting retention of facts and development of skills of learning. Learning of professional acumen continues during their shipboard professional careers and it is imperative

that the methodologies for knowledge transfer implemented during their MET inculcate in them the skills of learning to transform them into lifelong learners.
Techniques of 'collaborative learning' are student-centred learning approaches that actively involve them in thinking, propounding their ideas, clarifying, explaining, reflecting and enquiring thus developing deep understanding of concepts. Application of collaborative learning techniques in MET institutions while enhancing comprehensive understanding of the subject matter and social skills will also help the students in developing attributes of lifelong learners which are essential for them to learn from dynamic work situations on job and professional development along with peers.

2. Demands for multiple skills

Operators, like marine engineers in ship's machinery spaces are at the centre stage of operations interacting with machines, technology and the work environment. They intervene to prevent undesirable operational deviations and in the event when such deviations do occur, apply appropriate counter measures to maintain safety and efficiency of operations. Through their timely preventive actions and quick recovery processes they mitigate the consequences of incidents or accidents. The cognitive processes which enable operators to make decisions, judgments and plans of actions to achieve desired objectives are however the very processes which can fail and lead to error [3]. According to Kuo the factors responsible for errors on part of the operators encompass personal attributes of knowledge, skills and experience as well as physical, physiological, psychological and psycho-sociological characteristics of individuals [6].

A socio-technical system comprises people at all hierarchical levels and irrespective to their position in such a system they are prone to committing errors. Consequences of operational failures at the sharp end resulting in what has been termed as 'active failures', and of the failures in planning and control termed as the 'latent failures', are jointly responsible for undesirable incidents or accidents [7], (Figure 1).

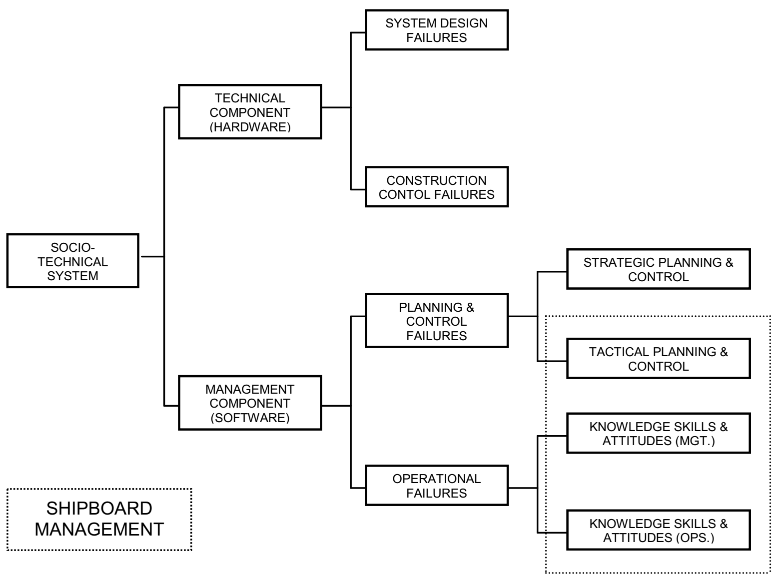

Fig. 1 Socio-technical system, management components and sources of failure

The management component or the (software) of a socio-technical system, like a ship, comprises planning and control at two levels. Upper or the shore management of a shipping company or a ship management company is responsible for strategic planning. The lower level comprises the shipboard management which is responsible for the tactical day to day planning, controls and shipboard operations that involve interactions at the human-machine interfaces. Consequently the shipboard engineers are responsible for planning of operations as well as for executing them and are therefore required to possess a combination of management and operational competence commensurate with each individual's hierarchical position on board. Emphasis of either type of competence changes as they gradually move up the management hierarchical ladder from support level to the operational level and finally to the management level as each one moves through his/her respective career path.

3. Human element in accident causation

3.1 Competence of shipboard engineers

Aetiological literature on accidents vehemently refers to the influence of various environmental, organizational and personal factors on operators at the human-machine interface in committing errors, mistakes and resorting to violations. Such analyses are of course based on the assumption that the operators possess the requisite knowledge and skills, they are selected commensurate with the essential competence demanded by their respective functional tasks and that they are adequately familiarised with the ship specific systems and procedures. Erroneous or unsafe acts committed by the operators at the human-machine interface leading to failures have been summarised by Cacciabue as the failures of planned actions in achieving their desired ends and termed as 'lapses', 'slips', 'mistakes' and 'violations' [8]. Mistakes are errors in selection of a suitable plan or a procedure and occur due to lack of knowledge, skills and experience of operators.

3.2 Competence mismatch

Competence of engineers in the context of shipboard duties refers to the application of knowledge, understanding and skills in a manner that their duties can be performed in a safe, efficient and timely manner [9]. Shipboard engineers' professional knowledge, technical skills, abilities, aptitude, social skills and attitudes must match the required level of competence for a particular ship's systems and the work environment. The requisite expertise of engineers changes in character as the ship technology changes. It also changes when there is need to replace the experienced engineers who have to leave the ship [10]. Employment of shipboard staff in commercial shipping is marked with high turnover and short term employments. Whenever a ship's flag or its managing owner changes there is a change in the organizational structure, policies and procedures demanding changes in crews' behavioural responses to meet the new requirements. According to the International Safety Management Code (ISM Code) a ship's safety management system must be implemented afresh upon change of company. The transportation safety board (TSB) of Canada, based on their random sampling of Sea-web database of vessels between 8000 and 50,000 deadweight tonnes and constructed in 1997, have reported that 55% of such vessels, on an average, had almost three managers per vessel over the intervening 10-year period [11]. Multiparty and fragmented ship management structures, technological developments in shipboard engineered systems, globalization of seafarers, short tenure of seafarers on board, shortage of trained seafarers, diversity in standards of MET and fast track education and training in some countries with emphasis on quantity rather than quality contribute to undesirable lack of competence of seafarers and a mismatch between the available and the desired levels of competence.

3.3 Accident causal factors

Several accident causation models and human error taxonomies have been developed by researchers for systematic reporting of accidents, their aetiological analysis and for predicting failure modes and mechanisms. Some researchers have used the terms organizational factors, job factors and individual factors for categorising error causation factors leading to unsafe acts [12]. In this context the individual factors subsume mental & physical abilities and capabilities comprising *inter alia* professional knowledge, skills, training and experience. Some of the taxonomies are fairly explicit in specifying inadequacy of knowledge, skills or training of operators while others use terms such as mental limitations, lack of awareness, ignorance etc.

Most of the international safety conventions and regulations have been developed on the basis of lessons learnt from past accidents yet there exists no centralised and harmonised global data of investigation reports on maritime accidents. Most national maritime administrations do maintain their individual databases of accident investigations reports and are available in the public domain on their websites. Accident investigations reports from the following sources have been reviewed for this research:

Australian Transportation Safety Bureau (ATSB)
Transportation Safety Board Canada (TSB)
Danish Maritime Authority (DMA)
Marine Accident Investigation Branch UK (MAIB)
National Transportation Safety Board USA (NTSB)

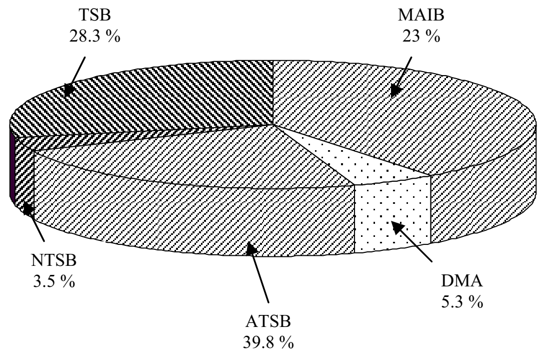

Fig. 2 Distribution of 113 machinery space accidents reports among five investigating authorities

Numbers of reports from each of the above organizations differ depending on the initiating years of posting of reports on their respective websites and their availability in electronic format. Reports of accidents involving fishing vessels, pleasure crafts and vessels less than 500 gt or those with propulsion machinery of less than 750 kW were not included in the review. From the remaining 782 accident investigations reports those pertaining to accidents in machinery spaces or resulting into personal injuries to the engineering staff were shortlisted. Thus a total of 113 investigation reports of machinery failures and occupational accidents in machinery spaces were further reviewed for this analysis. Each accident investigation report in its final conclusions or findings has indicated the most probable causal factors identified by the investigators. In these 113 reports a total of 288 probable causal factors have been identified, which for the purpose of this analysis have been placed under three groups, namely: Shore management factors; Shipboard management factors and the Individual factors. Only those individual factors that are applicable to the shipboard engineering staff have been considered for this analysis. It is noted that:

Deficiency of knowledge of engineers has been identified as one of the probable causation factors in 31.8 % accident reports. Proportion of causes on account of deficiency of knowledge, experience and training is 19.1% of total causation factors.

In a noteworthy study conducted by Makoto Uchida [13] reviewing court judgement reports of accident enquiries from Japan Marine Accident Inquiry Agency spanning from year 1995 to 2003, a similar distribution is noted. In his study 173 judgement reports of accidents related to the marine engine management on merchant ships were statistically analysed on the bases of methodology vide IMO Resolution 884 (21). The study revealed that the accident attributed to human error related causes were due to knowledge-based mistakes and amounted to 20.7% of total causes.

4. Professional knowledge and competence

4.1 Diversity in MET standards

In spite of the remarkable achievement in the international regulatory regime implemented through the International Convention on Standards of Training Certification and Watchkeeping for Seafarers (STCW) the standards of maritime education and training still elude preciseness that they are intended to attain on global basis. Save for the limited guidance in the form of specified competencies, the contents and the standards of MET syllabus are still shrouded with vagueness. Rapidly changing technology has always created a gap between the static model of competence standards set by MET institutions and the dynamic nature of competence model demanded by the changing technology. There is a perpetual time lag in bridging this gap and as a rapid and short term measure there are increasingly high demands for proactive training measures e.g. training in the electronic chart display and information system (ECDIS) for navigators, electronic controls on intelligent engines for engineers. This inevitable gap varies amongst MET institutions nationally as well as internationally.

4.2 Social competence

Present crewing pattern characterised by multinational crew has introduced variances in professional standards on board. Seafarers with diverse ethnic and cultural backgrounds are required to work together in teams which call for pertinent social skills on part of the seafarers [14]. Developing amicable human relations, team work and leadership skills are legitimate and valuable classroom goals not just extracurricular ones [15]. The STCW Convention requires marine engineers to be proficient in sixteen specified competencies before they are considered competent for shipboard engineering operations. None specifies or implies development of social skills.

4.3 Transfer of learning to work environments

The main focus of education and training in the MET institutions, as also mandated by the STCW Convention, is on development of professional skills on a firm foundation of theoretical knowledge. The philosophy of MET is based on the belief that once the prospective engineers have acquired the minimum requisite knowledge and practical skills they will be able to apply the learnt knowledge with necessary modifications to meet the varying demands of operations on board. Transfer of learning and its application to work situation is context sensitive and is easier if the learning takes place in similar environments as the actual work environment. The learning that occurs during onboard training, practical exercises in simulated conditions and leaning on job is more easily transferred than those learnt in the class room [5]. The extent of knowledge and skills transfer to work situations also depends upon the ease with which learning can be retrieved, which in turn, is a function of how well the material was learnt. Stronger the understanding and comprehensive the learnt knowledge more readily such transfer can occur. Conceptual learning that involves deep understanding is more likely to be transferred than the material that is merely committed to rote memorisation, because thinking at deeper level of abstraction facilitates transfer by fostering meta-cognition [16].

4.4 Knowledge transfer in MET environment

Swedish researchers Marton and Saljo on basis of their study, three and a half decades ago, suggested a shift of focus from teachers to learners for better learning achievements. Delivery of course curricula in educational institutions, MET providers being no exception, continues to be the traditional teacher-centred [17]. The traditional method relies on classroom delivery of lessons in a linear fashion and has been referred to as a 'push' method, where the teacher is pushing the learning material to students in logical steps by step fashion [18]. In such teacher-centred learning activity the learners play a passive role expecting to be provided with new knowledge that they can add to their pre-existing repertoire. In this form of teaching the learners do learn provided they are thinking and making connections with other ideas and experiences and are thus active. If the learner is not able to make necessary cognitive connection with new information due to his/her limited existing knowledge and experience, if the information is too complicated, if it is delivered too quickly for him/her to assimilate or if there are environmental distractions the learner may not be able to keep himself/herself engaged in the process of active involvement. This type of passive learning is therefore inflicted with a strong likelihood of learners' cognitive dissociation with the discourse and their mentally wandering off in spite of physical presence in the class. Such students then need to put in extra efforts for learning through self reading, tutorials or peer help, failing which they may resort to rote learning for clearing the examinations.

Research over half a century espouses that 'teachers cannot simply transfer readymade knowledge to students' [19] and that the students have to create their own knowledge through understanding of the new information and its assimilation with reference to their existing knowledge repertoire, either to modify or to form new concepts. This calls for active involvement of a learner in the process of learning. When confronted with new information a learner's curiosity causes an intrinsic state of mental tension that makes him/her strive for more information. This kind of intrinsic motivation to learn is stronger than the extrinsic motivation engendered from threats of examinations or enticement of rewards. To potentiate comprehension and deep learning the learners are required to be kept engaged in the process of interpretation and interrelation of information; overt questioning the teacher/author or covert self interrogation, reflection and critical thinking. Acquiring skills for learning is a prominent feature of an educational process and has a lifelong implication on the professional lives of people. MET institutions in addition to ensuring that their students learn how to perform their tasks also need to inculcate, through application of suitable teaching techniques, the skills of learning that they could apply during their professional careers as well.

5. Active learning process

5.1 Collaborative learning

Some of the educational techniques that keep students engaged in the process of learning are characterised as group based learning methods under the name of 'collaborative learning'. In such student-centred learning processes the students are essentially required to actively involve themselves as members of small groups to seek and assimilate relevant information on a particular subject matter, a query or a problem through interactions among themselves or at times also involving the teacher. They are required to engage themselves intellectually to discuss, reflect, argue, convince and disagree/agree to comprehend the concepts or look for solutions depending on the preset targets of learning. The students are responsible for their own learning and the built in interdependence feature of the group work makes them responsible for other group members' learning. There is an intrinsic motivation for the group members for their active participation for own success which in turn is linked to the success of their group. Such an approach which is based on the theory of constructivism, in addition to engendering deep learning, also helps the students in developing skills of learning. As the group members have to interact with each other the development of social skills for communications as well as respecting other's ideas, putting forth one's ideas convincingly without offending others and teamwork is another desirable offshoot feature [20]. Collaborative learning is an umbrella term that encompasses a variety of educational approaches in which students collaborate to apply their intellectual efforts jointly to search for solutions, constructing meanings or creating something new with information and ideas [15]. The process provides them an exposure to diverse view points. They are challenged socially and emotionally requiring them to propound and defend their ideas which help them in creating their unique conceptual framework of subjects/topics/events discussed. The group atmosphere of learning affects both the success and satisfaction in learning [21].

Number of research studies in the US has been conducted at the primary, secondary and tertiary level including engineering colleges, by comparing achievement of students who participated in collaborative learning with those in reference groups having attended same courses through the traditional class room instructions. Majority of such studies have shown the collaborative learning to have enhanced learning achievements. Positive achievement effects were noted in 63 % cases with 32.6 % indicating no improvement and in 4.4 % cases negative trend was noted in a review based on 29 studies done at elementary and secondary grades [22]. A similar review in 2008 of fourteen studies conducted in five Asian countries at three levels covering diverse subjects of basic sciences, engineering and social sciences indicated positive achievement effect in 53.3 %, no effect in 20 % and negative effect in 26.7 % cases [23]. This review also noted that that positive achievement effects were comparatively higher, in 75% cases, at the college level. Johnson and Johnson on basis of their study of eight different cooperative learning methodologies through 158 studies have concluded that though there are variations in level of positive achievement but all show a positive achievement effect [24]. Application of collaborative learning techniques in the MET institutions will help students in deeper understanding of subjects matter as well as in developing attributes of lifelong learners. Such skills learnt prior to embarking on their marine engineering profession will provide requisite motivation for them to apply the collaborative learning principles for learning from work situations and for professional development amongst peers.

5.2 Impediments to implementation

Although initiated nearly eighty five years ago the collaborative learning techniques have not gained much popularity outside the USA for multifarious reasons. The flexibility of structures, extent of teacher involvement, time duration of application and assessment of learning have generated a wide variety of applications. Consequent loss of its specificity with many unable to differentiate between group learning and teaching students by seating in small group has been responsible for its slow acceptance [25]. Societal resistance from the feeling that educational achievements were being sacrificed to irresponsible permissiveness has adversely affected its growth even in the US [26]. In spite of favourable results on enhanced achievement of students as shown by a number of research studies in secondary and post secondary educational institutions the scepticism about its success in view of a new and untried methodology, longer time required for delivery of curriculum, extra work for preparation for implementation, though only initially, and the unwillingness of teachers to give away control of teaching process have been impediments in application of collaborative learning systems in educational institutions.

6. Professional development of shipboard engineers

6.1 On-the-job learning

Successful completion of mandatory pre-sea courses at their MET institutions is only the initial phase of professional education and learning for marine engineers. The second phase of learning, rather the actual professional learning, through application of learnt knowledge and skills in actual work environments starts when the prospective marine engineers take on the role of operators aboard ships. This phase of professional development through on job learning and experience has its genesis in participation in a social practice but in a disparate social environment than that of educational institutions. Akin to apprenticeship, at least in the initial stages, professional learning is formalised by a progression through tasks of increasing accountability [27]. Through their successively widening responsibilities for operating equipment of greater complexity or performing task where wrong actions can have significant consequences, they are gradually exposed to the unique characteristics of various shipboard engineered systems, normal working parameters and deviations thereof. Maintaining currency of safe operations requires them to routinely assess the operating conditions and the influence of work environments, select the course of action in cognizance with specific rules, procedures and traditional practices peculiar to the ship. This allied with demands for continuous confirmation or modifications of previously learnt concepts progressively add to their repertoire of knowledge, skills and experience, an essential element in professional development.

6.2 Development through collaboration

Performance goals, activities and the social setup are unique to each ship's machinery spaces. Under the organizational and environmental influences they also keep changing with time and get accentuated due to turnover of the engineering staff. This makes the socio-technical setup on each ship a unique and dynamic amalgam of varied levels of professional knowledge, skills and experience. Each technical problem even when occurring on an identical system, sub-system or a piece of equipment is unique because of its deterministic variants and situational characteristics caused by technical, organizational and environmental influences in that particular case. When practitioners hold a mental model of a system that is inaccurate or incomplete their operational responses to the system are inappropriate as well. Having knowledge of one kind, e.g. operational action in a particular situation and on an equipment on previous ship, is not necessarily applicable to the equipment of the same make on another ship due to its individual characteristics and asymmetric situational context. The mental model needs to be created anew or modified in the new situation.

Incumbents are continually faced with the task of assimilating nuances of their new setup through familiarisation, instructions, guidance, formal & informal talks, over hearing, observing other's actions, self exploration and through interaction with peers. By exchanging information, knowledge and thoughts they create a structure, a blueprint or a mental model for understanding of similarities or discrepancies in the events enhancing familiarity amongst various situations. Need for such exchange can hardly be disputed as it is almost unlikely that each one in the team has faced a particular situation in his/her past shipboard experience. It may be, and by good fortune, that one in the team has the experience of such a particular situation who can share his/her experience. Such an exchange increases the individual capacity of team members to act more appropriately in proximate situations.

6.3 Peer collaboration on board ships

In absence of guidance, mentorship or peer help through amicable social interactions in work place the learning of professional acumen by the incumbents is by hit-and-trial method i.e. learning through mistakes. An engineer faced with a novel situation or condition of an equipment or a part thereof makes his/her conclusions relying on personal repertoire of knowledge experience and available documented information and would like to seek affirmation to his/her conclusions. Without any feed back or reinforcements on the validity of his/her perception he/she is in a dilemma whether his/her conceptual assessment is right or wrong and the degree of its correctness or otherwise. That people are social creatures who like to talk with each other about topics of common interest [30] is squarely applicable to the engineers on board especially under such conditions of ambivalence.

Need of knowledge exchange on engineered system, organizational set up and working environments specific to the ship through mutual coordination cannot be over emphasized.

Formalized systematic collaboration among team members facilitates transfer of pertinent information from those who have to those who need it, with all the benefits of collaborative involvement as mentioned in paragraph 5.1 above. Such peer collaboration for learning, aside from sharing knowledge of systems characteristics, is also extended to solving technical problems, risk assessment and risk management utilizing the strength of varied knowledge and experience of all team members. In absence of deliberate, systematic and formal transfer of knowledge through interactions the learning still occurs but in a fragmented manner, at uncertain pace and at times at the cost of efficiency, damages, personal safety and even ship safety.

If collaborative learning is to be applied on board it has to be conceptually different than that in a class room scenario. The team of shipboard engineers would need to assume the responsibility of leading as well as controlling the coordination activities within the group to achieve learning objectives, which are also to be set by the team. A suitable framework is needed to guide the team members for its effective and beneficial conduct. Success of the collaborative learning process requires active and amicable participation of each member and calls for their social skills of good communication, respect for each one's ideas and defending one's ideas without offence to others and common goal. MET institutions do not apply collaborative techniques the engineers are not expected to have the desirable social skills necessary for application of collaborative learning process. Desirability of applying collaborative learning techniques in shore MET level is emphatically perceptible.

7. Conclusions

Research has identified that inadequacy of professional knowledge is one of the factors responsible for shipboard accidents. Diversity in MET standards, methods of curricula delivery, assessment procedures and employment pattern of marine engineers constrain the process of comprehensive understanding of engineering concepts and on job learning. Objectives of MET generally confine to providing specified generic engineering and seamanship knowledge with some basic skills to perform tasks on board. The teaching methods adopted for achieving these objectives however fall short of the processes that could inculcate skills of learning. Application of suitable techniques in the MET institutions would promote students' comprehensive understanding of subject matter which is an essential feature for transfer of learning to work situations. It will also help them in developing skills of learning, cooperation and team work, the desirable personal attributes for shipboard duties.

Specific knowledge of the engineered systems and influence of work environment on them are unique to each ship. All possible problems, machinery conditions and work situations cannot be perceived, documented or studied for prescribing solutions. Every engineer cannot get an exposure to all perceivable situations but amongst the team of engineers on board there is a unique wealth of knowledge and experience that must be shared for mutual learning and sound professional development. This needs to be achieved through formal application of a suitable variant of collaborative learning on board ships.

Implementation of collaborative learning for marine engineers' learning and development on board will require a suitable strategy, a framework for its effective application, guidance and training. This calls for further research that would explore feasibility of its application, to develop suitable strategies and procedures for its application for the benefit of marine engineers and safety of ships, persons and the environment.

References:

[1] Mearns K., Flin R., Fleming M. and Gordon R., "Human and organizational factors in offshore safety", *Project report,* HMSO, Norwich, UK, (1997).

[2] Hollnagel E., *"Barriers and Accident Prevention"*, Ashgate Publishing Ltd. UK, (2004).
[3] Mitchell K. and Bright C K., "Minimising the potential for human error in ship operation, Management and operations of ships – Practical techniques for today and tomorrow, London, Paper 17, IMAS, 95 (1995), pp 171-177
[4] Boisson P., "Safety at sea – regulations and international law", Bureau Veritas, (1999)
[5] Cunningham I., Dawe G. and Bennett B., *"Handbook of work based learning"*, Ashgate Publishing UK, (2004).
[6] Kuo C., *"Managing Ship Safety"*, LLP Reference Publishing, UK (1998).
[7] Reason J., *"Human Error"*, Cambridge University Press, UK (1997).
[8] Cacciabue P.C., *"Guide to applying Human Factor Methods"*, Springer, (2004)
[9] Morrison W.S.G., *Competent crews – safer ships"* World Maritime University, (1997)
[10] Cook R.I., *"How complex Systems Fail"* Cognitive Technology Laboratory, University of Chigago, (2000).
[11] Transportation Safety Board of Canada, report M07 LOO 40, retrieved 11 April 2010 from http://www.tsb.gc.ca/eng/marine/index.asp
[12] Er Z.and Celick M., "Definition of human factor analysis for the maritime safety Management process", *Proceedings of the conference on Maritime Security and MET* of IAMU, AGA No. 6, Malmo, Sweden, 24-26 October (2005), pp 235-243.
[13] Uchida M., "Analysis of human error in marine engine management", IAMU, AGA No.5, Tasmania, Australia, (2004), pp 85-93.
[14] IMO, "IMO: Safer shipping demands safety culture", *IMO News, 3*, (2002)
[15] Smith B.L. and MacGregor J.T., "What is collaborative learning", National Centre for Post Secondary Teaching, Learning and Assessment, Pennsylvania, (1992), google.com/search retrieved 6 April 2010.
[16] Phillips D. C. and Soltis J.F., *"Perspectives on learning"*, Teachers College Press, New York, (2009).
[17] Cannon R. and Newble D., *"Handbook for teachers in universities and colleges"*, Kogan Page Ltd., London, (2000).
[18] Ircha M.C. and Balsom M.G., "Educational technology: Enhancing port training", *WMU Journal of Maritime Affairs*, Vol. 4, No 2, pp 211-225, (2005).
[19] Barkley E.F., Cross P. and Maor C.H., *"Collaborative learning techniques - A handbook for college faulty"*, CLPD, University of Adelaide, Australia (2005), http://www.adelaide.edu.au/clpd/resources/leap retrieved 30.06.2010
[20] Noble A., Ingleton C., Doube L. and Rogers T., "Leap into Collaborative Learning", Centre for learning and development, University of Adelaide, Australia (2000).
[21] Davis B.G., *"Tools for Teaching"*, University of California, Jossey-Bass Publishers, USA, (1993), http://teaching.berkeley.edu/bgd/collaborative.html, retrieved 20.06.2010
[22] Slavin R.E., "When does cooperative learning increase student achievement?" *Psychological Bulletin,* vol. 94, No.3, p 429-445, (1983).
[23] Thang P.T.H., Gillues R and Renshaw P., "Cooperative learning and academic achievement of Asian students: A true story", *International Education Studies* Vol. 1, No.3, p 82-88, (2008), www.ccsenet.org/journal.html, retrieved 23 July 2010
[24] Johnson D.W., Johnson R.T. and Stanne M.B., "Cooperative learning methods: A meta-analysis",(2000), http://www.co-operation.org/pages/cl-methods.html, 28 June 2010
[25] Johnson D.W., Johnson R.T., and Smith K., "State of cooperative learning in post secondary and professional setting", *Education Psychology Review*, Vol. 19, PT 1, Springer Science + Business Media, (2007), published on line.
[26] Mouton J.S. and Blake R.R.,*"Synergogy A new strategy for education, training and development"*, Jossey-Bass Ltd. London, (1984).
[27] Billet S., "Critiquing workplace learning discourses: Participation and continuity at work", *Studies in the Education of Adults,* 34, No. 1 pp 56-67, (2002)
[30] M.S. Khine M.S. and Lourdusamy A., " Using Conversant Media as a collaborative learning tool in teacher education", *Australian Journal of Educational Technology*, 19(2), pp 260-274, (2003).