ISTANBUL TECHNICAL UNIVERSITY ★ GRADUATE SCHOOL OF SCIENCE ENGINEERING AND TECHNOLOGY

ENHANCEMENT OF THE ENGINE ROOM RESOURCE MANAGEMENT CONCEPT VIA THE INTEGRATED MODEL OF TRAINING EFFECTIVENESS AND EVALUATION

M.Sc. THESIS

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Department of Maritime Transportation Engineering

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ISTANBUL TEKNİK ÜNİVERSİTESİ ★ FEN BİLİMLERİ ENSTİTÜSÜ

EĞİTİM ETKİNLİĞİ VE DEĞERLENDİRMESİ BÜTÜNLEŞİK MODELİ İLE MAKİNE DAİRESİ KAYNAK YÖNETİMİ KONSEPTİNİN İYİLEŞTİRİLMESİ

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HAZİRAN 2020

Bulut Ozan CEYLAN, a M.Sc. student of ITU Graduate School of Science Engineering and Technology student ID 512181017, successfully defended the thesis entitled "ENHANCEMENT OF THE ENGINE ROOM RESOURCE MANAGEMENT CONCEPT VIA THE INTEGRATED MODEL OF TRAINING EFFECTIVENESS AND EVALUATION", which he prepared after fulfilling the requirements specified in the associated legislations, before the jury whose signatures are below.

Thesis Advisor :	**Prof. Dr. Metin ÇELİK** İstanbul Technical University	.....
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To my spouse,

FOREWORD

In this study, we conduct considerable improvements to a model course on engine room resource management. I would like to express my gratitude to my thesis supervisor, Prof. Dr. Metin Çelik for his continuous encouragements and guidance on my studies. I am also grateful to maritime professionals of prestigious shipping companies to provide technical information support to thesis. We will keep them informed about the thesis deliverables.

I would like to extend a special appreciation to my family who promote ongoing motivation and distinguish support during my studies.

June 2020

Bulut Ozan CEYLAN
(Marine Engineer)

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ABBREVIATIONS

ACRM : Anesthesia Crisis Resource Management
ANTS : Anesthetists' Nontechnical Skills
BRM : Bridge Resource Management
CIPP : Context Input Process Product
CIRO : Contents Inputs Reactions Outcomes
CRM : Crew Resource Management
ERM : Engine Room Resource Management
ETCC : Emergency Team Coordination Course
HRM : Human Resource Management
ICOR : Input Output Control Resource
IMO : International Maritime Organization
IMTEE : Integrated Model of Training Evaluation and Effectiveness
IPO : Inputs Process Outputs
MET : Maritime Education and Training
MRM : Maintenance Resource Management
NOTSS : Nontechnical Skills for Surgeons
OEM : Organizational Elements Model
ROI : Return on Investment
RRM : Rail Resource Management
SCM : Success Case Method
STCW : Standards of Training Certification and Watchkeeping
TCRM : Train Crew Resource Management
TRM : Team Resource Management

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ENHANCEMENT OF THE ENGINE ROOM RESOURCE MANAGEMENT CONCEPT VIA THE INTEGRATED MODEL OF TRAINING EFFECTIVENESS AND EVALUATION

SUMMARY

International regulations are accepted as a result of new technological developments or accidents. In this context, aviation community developed cockpit resource management concept to reduce the numerous fatal accidents in aviation field which caused by human fault. The focus of cockpit resource management spreads outside to the cockpit for improving the safety culture. The concept of resource management firstly announced in the aviation industry and the training was progressively improved then enlarged to other groups. Concept was firstly named as Crew Resource Management (CRM) and then called by different names such as MRM, TRM, ACRM, ETCC, BRM, and ERM. Even if they take many different names, all these trainings have only one goal, reducing the rate of human fault in accidents.

Trade in the world is developing day by day and approximately 90 percent of this trade is maintained by shipping. Therefore, maritime sector is accepted as the pioneer field in the world trade. With the growing popularity of maritime sector, number of studies in this field has started to increase. Studies related with maritime accidents have mostly focused on accidents that occurred by human fault. Thus, human fault is one of the most studied topics in the maritime field.

Many studies in different fields such as aviation, offshore, healthcare, maintenance, and railway highlight human fault as the main cause of accidents. One of these fields is maritime sector. International Maritime Organization (IMO) recognizes that safe operation of ships is not possible without effectively trained seafarers. Therefore, IMO has proposed some mandatory requirements to reducing human fault factor in the maritime accidents. In the conference, which was held in Manila, Standards of Training Certification and Watchkeeping (STCW) was announced new amendments in June 2010.

After the Manila amendments, new key issues such as Engine Room Resource Management (ERM), Bridge Resource Management (BRM) trainings came into prominence. ERM is the mandatory training, which is stated under the STCW tables A-III/1 and A-III/2. This training includes allocation, assignment, and prioritization of resources; teamwork, effective communication, assertiveness and leadership, situational awareness, decision-making, team experience subjects. However, the ERM have a complex and intensive content. Therefore, many training courses, shipping companies, seafarers and other organizations in the maritime industry perceived the ERM concept as a kind of simulator training (IMO model course 2.07). From training institutions to maritime companies, there are some problems about perceiving, learning, transferring and especially evaluating the concept of ERM. In addition, when the training procedures of shipping companies were examined in detail, it was seen that the ERM concept and its requirements was not found in the training procedures.

This master thesis contains study in both theoretical and practical level, the thesis is organized based on a literature review, industrial survey, methodology development, demonstration and enhanced concept proposal.

In this thesis, deficiencies have been determined and the model that best addresses these deficiencies of the ERM concept has been selected. Integrated Model of Training Evaluation and Effectiveness (IMTEE) is the newest and most cited study among other models. The most important factor in choosing IMTEE model is that, this model is different from classical models and it is considered suitable for ERM concept since it is a multi-stage and integrated model. Application requirements of IMTEE and its flowchart was designed. According to the flowchart, improvements are separated and coded considered its stage and group. Then, overview of suggested improvements was explained. In the application section, firstly needs of ERM concept were analyzed and listed. Training content was formed and changes in learners designed by the help of individual, training characteristic and various evaluation methods such as, trainee performance evaluation form, ERM knowledge modules etc. Organizational payoffs were shaped by using individual, training, organizational characteristics, crew appraisal forms and company reports. By applying this model, an enhanced ERM concept was suggested to resolve identified deficiencies.

The proposed, enhanced ERM concept offers a solution to deficient sides of ERM. Considering the developing maritime sector and increasing human fault rate, the role of ERM concept is undeniable. It is important for maritime sector to do more study and to open new horizons.

EĞİTİM ETKİNLİĞİ VE DEĞERLENDİRMESİ BÜTÜNLEŞİK MODELİ İLE MAKİNE DAİRESİ KAYNAK YÖNETİMİ KONSEPTİNİN İYİLEŞTİRİLMESİ

ÖZET

Uluslararası kurallar genellikle, büyük kazalar veya önemli teknolojik gelişmeler sonrası kabul edilmiştir. Havacılık sektörü, insan hatası nedeniyle gerçekleşen pek çok ölümlü kazayı azaltmak amacıyla 1970li yıllarda, ilk defa pilot köşkü kaynak yönetimi kavramını geliştirmiştir. Geliştirilen bu eğitim daha sonra, pilot köşkü dışına çıkarak havacılığın tüm dallarına yayılmıştır. Bu nedenle, kavram isim değişikliği yaşayarak personel kaynak yönetimi adını almıştır. Ekip kaynak yönetimi (CRM) eğitimi ilk olarak askeri alanda, daha sonra ise sivil havacılıkta zorunlu hale gelmiştir.

CRM kavramının havacılığa bağlı diğer alanlara yayılmasıyla eğitim farklı isimler almıştır. Örneğin, bakım onarım sektöründe Bakım Onarım Kaynak Yönetimi (MRM), hava trafik kontrol alanında Takım Kaynak Yönetimi (TRM) isimlerini almıştır. Bu kavramın sağlık sektörüne geçişi ise 90lı yıllarda olmuştur. Eğitim ilk olarak anestezi alanında uygulanırken daha sonra tüm sağlık sektörü alanlarına yayılmıştır. Sağlık sektörü de havacılık gibi yüksek risk içeren bir alandır. Yapılan çalışmalar, ölümle sonuçlanan hatalarda insan faktörü payının yüksek olduğunu göstermektedir. Mevcut insan hatası faktörünü azaltmak amacıyla havacılıktan ilham alarak sağlık sektörüne uyarlanan eğitim, Anestezi Kriz Kaynak Yönetimi (ACRM) olarak adlandırılmıştır. Diğer sağlık sektörü alanlarında ise Acil Durum Takım Koordinasyon (ETCC) kursu ve Cerrahlar için Teknik Olmayan Beceriler (NOTSS) kursu duyurulmuştur. CRM eğitiminin demir yolu sektöründe uygulanması, Tren Personeli Kaynak Yönetimi (TCRM) kursu ile olmuştur. Bu kurs daha sonra yönetimlerin desteği ile Demiryolu Kaynak Yönetimi (RRM) haline gelmiştir. Diğer riskli sektörlerde olduğu gibi kazalardaki insan hatası payının son derece yüksek olduğu denizcilik sektörüne bu kavramın uyarlanması 90lı yıllarda olmuştur. İlk defa bir denizcilik firmasının CRM eğitimi ile tanışmasıyla başlayan süreç, 1994 yılında dev bir firmanın Köprü üstü Kaynak Yönetimi (BRM) eğitimini duyurmasıyla devam etmiştir. Daha sonra ise Denizcilik Kaynak Yönetimi (MRM) eğitimi oluşturulmuştur. Ayrıca, deniz kazaları ile ilgili yapılan çalışmaların büyük bir kısmı, insan hatasına odaklanmıştır. Bu nedenle insan hatası, denizcilik alanında en çok çalışılan konulardan birisi haline gelmiştir.

Tüm bu gelişmeler sonrası 2010 yılında Filipinlerde, Uluslararası Denizcilik Örgütü (IMO) tarafından yürütülen konferansta Gemi Adamlarının Eğitim, Belgelendirme ve Vardiya Tutma Standartları (STCW) ile ilgili birtakım düzenlemeler yapılmıştır. Bu düzenlemeler sonucu Köprü Üstü Kaynak Yönetimi (BRM) ve Makine Dairesi Kaynak Yönetimi (ERM) kavramları ortaya çıkmıştır. Bu gelişmenin etkisiyle denizcilikte durumsal farkındalık, karar verme, kaynak yönetimi, liderlik gibi kavramlar önem kazanmaya başlamıştır ve pek çok ERM, BRM kursu oluşturulmuştur. Kaynak yönetimi kavramı 70li yıllarda havacılık sektöründe başlamıştır ve daha sonra bu kavramın özellikle yüksek risk içeren alanlara

taşınmasıyla mevcut eğitimin MRM, TRM, ACRM, ETCC, BRM, ERM gibi farklı isimler aldığı görülmüştür. Farklı isimler almasına rağmen tüm bu eğitimlerin ortak amacının, kazalardaki insan hatası oranını azaltmak olduğu anlaşılmaktadır.

Havacılık, denizcilik, sağlık, bakım onarım, demiryolu gibi farklı alanlarda yapılan birçok çalışma, insan hatasını kazaların ana nedeni olarak vurgulamaktadır. Bu alanlardan biri de denizcilik sektörüdür. İyi eğitilmiş denizciler olmadan güvenli gemi operasyonlarının yapılamayacağını bilen IMO, deniz kazalarında insan hata faktörünü azaltmak için bir dizi kural yayınlamıştır. Bu bağlamda, Makine Dairesi Kaynak Yönetimi (ERM), STCW tabloları A-III/1 ve A-III/2'de belirtilen zorunlu eğitimlerden bir tanesi haline gelmiştir. ERM kavramı kaynakların tahsisi, atanması ve önceliklendirilmesi; takım çalışması, etkili iletişim, özgüven, liderlik, durumsal farkındalık, karar verme ve ekip deneyimi gibi konuları içermektedir. Ancak ERM eğitimi karmaşık ve yoğun bir içeriğe sahiptir. Bu nedenle, birçok eğitim kursu, denizcilik şirketi, denizciler ve denizcilik sektöründeki diğer kuruluşlar ERM eğitimini IMO Model Kurs 2.07 eğitimi (Makine Dairesi Simülatör Eğitimi) olarak algılamışlardır. IMO Model Kurs 2.07 geniş kapsamlı bir makine simülatörü kursudur. Eğitim teknik beceriler ile ilgilidir ve makine dairesinde bulunan çeşitli sistem ve donanımların kullanımı, devreye alınması ve verimli işletilmesi gibi konuları içermektedir. Ayrıca IMO 2.07 kursu ERM kursu gibi zorunlu olan bir kurs değildir. STCW tablo A-III/1 ve A-III/2 ERM kursu ise, katılımcıların durumsal farkındalık, liderlik, karar verme gibi teknik olmayan becerilerini geliştiren zorunlu bir kurstur. Yaşanan bu karmaşıklık, ERM eğitimini veren kursların eğitim içeriklerine de yansımıştır. Ayrıca ERM konseptinin denizcilik sektörüne tam olarak aktarılamadığı da açıktır. Kısaca, eğitim kurumlarından, denizcilik şirketlerine, denizcilere kadar mevcut ERM konseptinin algılanması, öğrenilmesi, aktarılması ve ölçülmesinde sorunlar yaşandığı düşünülmektedir.

Tezde hem teorik verilerden hem de saha çalışmasından yararlanılmıştır. İlk olarak kaynak yönetimi ve eğitim değerlendirmesi alanlarında literatür incelenmiştir. Bu çalışma, yapılan saha çalışmaları ile desteklenmiştir. Ayrıca tezin ilk kısımda, ERM kursunda kazandırılması hedeflenen yeterlilikleri anlamak, ERM içerik ve çıktılarını incelemek, denizcilik şirketlerindeki ERM uygulama eksikliklerini gözden geçirmek, ERM konseptine iyileştirmeler önermek ve son olarak geliştirilmiş bir ERM konsepti önermek hedefleri belirlenmiştir.

Saha çalışmasının ilk adımı olarak çeşitli denizcilik firmalarıyla görüşülmüş, firmalardan şirket talimatları ve formları temin edilmiştir. Temin edilen bu veriler düzenlenmiş ve incelenmiştir. IMO tarafından belirlenen ERM konsepti ile şirket talimatları arasındaki boşluklar saptanmıştır.

Daha sonra ERM eğitimi veren kursların içerikleri, yapıları, değerlendirme yöntemleri ayrıntılı bir şekilde incelenmiştir. Mevcut kursların, STCW tablo A-III/1 ve A-III/2 ERM eğitimini kapsamlı bir simülatör eğitimi olarak algıladıkları, ağırlıklı olarak teknik beceriler kazandırılan 2.07 IMO model kursu ile ERM eğitimini karıştırdıkları görülmüştür. Ayrıca ERM konseptini daha iyi anlamak adına araştırmacıların uyguladığı analiz yöntemlerinden yararlanılmış, eldeki mevcut verilerden de faydalanarak ERM konseptinin eksik yönleri belirlenmiştir.

Eksiklikler tespit edildikten sonra, ERM konseptinin güçsüz yönlerini en iyi şekilde giderecek model üzerine çalışılmıştır. Güncel, bütünleşmiş ve ERM konseptine en uygun gözüken IMTEE modeli, özellikle değerlendirme yönünün kuvvetli olması nedeniyle tercih edilmiştir. Daha sonra, bu modelin uygulama gereksinimleri

belirlenmiş ve akış şeması oluşturulmuştur. Ayrıca oluşturulan bu şemada yapılacak olan geliştirmeler, modelin seviyelerine ve iyileştirmenin sınıfına göre ayrılarak isimlendirilmiştir. Daha sonra bu iyileştirmeler, önerilen geliştirilmiş ERM konseptinin her basamağında uygulanmıştır.

Bu çalışmada ERM, bir simülatör eğitimi değil STCW'nin yapısını çizdiği, teknik olmayan beceri eğitimi olarak ele alınmıştır. IMTEE modeli gereğince, ERM konseptinin ihtiyaç analizi yapılmıştır. Bu analiz sonrası ERM üç kısma ayrılmıştır. Bunlar: eğitim içeriği, kursiyerlerdeki değişim ve organizasyon kısımlarıdır. Eğitim içeriği oluşturulurken bireysel özellikler dikkate alınmıştır. Ayrıca katılımcıların kurs hakkındaki görüşleri, eğitim içeriğini belirlemede etkin hale getirilmiştir. Kursiyerlerdeki değişim ise kendi içinde üç kısma ayrılmıştır. Bu kısımlar, doğrudan bireysel ve eğitim özellikleri dikkate alınarak oluşturulmuştur. Eğitim sonrası yeterlilik, eğitim sonunda öğrenilen bilgiler ve katılımcıların kurs performansı için farklı değerlendirme yöntemleri modele eklenmiştir. Ayrıca kısımlar arasındaki farklar ve değerlendirme yöntemlerinin ne şekilde, ne zaman yapılacağı gibi unsurlar belirlenmiştir. Son olarak organizasyon düzeyinde incelemeler ikiye ayrılmıştır. Bunlar: öğrenilen bilgilerin iş ortamına transferi ve sonuçlarıdır. Ayrıca organizasyon düzeyinin, her üç tip özellikten de etkilendiği ifade edilmiştir. Geliştirilmiş ERM konseptine göre tüm bu kısımlar birbirleriyle bağlantılıdır ve doğrudan veya dolaylı olarak eğitim yapısına etki edebilmektedir. Son olarak bu modelin en kuvvetli yönü, çok aşamalı olan ölçme ve değerlendirme kısmıdır. Geliştirilmiş ERM konsepti, ölçme işlemini klasik yöntem olan eğitim sonu tek bir test ile değil eğitim içeriğinden, katılımcılara ve şirket yapısına kadar her basamakta, çok aşamalı olarak yapmaktadır.

Önerilen, geliştirilmiş ERM konsepti daha önceden tespit edilen sorunlara çözüm önerisi sunmaktadır. Ayrıca araştırma sırasında literatürde ERM ile ilgili sınırlı sayıda çalışma bulunmuştur. Bu çalışmanın, denizcilik alanına, Makine Dairesi Kaynak Yönetimi konusunda katkıda bulunması hedeflenmektedir. Gelişen denizcilik sektörü ve kazalardaki yüksek insan hatası payı göz önüne alındığında, ERM konseptinin rolü göz ardı edilemeyecek düzeydedir. Bu alanda daha çok çalışma yapmak ve yeni ufuklar açmak denizcilik sektörü için son derece önemlidir.

1. INTRODUCTION

Maritime transportation has vital role in the world trade to maintain sustainability of supply chain. The statistical investigations addresses that about 90% of world trade is carried by different types of ships (Li et al., 2015). Although maritime transportation is exceedingly preferred, it still has number of issues open to improvement. As global standard-setting authority for the safety, security and environmental performance of international shipping, the International Maritime Organization (IMO) emphasizes the popularity of sector, but notes its potential challenges and risks (International Maritime Organization, 2004).

The operating environment of merchant ships is so dynamic and complex. Particularly, the engine room, equipped with machinery system, has extreme working conditions such as high temperatures, excessive vibrations, limited areas, noisy sections. McNamara et al., (2000) expressed the concerns about the combination of dangers and consequences in detail. Recently, the countermeasures such as safety regulations, inspections, surveys, machinery technology, training and certification against the mentioned hazards is expected to be more strength. The focus of the maritime authorities is still human fault while there is an increasing trend in comprehensive researches through providing technological solutions and organizational developments to achieve high level of regulatory compliance onboard ships.

The facts and figures on human fault, also cited as human element in literature (O'Neil, 2003), underlines the key issues (i.e. decision error, violation of regulations etc.). Various scientific studies and technical reports demonstrate the effect of human fault specific to ship accidents. It is clearly stated by (Rothblum, 2000), the human fault contributes to the vast majority (75-96%) of maritime casualties. The study specifically cited the human fault contribution ratio in tanker accidents (84-88%), towing vessel groundings (79%), collisions (89-96%), fires and explosions (75%).

Human fault is thought to contribute to most of the accidents in the maritime sector (Safety Shipping Review of Allianz, 2017). According to study, nearly 75% to 96% of

maritime accidents can be happened because of the human fault. When studies conducted to examine the reasons of maritime accidents, human fault has been shown to play a huge role in accidents at sea which thought to be approximately 75-90% (Fan et al., 2018).

The maritime field focused on improving the reliability of machinery, equipment, hardware, system, engine such as, propulsion, auxiliary machineries, main engines, safety systems. Improving ship technology provides, decreasing accidents and increase work efficiency. Hence, today's ship systems are exceptionally safe and technically advanced (Galieriková, 2019). On the other hand, maritime industry faces new challenges today. Approximately two decades ago, the average cargo ship had nearly 35-45 ship personnel (Grech and Horberry, 2002). Nowadays, technological developments entail to decline crew number onboard. In some situations, Very Large Crude Carrier (VLCC) Vessel just have 22 seafarers.

Technological developments have two different sides, improvements in maritime industry aids to decrease probability and consequence of maritime accidents but, with the technological developments, the link between accident and human fault has emerged (Hetherington et al., 2006). Today, the target point of researchers in maritime accidents has been changed from the machinery problems to the human faults (Luo, 2016).

International regulations are often formed as a result of new technological improvements or fatal accidents. International Maritime Organization (IMO) which knows that safe and efficient ship management is not possible without well-trained seafarers, proposed some mandatory requirements. Various arrangements have been made by IMO to decrease the effect of the human fault in maritime casualties. Standards of Training, Certification and Watchkeeping (STCW) Code set up vital requirements on seafarer training and certification on a transnational stage. These requirements are compulsory not only by local governments but also in all member countries and member states are obliged to meet or exceed the standards of IMO.

According to STCW, chapter one includes general provisions, chapter three is about engine department and chapter eight states watchkeeping. Ship crew such as chief engineers, first engineer and second engineer are responsible for watchkeeping on board ship. They have to comply with relevant requirements and guidelines for

watchkeeping standards in the STCW Code. According to watckeeping standards, ship crew must be on duty between designated hours. For this reason, it is obligatory to have personnel in the engine room of the ship at all times, except during the unman periods. Considering the ship's engine room, duty engineer who is responsible for watch keeping is the chief engineer's representative in the engine room and he is in charge of keeping engine room space safe and efficient at all times. To ensure this, duty engineer must make continuous checks and measurements. For instance, second engineer must control main and auxiliary engine exhaust values, lube oil pressures, pump leakages, boiler pressures, fuel oil viscosity, freshwater and seawater temperatures and pressures at regular intervals. Therefore, watchkeeping standards of STCW is extremely important for efficient and safe operations in the ship's engine room.

As mentioned before, the STCW was amended as a consequence of requirements such as new technological development or accident. As a result of fatal accidents which was caused by human fault, the conference was held in Manila, the Philippines. Various amendments were decided in STCW in June 2010. Within the amendments adopted, there was an important change to nearly all chapter of the STCW. After this arrangement, new key issues such as working hours, effective communication, leadership, distance learning, teamwork has occurred and the amendments entered in force in January 2012.

Engine room Resource Management (ERM) is one of the mandatory training that is stated under the competence of maintaining a safe engineering watch table A-III/1 and A-III/2. ERM training includes allocation, assignment, and prioritization of resources and teamwork, effective communication, assertiveness and leadership, situational awareness, decision-making, team experience terms. Considering ERM requirements, it has really complex and broad context (Ceylan et al., 2019).

ERM training and ERM concept are the different subjects. It is necessary to draw the difference between ERM training and ERM concept. ERM concept refers to ERM training, qualification gains and organizational structure that will enable these qualifications to be used. In fact, the ERM concept suggests to a comprehensive structure that concerns all stakeholders such as seafarers, training courses and shipping companies, ERM training is only one component of it.

Engine room operation is heavily dependent on human factor. Considering the diesel-generator injector overhaul, engineer who charge of diesel engine overhaul, adjust pressure of injectors and set their tightening torques. Therefore, human fault possibility increases in the ships engine room (Jiang, 2012). In fact, ERM is mainly aimed at reducing human fault rate in the accidents. In other words, it is about non-technical skills such as decision-making, leadership, teamwork etc. of seafarers. However, several deficiencies are observed while transferring the ERM concept to the maritime field. STCW A-III/1 and A-III/2 ERM training course is often confused with an IMO 2.07 model course. According to STCW, ERM includes non-technical skills such as situational awareness, decision-making, resource allocation, leadership and assertiveness and it is a mandatory course for seafarers. On the other hand, IMO model course 2.07 has technical course content about starting up, using of main engine, boiler, compressor, separator, diesel generator, pumps; understanding and operating electrical diagrams, piping systems, black out and other emergency procedures. In brief, ERM is a mandatory non-technical skill course but IMO 2.07 is a long-term engine simulator course. Maritime stakeholders especially training courses misunderstood the ERM training course and applied it as an IMO 2.07 model course. In addition to this, in order to determine the deficiencies in this area, procedures of shipping companies were examined in detail. ERM concept was not found in the training procedure of almost any company. Therefore, it is obvious that, application of ERM concept to the maritime field is deficient. Therefore, aim of the thesis is to advise an enhanced ERM concept by using integrated model of training effectiveness and evaluation model.

1.1 Aim and Scope

ERM is the compulsory training course, which is presented in the STCW table A-III/1(minimum standard of an engineering watch) and table A-III/2 (management level). In this context, marine engineers must set out ERM skills (decision-making, situation awareness, leadership, assertiveness, prioritization of resources etc.) and they have to get an ERM certificate to work onboard. Shipping companies should control their engineers to have this certificate and that they are qualified with ERM principles. However, it was seen that the ERM concept was not fully applied to maritime field. There is a big gap between the STCW table A-III/1 and A-III/2 ERM concept and the

currently applied ERM concept in maritime field. Therefore, the purpose of this thesis is to analyze the STCW A-III/1 and A-III/2 ERM training course motivation and then its content and outcomes more clearly. Secondly, to identify the problem by examining the current ERM training courses, company procedures, training assessments. Finally, to draw an enhanced ERM concept for maritime sector.

1.2 Thesis Objectives

STCW draws ERM training course content under tables A-III/1 and A-III/2. According to these tables, ERM includes nontechnical skills such as decision-making, situational awareness, leadership, and assertiveness. The purpose of these tables is reducing human fault rate in maritime accidents. On the other hand, the ERM training have a very intensive content and many training courses, shipping companies and seafarers perceived the ERM as a kind of simulator training. ERM training (according to tables A-III/1 and A-III/2) and IMO model course 2.07 are the different courses. IMO 2.07 (simulator training course) has technical course content such as using diesel generators, separators; black out procedures; starting up main engine, boiler, and compressors. In addition to this, unlike ERM training course, IMO 2.07 is not a mandatory training course. In addition to this, ERM concept was not found in Turkish shipping companies' procedures and forms. It has been observed that shipping companies take this training within the mandatory regulations that set by IMO. Consequently, problems were observed about perceiving, learning, transferring and evaluating the concept of ERM. To overcome this problem, thesis objectives includes the following items:

i. Understanding the targeted competencies of ERM training course,
ii. Analyzing ERM training course contents and outcomes,
iii. Reviewing the shortfalls of ERM practices in shipping companies,
iv. Suggesting improvements on ERM concept,
v. Proposing an enhanced ERM concept.

1.3 Thesis Organization

Since the topic of this thesis requires study in both theoretical and practical level, the thesis is organized based on a literature review, industrial survey, methodology development, demonstration and enhanced concept proposal.

The studies were selected from in journals or conferences that include literature review or document work, those related to maritime, aviation, healthcare, railway domain, much cited and recently written ones. All these articles were separated and coded according to their field. The methods used in the studies are grouped and examined in the same way.

Various databases were used to search for these terms: Engine Room Resource Management, decision making, human factor, integrated model training evaluation, BRM, maintenance resource management, ERM, evaluation methods, assessment models, human factor, maritime training, offshore resource management, training evaluation, training effectiveness, effective communication, nontechnical skills, organizational characteristics, training characteristics, crew resource management, Bridge Team Management, individual characteristics, training design, simulator-based training, health-care resource management, maritime safety, performance evaluation, training behavioral markers, situational awareness, CRM, Team Resource Management, assertiveness and leadership, Bridge Resource Management.

Structures and contents of the ERM training courses were examined. In addition to this, the evaluation methods of the existing training courses were studied in detail.

To complete industrial survey, several technical visits to the number of six shipping company located in Turkey are completed. Afterwards, training procedures were received from these companies in order to analyze. Training procedures were examined in detail. The gap between the STCW table ERM concept and the current ERM practices is determined.

The first chapter includes introduction, aim and scope of the thesis. Thesis objectives and organization are also explained in this chapter. Second chapter includes, detailed literature review on both resource management concept and training evaluation methods. This chapter also includes studies in thesis subject's field, industrial feedbacks and critical review. As a suitable methodology, Integrated Model of Training Evaluation and Effectiveness (IMTEE) is introduced in the chapter three.

Additionally, application requirements of IMTEE and its flowchart is designed in this chapter. Enhanced ERM concept was presented and explained in the chapter four, which is named IMTEE application to ERM. This chapter includes needs analysis, training content and design, changes in learners, organizational payoffs, multi-stage evaluation, characteristics, overview of suggested improvements and proposed enhanced ERM concept. Finally, the last chapter includes conclusion, discussion and further issues.

2. LITERATURE REVIEW

This chapter includes the detailed literature review on three key aspects: i) Resource management concept applied in different fields; ii) Training evaluation models; iii) Practical field studies. In addition, the chapter provides an industrial feedback survey and its critical review.

2.1 Literature Review on Resource Management Concept

International requirements are generally accepted as a result of new technological developments and accidents. In the 1970s, aviation community developed cockpit resource management concept to reduce the numerous fatal accidents in aviation field which caused by human fault. The focus of cockpit resource management spread to areas outside the cockpit to include cabin crew for improving the safety culture (Chute and Wiener, 1994, 1995; Vandermark, 1991). As a result, according to Simpson et al. Cabin Resource Management training, which includes flight deck and cabin crew, has become widespread (Simpson et al., 2004). The training was progressively improved and enlarged to other groups. Therefore, the concept was named Crew Resource Management (CRM). In the United State military flight crews, CRM training became mandatory in the 1990s. In 1998, training became mandatory for commercial flight crews (Salas et al., 2006).

Aviation community applied human fault training to their own field from the aviation sector. The training has been entitled, Maintenance Resource Management (MRM) (Stelly and Taylor, 1992; Taylor, 2000). The aviation maintenance community evolved MRM to reduce the high number of catastrophic accidents which caused by human fault about maintenance. MRM training programs shared a common framework with CRM program. Additionally, MRM training includes communication, workload management and human fault like CRM program. (Reason and Hobbs, 2003). According to Patankar and Taylor (2004, 2008), MRM has a positive effect on

reducing aircraft damaged events, increasing personnel safety and increasing investment values.

In the other aviation field, Air Traffic Control has used human factors training in a same way to CRM (Andersen and Bove, 2000). They produced Team Resource Management (TRM), and afterwards Threat and Error Management (TEM) was designed. These programs were an effective way to enhance personnel's knowledge to reduce human faults (Kontogiannis and Malakis, 2009). Europe's current air traffic situation EUROCONTROL financed the improvement of TRM training in the Europe. Afterwards, EUROCONTROL formed a TRM User Group which support the usage and improvement of TRM in Europe and the group be formed of air traffic controllers. TRM training has been provided by civil and military institutions, broader TRM training equipment and technical support has been provided in some European countries (EUROCONTROL, 2004).

The intention of the CRM concept was to evolve flight crews' ability like leadership, decision-making, teamwork concept, assertiveness and situation awareness (Kanki et al., 2010). The above-mentioned items will be referred to as nontechnical skills later (Flin et al., 2008). According to Wahl and Kongsvik (2018), CRM training may be comprehended as a risk diminishing method, if the organizational framework understands nontechnical skills correctly. CRM training provides participants with the nontechnical skills required to manage resources effectively.

Training of nontechnical skill which is named CRM, firstly improved for flight deck crew, later CRM training adapted and to the maintenance community of aviation, Air Traffic Control. The notion of CRM training has been transferred to other domains especially in high-risk domains such as, maritime field, railway industry, anesthesia and intensive care in health care domain, the military sector, nuclear power production, offshore platforms and oil production industry to improve the performance of participants and teams in normal and emergency situations. (Flin et al., 2003).

Anesthesiologists started the first adaptations of CRM concept to health care sector in the early 1990s. Principles of CRM are generally applied under anesthesia and CRM training later spread to other areas in the health sector (Helmreich, 1995, 2000; Pizzi, Goldfarb, and Nash, 2001). Today, the healthcare industry sets high standards about nontechnical skills training, and has conducted studies on what constitutes the best

practice the industry can do (Hayward et al., 2019). As in other areas, health-care sector includes always high-risk activity and difficulty, which has a potential for human life-threatening conditions. Therefore, Effective teamwork, decision-making, situation awareness and crisis management are vital in many areas of health care, including emergency care, anesthesiology, intensive care, operating room and surgery (Hayward et al., 2019). Gaba et al. (2001) studied the anesthesiologist's reactions in simulated emergencies in the health care operating room. According to their findings, study advised that anesthesiologists had an insufficient systematic training in nontechnical skills for emergencies. Sexton et al. (2000), studied on evaluating behaviors to stress, emergency error and teamwork by using a changed aviation questionnaire, the Cockpit Management Attitudes Questionnaire (CMAQ). According to the results of the study, approximately 70% of surgeons reported that they can perform effectively in critical times even when they are tired. Helmreich and Merritt (1998) stated that, identical beliefs regarding inerrancy might be found in examination of aviation pilots. After these developments, Crew Resource Management training was firstly announced in the health care field in the name of Anesthesia Crisis Resource Management (ACRM) training. It has been found that approximately 65-70% of human life threats in anesthesiology are due to human fault and anesthetists have little practice in managing crises (Howard et al., 1992). Therefore, ACRM courses aim to provide various responses to participants to conduct fatal situations, involving the ability to effectively arrange the team and employ all resources in an emergency which threating a human life (Howard et al., 1992). Now anesthesia training in simulation on ACRM, which is based on recently developed CRM concept, is very important. Researchers expected that training become widespread in other health care areas (Gaba et al., 2001).

Health care sector designed Emergency Team Coordination Course (ETCC) by adapting ACRM and CRM for Emergency Department of health care (Risser et al., 1999). Emergency Team Coordination Course concept includes the five main principles such as, teamwork, workload allocation, problem solving, communication team making. ETCC training based on enhancing team-working skills by avoiding human faults (Shapiro et al., 2004).

Fletcher et al. (2003) analyzed behavioral marker systems, which is used in anesthesia, and developed a taxonomy. These markers were published as Anesthetists'

Nontechnical Skills (ANTS) book (University of Aberdeen and Scottish Clinical Simulation Centre, 2004). These markers include four essential topics, which is significant for efficient performance in field of anesthesia. These topics are task management, decision-making, team working and situational awareness. The development of Anesthetists' Nontechnical Skills has composed the development of Nontechnical Skills for Surgeons (NOTSS) behavioral marker system in other medical domains (Fletcher et al., 2003).

Railroad sector is the other high-risk industry. As in other sectors, the human factor plays an important role in accidents in the railway sector. Human fault was indicated as a common factor to 37% of all train casualties (Federal Railroad Administration, 1999). In addition to this, concepts related to CRM training have been identified as a contributing factor in some rail crash (Office of Transport Safety Investigation, 2004).

In 1999, (National Transportation Safety Board, 1999) firstly stated that if railway workers are trained by Train Crew Resource Management (TCRM) training, railway security will be increased. In addition to this, they recommended that this training be improved for all train personnel. In 1999, Canadian Pacific Railway designed a CRM course, which lasts in two days. The CRM training course includes requirements of teamwork, effective communication and eliminating human fault. The Australian rail industry understood that training was necessary after the Waterfall accident. "All Railway Safety Employees must attend CRM training to boost their skills in using resource.'' report was published after the accident (Ackerman, 2005).

The Federal Railroad Administration (FRA) formed a CRM training to train and train engine workers. The program includes leadership, decision-making, crew coordination, assertiveness, teamwork, situational awareness. This CRM was made accessible to all railway field in June 2004 (Federal Railroad Administration, 2004).

Australian Rail Industry made a National Rail Resource Management Project which were completed in 2007 (Klampfer et al., 2007). This project named as a RRM. The training sponsors encouraged the railroad workers to apply RRM training. The magnitude and extent of the project was big enough to provide opportunities to enhance the implementation of nontechnical skills into the rail industry as in aviation and other fields (Alcock et al., 2013).

As in the maritime field, offshore platforms and oil-gas industry has a powerful teamwork and work assistance ethic with a different crew. Studies about offshore accidents have explained that, human fault is commonly identified as a contributing factor as in the maritime, health and railroad sector. (Flin et al., 1996; Mearns et al., 1997). CRM was first adapted to the offshore sector in 1990s. CRM concept in the aviation field has been turned into a training program for offshore control room operators that focuses on emergency training and proficiency evaluation. In this course four vital areas were developed: assertiveness, effective communication, decision-making and stress factor (Flin and O'Connor, 2001).

The first crew resource management training for offshore platform field was announced in 1999 (O'Connor and Flin, 2003). This course, which would take 2 days, was designed to enhance safety for production and maintenance crews. Training content involved parts on factor of stress, teamwork, team coordination, fatigue, effective communication, decision-making and awareness of situation. The CRM training for offshore crews aimed to provide an enhanced situational awareness of providing these skills (Flin et al., 2003).

The basis of maritime and aviation resource management training is very similar. Both training was emerged after the critical accidents which including insufficient usage of available sources such as human resources, equipment, tools etc. on the ship's bridge or on the aircraft flight deck (Barnett, Gatfield, and Pekcan, 2004; Helmreich and Foushee, 1993; Lauber, 1993).

CRM in maritime measures the ability of trainees to using resources effectively in both normal and emergency situations and CRM is aimed at reducing maritime accidents by revealing critical deficiencies. There has been a huge effort to decrease accidents by improving maritime safety by IMO regulations, technologic progress and personnel training in the maritime industry. Therefore, many researches in the field of maritime accidents have been focused on usage of technologic developments in the maritime industry. Despite these efforts, human fault is still the primary reason in maritime accidents. United States Coast Guard (USCG) report states that approximately 75–96% of maritime accidents are caused by a kind of human fault. (Rothblum, 2000). His report show that, approximately 85% of tanker accidents, 80% of towing vessel groundings, 95% of collisions, 75% of fires and explosions caused by human fault. Safety Shipping Review of Allianz shows that; human fault or human element has

been regarded as contributing to plenty of accidents in the maritime industry. It is nearly 75-96% of maritime accidents may be occurred due to the human fault (Safety Shipping Review of Allianz, 2017). For this reason, CRM concept has started to yield the maritime sector to reduce human error. These figures clearly show the effect of human fault on industrial security. (Hollnagel, 2004; Reason and Hobbs, 2003).

After various casualties which fault of human was identified as the main reason was occurred, the maritime industry started to adopt the CRM concept to maritime sector in the 1990s (Grech et al. 2008). International maritime field became aware of the development and impressive impact of crew resource management training in aviation field (for flight deck crew, aviation maintenance community, air traffic control).

Warshash Maritime Centre developed and announced a training, which was for shipmaster and officers in Southampton. Training consists of bridge operations simulator-based training content (Haberley et al., 2001). The training content was formed on passage planning and communication between masters and maritime pilots. The training that mentioned above changed to the Bridge Team Management (BTM) course in the end. In 1992, seven leading maritime company cooperated with the Scandinavian Airlines System (SAS) Flight Academy to found an international Bridge Resource Management course attempt (Wahren, 2007). This initiative shows that CRM concept, which has already been developed and established in the aviation industry, can be transferred to the maritime industry. After that, first Bridge Team Management course was created in 1993 (Hayward et al., 2019). The executives of Maersk, a pioneer shipping company, applied CRM training for company seafarers in 1994 (Hayward et al., 2019). In the mentioned training, learning outcomes such as assertiveness, decision-making, situation awareness, leadership, effective communication, team working and emergency situation behavior were important to their bridge and engine personnel of all vessels.

The course was conducted theoretically in the classroom for 4 days and on the simulator for 3 days. Byrdorf (1998) stated that, company results about safety accident, near misses and damage records in 1992 to 1996 are reduced and the insurance cost of the company has decreased. Thanks to CRM courses, there is a decrease in accident rates and a decrease in company insurance premiums.

In 2003, the Swedish Club and BRM licensed organizations decided to change the training from bridge resource management to Maritime Resource Management (MRM). In addition, the Swedish Club (TSC) supervised the distributing of maritime resource management course by 40 training suppliers in regions such as Asia, Europe and America. The target trainee for maritime resource management course includes marine engineers, ships' officers and maritime pilots. The announced aim of the TSC MRM course is to create actual safety cultures in corporation that deal with human faults that cause accidents at sea. The training includes a range of trainers, workshops and simulators, which is named Computer-Based Training (CBT) modules. TCS MRM training program lasts in four days. Today, bridge or engine room simulators have many different situations and seafarers can attend this simulator courses in multiple BTM and/or BRM/MRM simulator training cycles (Hayward et al., 2019).

Dubai-based international shipping company announced a new MRM training program in 2006. The target of this program was using aviation CRM skills to extend training to the bridge. The MRM course used classical CRM training methods, classroom lessons, simulator exercises. This course took exactly 3 days (De´dale Asia Pacific and Vela International Marine, 2006).

IMO, declared a mandatory requirement, which is about CRM training's nontechnical skills for deck officers with duty for passenger safety. Competence standard contained emergency process, effective using of resources, managing passenger's safety, maintaining effective and clear communications. Nevertheless, these requirements are only generalized statements (Barnett et al., 2004).

IMO altered the standards of qualification for seafarers in Manila, the Philippines in June 2010. Plenty of amendments in STCW chapters was approved in the Manila conference. After this arrangement, new key issues such as working hours, effective communication, leadership, distance learning, teamwork has occurred. The amendments entered in force in January 2012. BRM and ERM are the obligatory training, which is introduced under the STCW tables. Now all ship officers must receive training called ERM, BRM and learn the principles of bridge and engine room resource management. Those who are successful in education need to be certified and renew their certificates in the future. In addition, as with Aviation, education began as lessons learned in the classroom, but turned into simulator-based education (Wahl and Kongsvik, 2018). According to Grech et al. (2008), training programs help raise

situation awareness in individual's capabilities. According to Barnett et al. (2005), the BRM and ERM training courses adapted from the aviation field. The objective of BRM was to reduce the risk of accidents by improving nontechnical skills, which introduced in resource management concept, was used by all maritime field. BRM and ERM aimed to encourage positive behaviors and effective communication, assertiveness and leadership, and compliance with STCW procedures (Hayward et al., 2019).

Eventually, the scientific evidence of studies and reports has emphasized that nontechnical talents act a significant role in human performance in broad range of fields such as, aviation, rail road, health care, maritime sectors. Although their names change according to the field of study such as CRM, ERM, BRM, TRM, HRM, MRM, ETCC, RRM, TCRM the trainings have only one goal. The goal is to provide knowledge to trainees that will minimize the human faults in accidents. All these studies demonstrate us; resource management training has major positive effect on accidents which caused by human faults. For this reason, ERM concept, which is almost unstudied field, should be researched more in detail.

2.2 Literature Review on Training Evaluation

People know the concept of evaluation as a single-stage method (only learning assessment). However, evaluation is a complex and multi-stage method (reaction, behavior, learning assessments).

Evaluation method actually dates back to previous years. The most popular, first and commonly known model is Kirkpatrick's framework. Kirkpatrick's four-stage measurement framework is the effortless method for comprehending training output's measurement and the most often used and cited model (Kirkpatrick 1959, 1976, 1979, 1996). Kirkpatrick's framework defines four categories of dimension: reaction, learning, behavior and results. Reaction contains evaluation of trainee's response to the course program such as quality or the conformity of the training. Organizations use this step via training evaluation forms. Learning evaluates indication of the gained in the training, which is in during the training. Behavior, explains knowledge, which obtained in training and applied on the job. Finally, results explain measurement goal of the company or organization (Bates, 2004). The four-stage model is a widespread for evaluating training. Salas and Cannon stated that, although new models have been designed, the four-level education assessment model remains the most popular and

frequently cited model. (Salas and Cannon-Bowers 2001). On the other hand, researchers made various criticisms of the Kirkpatrick's model. Guerci (2010) states that Kirkpatrick does not take into account the effects of the organizational context and leads to an overly simplified vision of the effectiveness of education. In addition, if the model does not take place at lower levels, it is impossible to obtain positive results at higher levels (Alliger and Janak, 1989).

Tannenbaum et al. (1993), worked on four stage Kirkpatrick framework by adding posttraining attitudes, training and transfer performance. Training effectiveness model included various terms such as individual characteristics, training needs analysis, training motivation, organizational characteristics, training reactions, posttraining motivation. Therefore, it is a very complicated model and has not been used much to evaluating the training performance.

Warr et al. (1970), suggest a new model, which is named CIRO (contents, inputs, reactions and outcomes). The model examines contents, inputs, reactions and outcomes of learning or training both before and after of the training or learning. The effective side about the CIRO model is, it a management training program and it is measured and targets are taken into account. Nevertheless, it was an outdated model and had some deficient sides.

The Noriaki Kano Model was developed to meet needs of individuals and customer satisfaction. It discriminates mandatory requirements, basic expectations, rational expectations (Kano et al., 1984). The Kano Model will not be useful for the enhancing the training course content because it depends on only customer satisfactions.

The Servqual model suggested a tool for measuring service quality. Researchers developed a framework to evaluate the gap between perceptions of customers and the standard of service provided. The model was structured in five dimensions: physical aspect, reliability, responsiveness or reactivity, insurance, empathy (Parasuraman et al., 1988). Therefore, it is a service quality-evaluating model and did not use much in training evaluating.

Brinkerhoff (1989) shaped a model, which added Kirkpatrick's four-stage model to 2 stages and recommend a model to evaluation of training that includes the 6 levels: goals, program designing, implementation of program, immediate outcomes, usage

outcomes, impacts. Considering its content, Brinkerhoff's model was very similar to the Kirkpatrick's model.

Inputs, Process, Outputs (IPO) Model was created by Bushnell (1990). This model examined firstly input level, which may influence participant's qualifications, design of program, trainer's quality and training equipment quality. The IPO model wants to manage the costs of training and offers many similarities with the CIRO model and it will not be useful for the evaluating training courses.

Roegiers and Bourgeois (1993) developed Open Box model. This model analyzed the three sections: institution, human resources (trainees and trainers), training framework. However, it was very simple model to evaluate complicated training outputs.

Kaufman and Keller (1994) stated that Kirkpatrick's four levels are deficient and they suggested that serious focus should be placed on the evaluation of education. They proposed that, keeping the four-level framework's features and they suggest a five-level evaluation framework. They expanded the Kirkpatrick's four level framework by trainee performance and organizational development. They suggested Organizational Elements Model (OEM) model, which was similar to the Kirkpatrick's model. They tried to improve Kirkpatrick's model by suggesting five levels for assessment. The 5 levels of evaluation model consist of: application, enabling-reaction, acquisition, company/organizational outcomes, society outcomes. The OEM model was similar to the Kirkpatrick's model in many aspects.

Holton suggested a Holton's Evaluation Model. In the model, evaluation concentrates on three stages of training: learning, individual performance and organizational outcomes (Holton, 1996). Model was insufficient to evaluate learning stage inasmuch as learning stage must be categorized for providing the efficient course framework.

Return-on-investment (ROI) model framework, which focus on investment, has entered the organizations. The model mediatizes the four stages Kirkpatrick framework of evaluation and adds a fifth stage to measure achievement in fields of Human Resources. The Phillips ROI model separates the evaluation of financial costs from the assessment of other organizational results. This evaluation model has four stages. In addition, this model shows that investments should not be taken into account regardless of the financial value of special education attempts like training or coaching

(Phillips, 1997). The ROI method is very popular due to its investment ideas. This model uses in financial organization and not suitable for training courses.

Dejean (2002) studied on Quality Circle model which is made by one-year evaluation questionnaires is about quality concept. This model includes several four-year assessments such as needs analysis, training objectives analysis, learning outcomes analysis. This quality-based model has a very long evaluation phases and it is not convenient for ERM concept.

Brown and Sturdevant (2002) suggested a model, which did not use vital principles of Kirkpatrick's four-stage model. They are studied on learning and behavioral change stages of training. They suggest that a difference should be made between subjective and objective learning via knowledge and behavioral transfer. The authors emphasize the significance of considering the characteristic of the working environment in a transfer measurement. Nevertheless, it is not sufficient to enhance ERM concept by only using working environment characteristics.

Brinkerhoff (2003) improved the Success Case Method (SCM). The SCM model answers these questions: what is happening, what is the result, did the program increase production, what is the results, how could the assertiveness be improved. However, this model is primary deficit in specifying the personnel on job behavior and problems in the working field. In addition, the model's transfer performance evaluation is not suitable for ERM concept.

A circular evaluation model, developed by Dejean (2004), applied to quality circle of Spanish universities. In this practice, trainees can assess the trainers and the lectures, which they learnt in addition to the program, school conditions, training equipment and available resources. The model is found strong enough in evaluating the trainee's reactions but it is insufficient to other evaluation stages.

Alvarez et al. suggested the Integrated Model of Training Evaluation and Effectiveness (IMTEE) in 2004. IMTEE explains the training results and makes it possible to formulate advises to enhance the effectiveness of training. The reactions of the trainees refer to the observed usefulness of the training by happiness questionnaire. Posttraining self-efficacy, cognitive learning in training and behaviors, which demonstrated on job field, are explained in the model. Finally, company, which names results, are described. Although the model has four stages, it has six evaluation

measures. These six evaluation measures and relationships between them are highly important in IMTEE model. The six targets of evaluation in the IMTEE model are during training performance, reactions, posttraining attitude, learning, transfer performance, results (Alvarez et al., 2004). IMTEE model is highly cited and newest model in the literature.

Researchers suggested Bournazel model, which aimed to evaluate a training system. Model consists of five categories of indicators: classical performance indicators, social indicators, accompanying indicators, innovation indicators and economic and financial indicators. These categories of indicators reflect five different stages of the training (Bournazel, 2005).

Researchers studied on the Dessinger-Moseley Model that includes four levels: formative evaluation, summative evaluation, confirmative evaluation and meta evaluation (Dessinger and Moseley 2006). The aim of this model is to express clearly decisions about any performance boost value.

Beech and Leather (2006), worked on combined model of evaluation. Model included these levels: reaction, learning, immediate effect level, intermediate effect level, ultimate effect level and financial level. They found that it is impossible to diversify the short and long time impact on training. Due to its evaluating methods, this model is not suitable for ERM concept.

A model, which is named CIPP (context, input, process and product), was proposed. This model had many features of CIRO model. However, content of CIPP provides status data for setting program goals, includes product program application and evaluation of product value and effectiveness results (Stufflebeam, 2007). This model was not suitable for application of training courses.

When all these methods are analyzed, IMTEE is the newest and most cited area among other models. In addition to this, due to its multi-stage and integrated model structure, it is thought that the Alvarez's IMTEE model will be useful for the enhancing and designing the ERM concept.

2.3 Practical Field Studies

This chapter contains resource management studies about aviation field, health-care field, nuclear power plant sector, offshore sector and maritime field respectively. In

this section, especially aviation and maritime field studies are introduced considering its field and year.

Woldring and Isaac (1999), studied self-report survey on 126 participants of European Air Traffic Control. Their survey was about decision-making, communication, team member roles, teamwork, stress factor and situation awareness. In the results of survey, positive reactions were generally reported. A positive change in attitudes was found in learning criteria. In the same year, Elliott-Mabey (1999), worked on aircrew attitude questionnaire on UK Royal Air Force (3212 aircrew). According the questionnaire, positive change in attitudes observed following initial training. The other aviation fieldwork, Thompson et al. (1999), evaluated relationship between CRM and performance during simulator training by using simulator observations CRM worksheets. Their work group was U.S. Air Force 16 MH-53J aircrews. In the study, the most successful crew demonstrated good communication, task management, situation awareness, coordination, risk management. As a result of this research crew resource management and crew's performance demonstrated positive and prominent correlation.

Taylor (2000) used self-report survey operations questionnaire and long-term before, during, after training data about maintenance resource management (MRM) training on U.S. aviation maintenance mechanics, employees and managers. According to the results of the research, excitement towards MRM training, the effect of training on safety and teamwork were high in terms of usefulness of training. In the aviation maintenance field, Goeters (2002) made a simulator observations study in Eastern European airline crews. Study included management, communication, teamwork and decision making criteria. Significant changes found in the study such as, providing standards, situational awareness about systems, problem solving, team making, option generation and choosing, decision making, and risk assessment.

Spiker et al. (2003) used C-5 CRM Process Worksheet to rate CRM behaviors. Their work group was U.S. Air Force 16 C-5 aircrews. Their work content included situation awareness, crew coordination, communication, decision making, task management, mission evaluation. The majority of work on the entire crew concentrated on training performance than the CRM related skills in process. In the study, accomplished teams were more constructive for them and identified areas that needed improvement during discussions and accomplished teams provided an environment for open exchange of

information. In the same year, Nullmeyer et al. (2003) used C-130 CRM Process Worksheet to asses situation awareness, crew coordination, communication, mission evaluation, risk management, decision-making, task management of the CRM training. Study intended to make simulator observations of U.S. Air Force 20 C-130 aircrews. The better performing crews demonstrated CRM skills more regularly than did other crews. The crew's CRM performance was lower than the schedule during task implementation. Afterwards, Lainos and Nikolaidis (2003), worked self-report survey on Greek airline cockpit and cabin crew members. 78% of participants admitted that the training content was suitable to flight crew job needs. 71% of trainees notified confirmation of the standard training methods. 82% declared the quality of the trainer was adequate. 86.6% of crew who works in cockpit consider their role as authoritarian. Only 10% of captain pilots see themselves as participant of flight crew. 20% of cockpit crew and 23% of cabin crew notified that teamwork was very important in their field and they wanted to work together. Katz (2003) studied CRM simulator observations on U.S. Army 16 aircrews. Positive changes founded in the crews' ability to maintain team working skills, sharing mission information, dealing with mission-threatening error. Additionally, Grubb and Morey (2003) studied performance evaluation checklists and scenario worksheets about CRM training on 35 U.S. Army pilots and aircrews. Study shows that increasing in team working skills, workload distribution levels, mission data exchange and managing emergency error.

If the health sector is researched, it will be seen that, there are many studies about resource management concept as in the aviation. O'Donnell et al. (1998) made a self-report survey on 34 nurses in U.S. medical community. Results suggested that participants' experiences were positive and that the major strength was the realism of the scenarios. Jacobsen et al. (2001) made videotape observations to 42 anesthetists in Scandinavian medical community. Training included cooperation, declaration, reevaluation, allocation, start of initial treatment, awareness, leadership and communication subjects. Trainees had difficulty diagnosing the problem. Participants demonstrated high situational awareness but any participant of training took the leadership. In the same way, Gardi et al. (2001) worked on videotape observations of CRM training on 32 nurse and anesthesiologist in Danish medical community. Many teams asked for assistance during the scenarios. Challenges were not tied to knowledge, but to poor resource management. One year later, Morey et al. (2002),

used both self-report survey and on-the job observation technique to evaluate 684 physicians, nurses, technicians in U.S. medical community emergency department CRM training performance. Trainees' attitudes toward teamwork improved. Teamwork improved. Clinical fault rate was decreased but the viewed fault rate did not alter.

Resource management studies have also been carried out in the nuclear industry. Harrington and Kello (1992) worked on 170 nuclear power plant control room personnel on U.S. nuclear power community by applying Control Room Operators Attitude Questionnaire. Demeanor about training was positive. Increased identification of stress effects observed on communication, and command responsibility behaviors of participants.

If the studies in the offshore field is examined, it will be seen that, O'Connor and Flin (2003) made a self-report survey on 77 participants in 3 sea production platforms of UK offshore oil community. Study included effective communication, situation awareness, teamwork, assertiveness, leadership, decision making which are about CRM concept. Participants responded positively to the course. They considered that training might be beneficial to offshore industry and they wanted more emphasis on CRM skills rather than theory. Knowledge about human fault did not enhance after the training but positive attitudes were found in decision-making but not toward all CRM skills. In addition to this, Sætrevik and Hystad (2017) made a questionnaire about resource management concept in offshore field. Study participants were leading offshore petroleum company personnel. Aim of the study was evaluating how situation awareness and leadership that affects personnel's risk assessments.

In the maritime field, an experimental work was studied by using 24 cadets in Royal Norwegian Naval Academy. Training content included decision making, communication, teamwork, emergencies. Twenty-four cadet's reactions about training were generally positive but no change was observed in mental model scores shared between educated and untrained groups (Brun et al., 2000). Two years later, Barnett et al. (2002) studied on a survey of marine and other experts in simulator training to understand how behavioral markers, use to appraise competence in emergency situation of maritime deck officers. They suggest that various simulation-based training have different strengths and weaknesses for crisis management.

Brun et al. (2005) worked on an experimental control-group work to examine the impact of a BRM training. BRM training was analyzed but the results are inadequate because the number of teams was not enough to evaluate the training. In the maritime military field, O'Connor (2011) formed a questionnaire for US Navy surface war officers and naval aviator officers to evaluate Bridge Resource Management training. He compares Surface Warfare Officers (SWOs) who attended BRM training, and did not attend. He stated that, since crew resource management training was first implemented in civil aviation, currently there are strong principles and technical features that can be used to evolve CRM trainings available from the aviation community. Therefore, researchers should employ this information to enhance CRM programs that have an affirmative impact on personnel's safety and performance phenomenon. Additionally, O'Connor and Long (2011) improved a prototype behavioral marker system for deck officers. Their focus group was US Navy junior officers. They set of 17 categories of nontechnical skills by using review of literature. Leadership, communication, situational awareness, decision making were their main skills on deck officers.

Hontvedt and Arnseth (2013) worked on video-based study by recording bridge simulator training. In the training, they used professional pilot and deck students to analyze the organization of bridge simulator training. In addition, Håvold et al. (2015) made a questionnaire about seafarers. Course was about anchor handling at Norwegian training center. This questionnaire intends to evaluate training of anchor handling teams.

Sandhåland et al. (2015) collected Norwegian continental shelf accident reports to identify factors affecting the bridge crew's ability to maintain situation awareness. This study organized and analyzed accident reports. According to study vessel crew's situation awareness changed during the accidents. One year later, Röttger et al. (2016) made two-factorial mixed and quasi-experiment study to evaluate the effect of Bridge Resource Management training of German Navy junior officers. The study measured the effectiveness of classroom based BRM training, which is the general principles of human behavior and performance in teams.

Wahl and Kongsvik (2017) arranged fieldwork to officers in shipping company (tanker companies preferred). Their research aimed to determine main nontechnical skills for maritime personnel. In the same way, Espevik et al. (2017) made questionnaire for

Norwegian deck officers to evaluate a CRM training concept. CRM courses aim to increase safety and decrease human fault factors. They suggested that the key is to increase the speaking ability. According to study, seafarers must attend minimum 4-hour course, which is aimed at improving speaking and listening skills. In addition to this, Galieriková (2019) categorized human fault, which are about maritime accidents. According to human fault framework, which is used Swiss cheese model, the basic categories of the classification process are unsafe behaviors, unsafe observation and the organizational factors.

In the marine engineering field, Jiang (2012) carried a research of engine department team based on ERM. The purpose of the study is to determine the role of each individual in the teamwork by completing the different task in the engine room. The training result showed that the crew had an effective role in raising team awareness and team spirit. However, no method and scientific data were observed in this study. In the same year, Yao et al. (2012) studied on the research of remote interactive ERM simulator. Their study suggested a scheme that how to design the remote interactive ERM simulator based on the resource management. Authors stated that after the completion remote interactive engine room resource management simulator, it would become the first ERM simulator in the world. Yet, the study assumes that ERM is only simulator training and the concepts within ERM such as situation awareness, decision making, proration of resources, teamwork were not mentioned.

Wu et al. (2015) made questionnaire to marine engineering students. Study aimed to suggest a quantitative measurement method of team performance skills according to ERM training. They used Analytical Hierarchy Process (AHP) for gathering marine engineer experts' opinion, behavioral markers system for decision consistence, and fuzzy comprehensive evaluation method for evaluating performance. Finally, Duan et al. (2017) worked on assessment method for ERM by intelligent simulator framework. According to authors, engineer-ship-resource system model and an assessment method based on intelligent optimization were proposed. Knowledge base, assessment index, membership functions, and optimal objective functions were constructed. Finally, the fuzzy relationship matrixes were obtained, and the assessment results were produced by multiple fuzzy comprehensive assessment. Their intelligent assessment scenario wanted to construct a virtual roaming in the engine room.

Studies show that, there are various studies in resource management concept especially in the field of aviation and health care. In the maritime field, considering CRM, BRM and ERM, current status of articles to address these human fault topics are widespread. However, there are some "gaps" in the maritime field about ERM concept. During the research about ERM, there are limited number of studies were found in the literature. Therefore, the sector requires much more studies about resource management concept in the engine room.

2.4 Industrial Feedbacks

After various accidents which human fault were identified as the primary cause was occurred, the maritime field started to internalize the CRM concept from the aviation community in the 1990s (Grech et al., 2008). IMO was changed the minimum standards of competence for seafarers in June 2010. In the Manila conference, various amendments in STCW was approved. After this arrangement, new key issues such as working hours, effective communication, leadership, distance learning, teamwork has occurred. The amendments entered in force in January 2012. ERM is the mandatory training, which is announced under the STCW A-III/1 and A-III/2 tables. In fact, new mandatory requirements caused the emergence of new terms such as situation awareness, decision-making, leadership, assertiveness, prioritization, allocation, time management, nontechnical skills etc. in maritime sector.

IMO designed ERM for improving seafarers' nontechnical skills to reducing the human fault rate in accidents. Yet, in the industry, there is a huge gap between A-III/1 and A-III/2 ERM concept and existing ERM practices. Maritime stakeholders such as training courses, seafarers, shipping companies perceived the ERM concept as an IMO Model Course 2.07 (simulator using training course).

First stage of industrial survey, several technical visits to the number of six shipping company located in Turkey are completed. Company and training structures and procedures of shipping companies were studied. Company deficiency reports, near-miss reports, company observation-nonconformity reports, annual evaluation forms, claim report forms, observation/non-conformity reports and follow up forms, master's monthly reports, accident reports and analysis forms, customer satisfaction evaluation forms, chief engineer's monthly reports, overhaul - trouble reports, internal audit check list form, master review report, company accident investigation and analysis form,

superintendent inspection check lists and reports, personnel appraisal forms and all training and documentation system were examined in detail. After this survey, ERM concept was not found in the training procedure of companies. In addition to this, it was observed that, any company use the posttraining evaluation procedures. Consequently, the gap between the STCW table A-III/1 and A-III/2 ERM concept and the current ERM application in the organizations is observed.

Second stage of industrial survey, contents of the all ERM courses and their training evaluation methods were examined. STCW A-III/1 and A-III/2 ERM training course is often confused with an IMO 2.07 model course. According to STCW, ERM includes non-technical skills such as decision-making, situational awareness, resource allocation, leadership and it is a mandatory training course for seafarers. On the other hand, IMO model course 2.07 has a technical course. In fact, ERM is a mandatory non-technical skill course but IMO 2.07 is a long-term engine simulator course. Current contents of ERM courses includes mainly usage of engine simulator (preparation of main engine, black out procedure, fault finding, usage of auxiliary systems etc.). However, IMO designed ERM concept aims for improving seafarers' nontechnical skills to reducing the human fault rate in accidents. In the courses industrial survey stage, it was found that there is a huge gap in the STCW ERM concept between current ERM training courses. Consequently, it was seen that many training courses, shipping companies, seafarers and all kind of organizations perceive STCW table A-III/1 and A-III/2 ERM training course as an IMO model course 2.07 (simulator using training course).

2.5 Critical Review

Resource management concept have been transferred from aviation sector to maritime field to reduce human fault rate in accidents. According to studies, resource management trainings have positive effect on accidents which caused by human faults. However, it was seen that the ERM concept was not fully applied to maritime field. There is a big gap between the STCW table A-III/1, A-III/2 ERM concept and the current ERM practices in maritime field.

Firstly, training procedures of shipping companies were examined in detail. It has been observed that shipping companies take this training within the mandatory regulations that set by IMO. ERM concept requirements and posttraining evaluation was not found

in the training procedures of almost any company. Only one company use training evaluation questionnaire (reactions of trainees) by using evaluation form. The form asked the seafarers to rate the training (not specifically ERM training evaluating form, form includes all kind of trainings).

Secondly, according to the detailed literature review, course structures and evaluation methods are very important in non-technical skill trainings. In this context, structures and course contents of the ERM training courses were examined in detail. In addition to this, the training contents of the existing courses and the training evaluation methods were analyzed. It is observed that there is a huge gap between STCW A-III/1, A-III/2 ERM concept and existing ERM training course contents. Training courses and other maritime stakeholders perceived the ERM concept as IMO Model Course 2.07 (simulator training course). IMO 2.07 course is a technical course about using, starting up, controlling; machineries, systems, diagrams, equipment etc. In addition to this, IMO 2.07 is not a mandatory course. In the same way, current ERM training course contents include mainly usage of engine simulator. However, IMO designed A-III/1 and A-III/2 ERM training course aims for improving seafarers' nontechnical skills such as, situation awareness, assertiveness, decision-making allocation of resources etc. for reducing the human fault rate in accidents.

Additionally, understanding the motivation behind the IMO A-III/1 and A-III/2 ERM concept, Ceylan et al. (2019), using Input Output Control Resource (ICOR) technique. ICOR analysis divides the process into minor, clear, obvious and manageable units and provides to discover where the problems happen in process. Thus, using the ICOR analysis gets advance of to find out the origin reasons of the problem.

According to their study, the inputs of ERM are limited when considering STCW tables and ERM application in the maritime field. Operational data and human resource data are the inputs of ERM. Control section of ERM is separated into two parts, internal inspections and external inspections. Company procedures, safety checklists are an example of internal inspections of ERM. External inspections of ERM is legal maritime legislation. The weakest and the most essential aspect of ERM concept is the control component. ERM has four main resources: human resources, equipment and tool resources, consumable resources and information resources. Considering the field of maritime, all these resources in the ship's engine room are very precious. Therefore, ERM concept tries to eliminate accidents by using all these

resources effectively. According to the STCW tables, outputs of ERM are allocation, assignment, and prioritization of resources, effective communication, assertiveness and leadership, situational awareness, consideration of team experience and team working skills (Ceylan et al., 2019).

They separated the ERM concept in to simple and more understanding parts by using ICOR and then they prepared the control matrix of ERM, safe engine operation, task allocation and teamwork topics found to be the most important points of the ERM concept. Considering their ICOR analysis control matrix, it can be observed that control stage of ERM is completely deficient. However, the control criteria play an important role in the ERM concept. They suggest that, ERM should be reorganized with enhancement and emphasis on the control leg (Ceylan et al., 2019).

Finally, they stated that, when the procedures of the companies are examined, it could be seen that there is almost no regulation, which is related to ERM. Companies have not integrated the ERM concept to their own procedures. According to this gap, shipping companies has opportunity to arrange some procedures about control leg of ERM such as implementation of ERM training follow-up programs, application of company assessment and examination after the ERM training. In addition to this, sufficient and qualified work power should be provided to ensure supply enough human resources according to ERM concept. Consequently, shipping company's procedures may be reorganized and prepared specifically for the ERM concept. For this reason, studying on an enhanced ERM concept will be very beneficial for the maritime sector (Ceylan et al., 2019).

After all deficiencies have been determined, aim of the thesis is to suggest enhanced ERM concept by using a training evaluation and effectiveness integrated method. The enhanced ERM concept will recommend a comprehensive solution to training courses, shipping companies, seafarers and all kind of organizations, which perceive ERM concept as simulator training.

3. METHODOLOGY

This chapter defines methodological background of the research. The methodology chapter includes general review of most used evaluation methods, comparison of training evaluation and effectiveness, Integrated Model of Training Evaluation and Effectiveness (IMTEE). The model mentioned briefly in the literature review on training evaluation will be explained. Then application requirements of IMTEE will be determined in this chapter.

3.1 General Review

Concept of evaluation is not a single-stage method in contrast; evaluation must be a complex multi-stage model (reaction, behavior, learning and assessments). Kirkpatrick's four-stage evaluation framework is the simplest technique for comprehending training measurement. In addition, it is the most frequently used and cited model (Kirkpatrick, 1959, 1976, 1979, 1996). According to Kirkpatrick's model, reaction section is about assessment of trainee's reaction to the training program such as quality or the conformity of the training. Organizations use this step via training evaluation forms. Learning action is defined as the effects and indicators of learning that take place during education. Additionally, behavior is learned in course and then applied on the job field. Result section intends to evaluate training's organizational goals and objectives. According to researchers, Kirkpatrick's model helps us understanding the role of diverse instruments and indicators by means of four level evaluation framework. This framework includes reaction, learning, behavior and result. According to Praslova (2010), the four level model is a widespread framework for evaluating training. As shown in the Table 3.1, Kirkpatrick's framework has reaction, learning, behavior and result stages.

Tannenbaum et al. (1993) studied and enlarged on Kirkpatrick's four level training evaluation model by adding new stages such as posttraining attitudes, training performance and transfer performance. In the model, reactions about training and posttraining attitudes are not related to any other stages of evaluation. However,

learning is related to training performance in addition to this training performance is related to transfer performance on job field, and then transfer performance is related to the results.

Table 3.1 : Kirkpatrick's framework.

Stage	Description
Reaction	Assessment of trainee's reaction to the training program such as quality or the conformity of the training. Organizations use this step via training evaluation forms.
Learning	Learning evaluates indicators of the learning, which learned during training. This stage related to learning outcomes of the training.
Behavior	Behavior addresses knowledge gained in training. It is applied on the job field.
Result	Results intend to provide measurement of training's organizational goals and objectives.

As it is seen in Figure 3.1, training effectiveness model includes individual characteristics, training needs analysis, training motivation, organizational characteristics, training reactions, posttraining motivation. It is a very complicated model and has not been used much to evaluating the training performance.

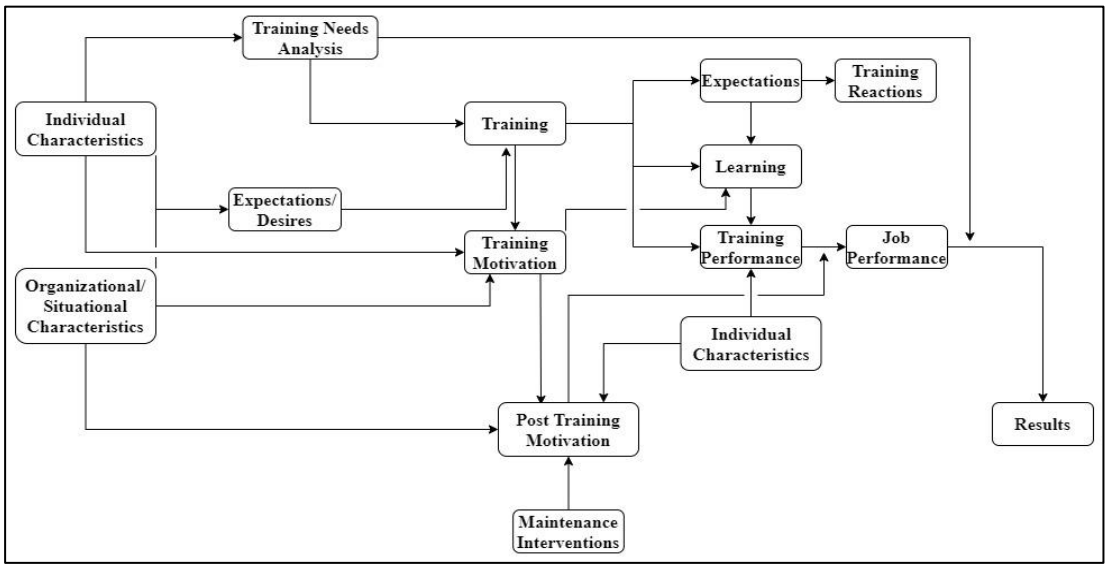

Figure 3.1 : Training effectiveness model (Tannenbaum et al., 1993).

3.2 Training Evaluation and Effectiveness

Training effectiveness and training evaluation are used interchangeably but they are two distinct structure. Training evaluation is a measurement method and it analyses the extent to the educational programs achieve their intended goals or not. Content and course structure is designed by considering students' reactions and organizational returns. On the other hand, training effectiveness is the measurement of the variables, which influence training outcomes before, during and after the training. These events have the potential to increase or decrease training results. Training effectiveness are studied in three types: organizational characteristics, individual characteristics, training characteristics (Alvarez et al., 2004).

Training evaluation is a methodological approach for measuring learning action as seen in the Figure 3.2. Effectiveness of training is a theoretical approach for comprehending those outcomes but training evaluation focuses only on outcomes of learning. This provides a micro-view approach of training results. Effectiveness of training concentrates on the all-learning process as a whole; therefore, it provides a macro-view approach on training outcomes. Evaluation of training aims to figure out the participant's benefits in training in the form of learning and transfer on job field performance. On the other hand, effectiveness of training aims to help the organizations by determining why individuals learned or did not. Effectiveness of training show us why these results are observed, and it helps experts develop recipes to improve education (Alvarez et al., 2004).

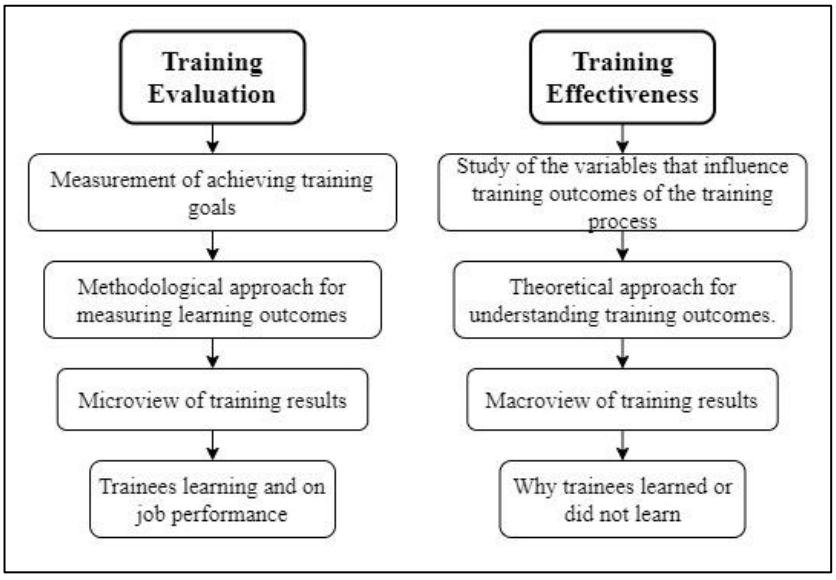

Figure 3.2 : Training evaluation and training effectiveness.

Although evaluation and effectiveness of training are the two separate structures and different concepts, only evaluation of training statement will be used to avoid confusion in the rest of the thesis.

3.3 Integrated Model of Training Evaluation and Effectiveness

Alvarez et al. recommended the Integrated Model of Training Evaluation and Effectiveness (IMTEE). This model named by multi-stage because of its consideration of both evaluation and assessment (Alvarez et al., 2004).

When looking at the Figure 3.3, it is observed that the IMTEE has four levels. Top level of the model is needs analysis. It is on the head of this model because it is widely associated with all stages of education. Needs analysis results are used for developing educational content and design, that will increase the benefits of stakeholders such as students, educational institutions and companies. According to Tannenbaum et al. (1993), needs analysis is about changes in learners, training content and design, organizational payoffs. The second stage of the model specify that needs analysis help the design of three objectives of evaluation. Training content and design can be measured by trainee's reactions about the course. Changes in learners measured by cognitive learning, posttraining attitudes and training performance of participants. Lastly, organizational outcomes can be assigned by evaluating transfer performance and result sections (Alvarez et al., 2004).

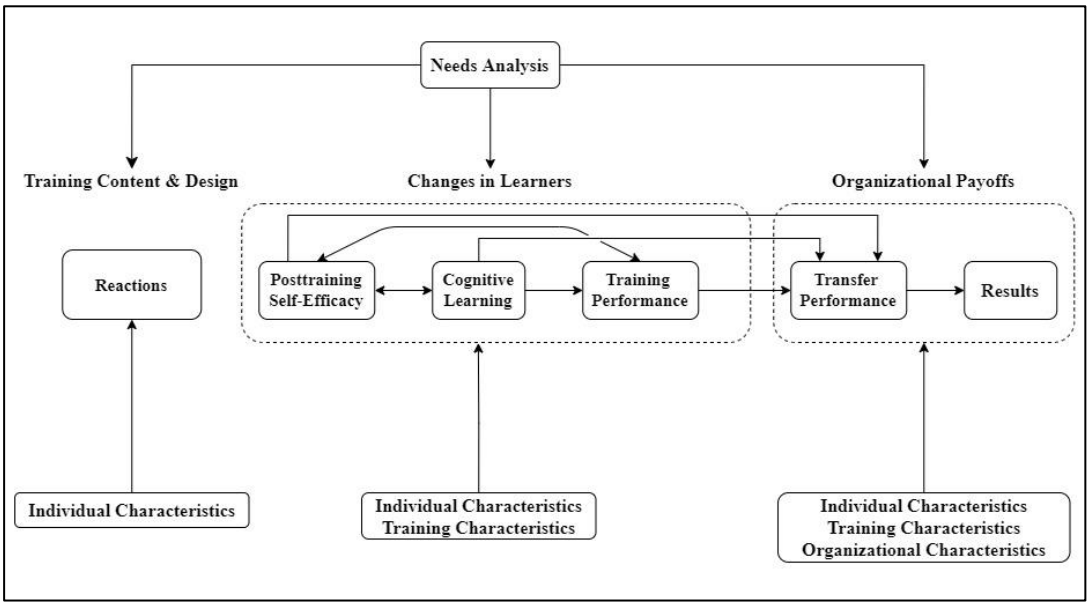

Figure 3.3 : IMTEE model (Alvarez et al., 2004).

Table 3.2 : IMTEE model (Alvarez et al., 2004).

Stage	Description
1	Needs Analysis
2	Training Content and Design, Changes in Learners, Organizational Payoffs
3	Reactions, Posttraining Self-Efficacy, Cognitive Learning, Training Performance, Transfer Performance, Results
4	Individual Characteristics, Training Characteristics, Organizational Characteristics

Although the model has four stages as seen in the Table 3.2, it has six evaluation measures. These six evaluation measures and relationships between them are highly important in the model's structure. Briefly, Alvarez et al. (2004) are suggesting six evaluation methods such as evaluating training content and design, changes in learners, and organizational payoffs the six evaluation measures. The six targets of evaluation in the IMTEE model are:

i. Reactions,

ii. Posttraining Self-Efficacy,

iii. Cognitive Learning,

iv. Training Performance,

v. Transfer Performance,

vi. Results.

Reaction is the first section. Alvarez et al. (2004) suggested that participants of training might be the best way for deciding the quality of training by using trainee's learned skill transfer ability to their job fields. Thus, reactions (affective reactions, utility, relevance, etc.) are used to measure the conformity of training content and design of training.

Posttraining self-efficacy is one of after training attitudes. Posttraining attitudes may contains self-efficacy, mastery orientation, motivation, attitudes toward diversity and teamwork. The IMTEE recommends that, posttraining attitudes should be a part of evaluation models because; it is related to changes in learners (Alvarez et al., 2004).

Posttraining attitude or self-efficacy is positively related to cognitive learning (Lorenz et al., 2000), training performance (Davis et al., 2000) and transfer performance (Lorenz et al., 2000). The IMTEE explain that the relationship between cognitive learning and posttraining attitudes as well as training performance and posttraining attitudes are reciprocal. On the other hand, posttraining self-efficacy affects transfer performance unilaterally (Alvarez et al., 2004).

Cognitive obtaining of knowledge is named cognitive learning. Cognitive learning measured by using classical paper and pencil or computer based tests about training content. Today, this is the most used and usually only one educational output evaluation method. As seen in the Figure 3.3, there is a reciprocal relationship between posttraining self-efficacy and cognitive learning. In addition to this, learning is related to training and transfer performance. According to Mayer (2011), we can define cognitive learning as follows; it is an increase in gained knowledge over time. Additionally, enhancing knowledge is at the center of cognitive learning. ERM training may use the following knowledge types.

i. Facts: factual knowledge about the characteristics of things.

ii. Concepts: models, schemas, categories, or principles.

iii. Procedures: systematic processes.

iv. Strategies: common methods for accomplishing the target.

v. Beliefs: opinions about how somebody's learning works (Mayer, 2011).

Training performance is a kind of talent about applying a new learned skill during the training. Comparing the transfer performance, training performance aims to observe and measure the trainee's performance during the training. Therefore, training performance evaluation has to be done during training. Tannenbaum et al. (1993) stated that, trainees can show competence in training easily but usually they cannot transfer newly acquired skills to the work environment. According to this, trainee's training performance scores is likely to be greater than transfer performance. According to IMTEE model, cognitive learning effects training performance. The transfer performance influenced by training performance unilaterally. In addition, relation between training performance and posttraining self-efficacy are reciprocal.

Transfer performance is related to behavioral changes that is occurred on the job field as a result of training. Trainee's transfer performance skill can be evaluated via supervisor, master or chief evaluations of on job attitudes. Company may use tests for evaluate the personnel's transfer performance ability after several months of training (Alvarez et al., 2004). According to Figure 3.3, the arrow from transfer performance to results shows that, there is a positive relationship between transfer performance and results. In addition to this, posttraining attitude, cognitive learning and training performance effects transfer performance.

The final stage of training evaluation is result. This section refers to observable outcomes as a result of training. For instance, organizational benefits of transfer performance to job field may include increased safety, efficiency and individual's morale in addition to this reduction in accident and injury rates. As shown in the Figure 3.3, results are affected by transfer performance.

In the fourth stage of model, individual characteristics, training characteristics and organizational characteristics are shown. Individual characteristics are about reactions of trainees; individual characteristics and training characteristics are related to changes in learners; and individual characteristics, training characteristics, and organizational characteristics are related to organizational payoffs.

As shown in the Figure 3.4, IMTEE is an integrated model. Its training content and design, changes in learning, organizational payoffs are about training evaluation. On the other hand, individual, training and organizational characteristics are about training effectiveness.

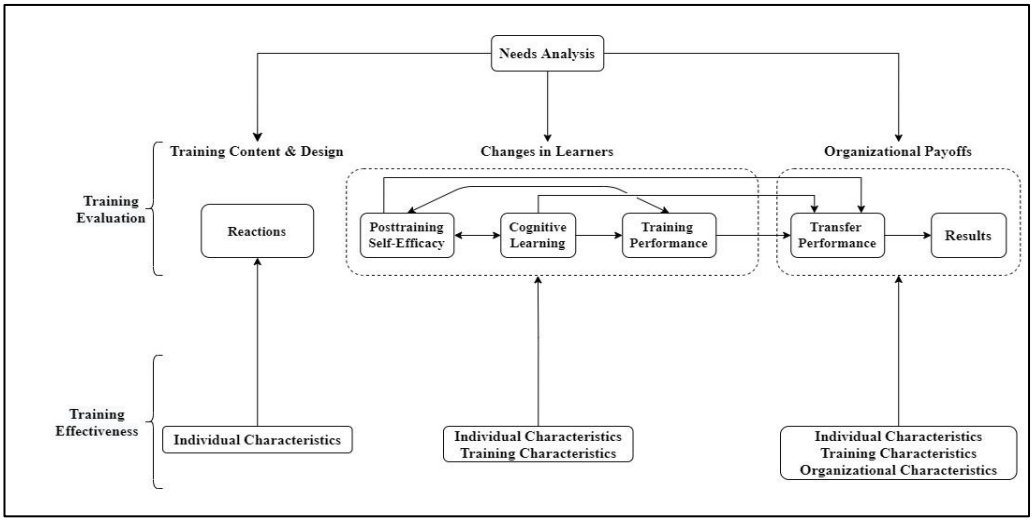

Figure 3.4 : Integrated model IMTEE **(**Alvarez et al., 2004).

Comparing the IMTEE model with other evaluation and effectiveness models, which are presented earlier in the detailed in chapter 2.1, it synthesizes the previous models. Additionally, it supports all of these models. This model combines the evaluation levels of reactions, self-efficacy and knowledge. In addition to this, it transfers individual, educational, organizational factors (Alvarez et al., 2004). IMTEE refers to an approach that investigate whether achieving the training goals or not. In addition to this, it also aims to examine the variables, which may affect the training effectiveness. Variables are individual, training and organizational characteristics. In this way, IMTEE described the training results and formulated the advices to increase the training effectiveness. In addition, IMTEE is the newest and most cited study among other models. The most important factor in choosing IMTEE model is that, this model is different from classical models. In addition, it is considered suitable for ERM concept since it is a multi-stage and integrated model.

3.4 Application Requirements of IMTEE

Aim of this chapter is to provide requirements of IMTEE while application of an enhanced ERM concept. Alvarez et al. (2004) suggested an integrated model IMTEE in 2004. When the model was analyzed, it was found the most suitable model for ERM concept. IMTEE has four levels: i) needs analysis ii) training content and design, changes in learners, organizational payoffs iii) reactions, posttraining self-efficacy, cognitive learning, training performance, transfer performance, results iv) individual characteristics, training characteristics, organizational characteristics. In addition to its' four level this model has six evaluation targets: reactions, posttraining self-efficacy, cognitive learning, training performance, transfer performance, results.

Considering application requirements of IMTEE, its flowchart is seen in the Figure 3.5. Flowchart improvements are separated and coded considered its stage and group. For instance, i3-c1 means first improvement of changes in learners at third stage of model. When designing the enhanced ERM concept, firstly data from STCW table A-III/1 and A-III/2, IMO Model Course 2.07, company reviews is entered the flowchart. Then needs analysis must be determined and listed. Needs analysis is on the top of the flowchart, it effects training content, multi-level evaluation and results. All needs of ERM concept must be organized in this section. Training content is designed according

to needs analysis results. Then, it must be shaped according to the improvements in allocation of resources and teamwork, effective communication, assertiveness and leadership, situational awareness, decision-making and team experience. If the content of training is not suitable for requirements, it must be prepared again. Additionally, training content markers must be determined in this section. Subsequently, changes in learners are identified; its steps are improvements in posttraining self-efficacy, cognitive learning, training performance. If the improvements are found insufficient, changes in learners must be prepared again. In the same stage, organizational payoffs must be identified. Its decision steps are improvements in transfer performance and results.

In this model, evaluation section is very important and it must be designed in multi-stage framework. Company training assessment, trainee performance evaluation, ERM knowledge module, crew appraisal, company reports (near miss reports, deficiency reports, accident reports, annual crew evaluation forms etc.) are adapted in multi-stage evaluation stage. If the evaluation decision steps are not suitable, evaluation stage must be prepared again.

Last stage of the model is characteristics. Its decision steps are improvements in individual, training and organizational characteristics. According to the model, individual characteristics effects training content and design. Training and individual characteristics effects changes in learners. Finally, individual, training and organizational characteristics effects the organizational payoffs. In addition to this, in the multi-level evaluation stage, all type of characteristics are important. Briefly, if the stages are not designed considering the characteristic factors, it must be reshaped. After all these steps, the ERM training and practices improvements are suggested. Then, enhanced ERM concept was designed.

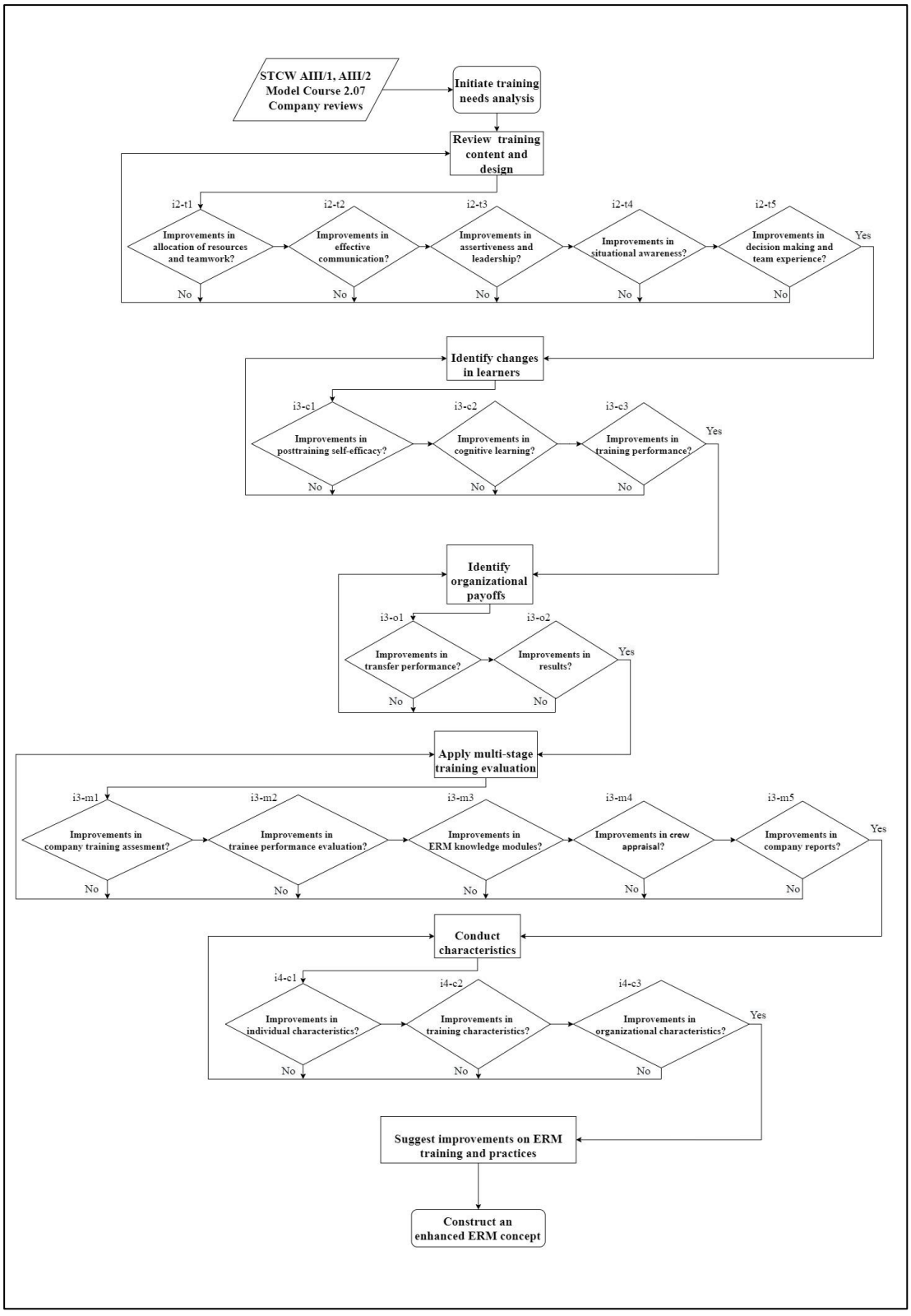

Figure 3.5 : Modified IMTEE flowchart.

4. IMTEE APPLICATION TO ERM

According to the thesis objectives about understanding the targeted competencies of ERM training course, perceiving the engine room resource management concept is very important. In fact, mandatory requirements, which was announced by IMO, aimed to decrease human fault rate in maritime accidents. ERM is one of these mandatory requirements, and it is a kind of training which contains nontechnical skills.

Competence of maintain a safe engineering watch in STCW table A-III/1, ERM has 5 basic principles: allocation, assignment, and prioritization of resources, effective communication, assertiveness and leadership, obtaining and maintaining situational awareness, consideration of team experience in Figure 4.1.

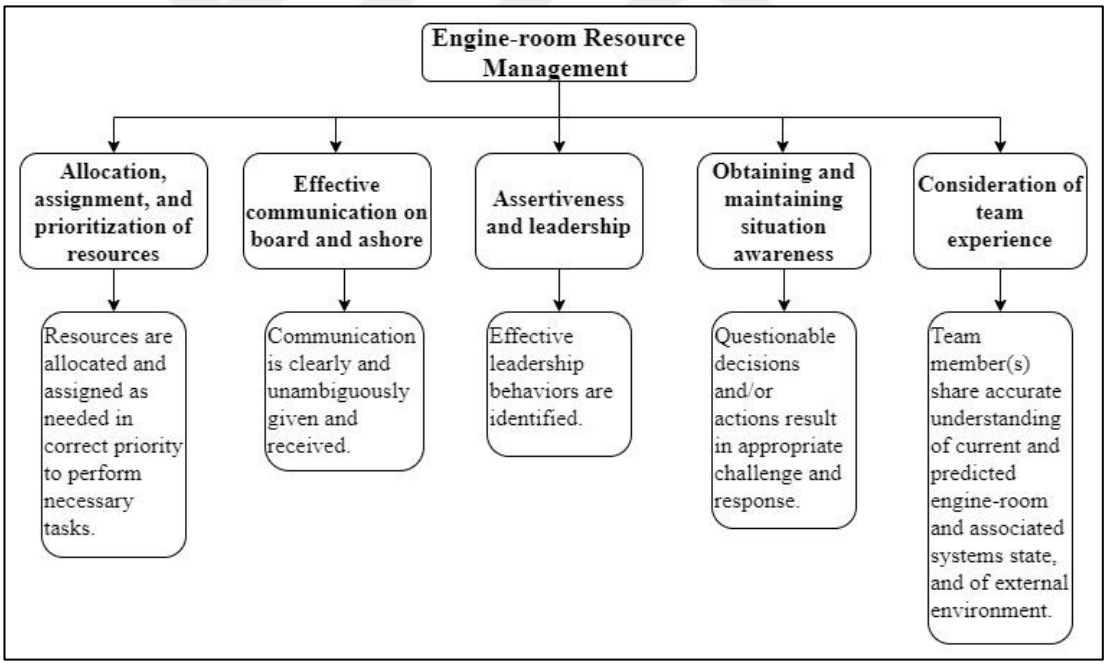

Figure 4.1 : Engine Room Resource Management in STCW (Ceylan et al., 2019).

Additionally, STCW table A-III/2 (management level for chief engineer officers and second engineer officers) includes allocation, assignment, and prioritization of resources, effective communication on board and ashore, decisions reflect consideration of team experience, assertiveness and leadership, including motivation, obtaining and maintaining situation awareness.

According to Ceylan et al. (2019), ERM has four main resources: human resources, equipment and tool resources, consumable resources and information resources (Figure 4.2).

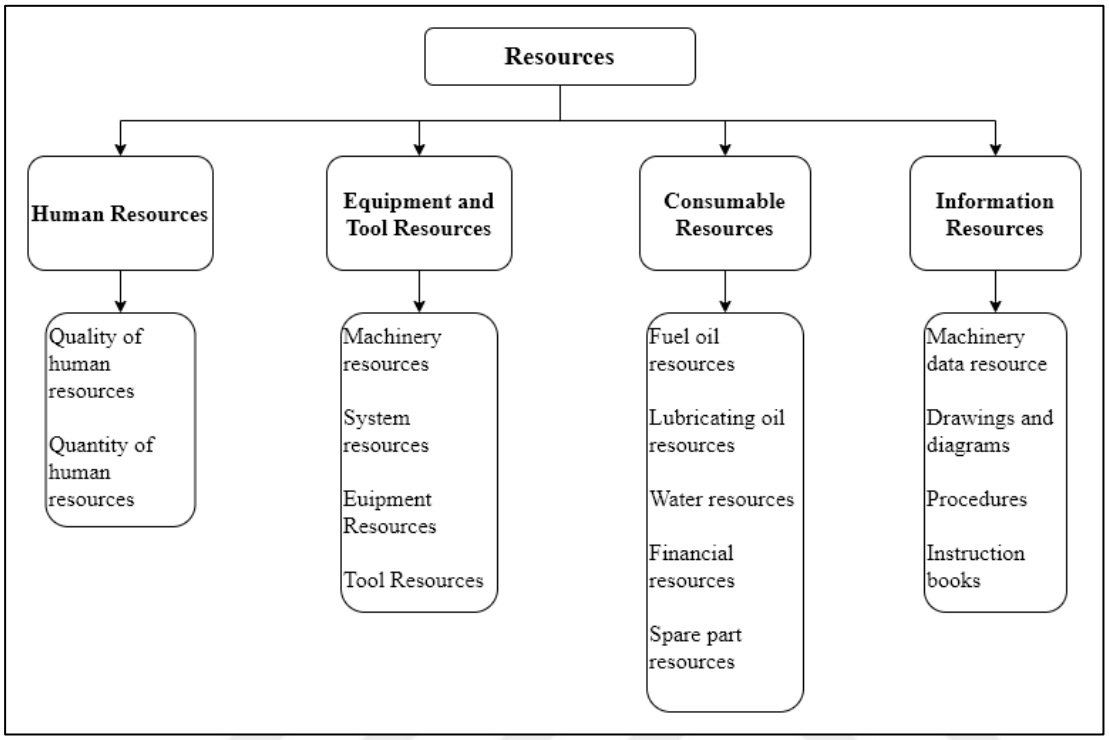

Figure 4.2 : Engine room resources (Ceylan et al., 2019).

As shown in the Figure 4.2, human resources can be separated into two sections as quantity and quality of human resources.

Equipment resources includes four main titles: machinery, system, equipment and tool resources. Machinery resources consist of main engine, boilers, diesel generators, separators, pumps, compressors, deck machinery etc. System resources includes all kind of system components such as piping systems (fuel oil, fresh water, lubrication oil, steam, seawater piping etc.). Equipment resources includes: safety equipment (fire detecting systems, fresh water sprinkler system, valve quick closing system, fire dampers, CO2 system, foam system, inert gas system, emergency fire system, dead-man alarm, lifesaving equipment, oil mist system etc.), automation equipment (remote control units, three-way valves, electronic-pneumatic-hydraulic controls, engine safety systems, etc.). Different kind of hand tools (wrenches, screwdrivers, pliers, cutters, files, striking tools, drills, pliers etc.) and measuring-control tools (meters, gauges, temperature measurement tools, pressure measurement tools, micrometer, electronic caliper, torque meter etc.) are constitutes equipment resources.

Consumables resources includes any kind of resources which is consumable on board such as water, fuel oil, lubricating oil, financial resources and spare parts.

Information resources includes all kind of information and data in the engine room. For instance, instruction books, internet, company overhaul procedures, company working hour procedures, pressure values, temperature values, drawings, diagrams etc. (Ceylan et al., 2019).

Considering thesis objectives about, reviewing the shortfalls of ERM practices, six shipping companies that located in Turkey were contacted to observe the effectiveness of the ERM concept. Company training procedures (4 Turkish Tanker Company, 1 Turkish Container Shipping Company and 1 International Shipping Company) were examined in detail. It has been observed that shipping companies take this training within the mandatory regulations according to table A-III/1 and A-III/2, which is in the STCW chapters. ERM concept was not found in the training procedure of almost any company. In company procedures, only the periods of certificates are written (when seafarer get this certificate and when they renew it). In addition, posttraining evaluation was not found in company procedures. Only one company use training evaluation questionnaire by using training evaluation form. The company asked the seafarers to rate the training. It is a kind of training happiness questionnaire.

Additionally, ERM training courses, maritime education and training activity (MET) developed courses, maritime faculties provided courses and government provided courses were examined in detail. The training contents and evaluation methods of the existing courses were also analyzed. It is observed that there is a huge gap in the STCW A-III/1 and A-III/2 ERM concept between existing ERM training practices.

Finally, Ceylan et al. analyzed the input, control, output and resource leg of ERM concept and they were detected that, control leg of ERM is deficient. Procedure about evaluating ERM skills of seafarers was not observed. Although ERM has many important aspects, it is thought that there are important deficiencies in the application of ERM to the maritime field (Ceylan et al., 2019).

4.1 Needs Analysis

Needs analysis is on the top of the enhanced ERM concept, it effects training content, multi-level evaluation and organizational payoffs. All needs of ERM concept must be

organized in this section. Needs analysis results are used for developing educational content and design, that will increase the benefits of stakeholders such as students, educational institutions and companies. In addition to this ERM needs analysis is constructed by the help of fieldwork. Shipping companies' procedures (especially training) were analyzed to design the needs of ERM concept. The gap between the STCW table A-III/1 and A-III/2 ERM concept and current ERM practices in maritime field was detected. Secondly, various ERM course contents were examined in detail. It was observed that ERM was understood as a simulator training and it was reflected in its' course contents. ERM training course contents includes mainly usage of engine simulator (preparation of main engine, black out procedure, fault finding, usage of auxiliary systems etc.). However, IMO designed ERM training aims for improving seafarers' nontechnical skills for reducing the human fault in maritime accidents. These skills include situation awareness, leadership, decision-making, assertiveness, allocation of resources for reducing the human fault in accidents. Additionally, Ceylan et al. (2019) analyzed ERM concept by using ICOR technique. It was detected that, control leg of ERM concept is deficient. Finally, the needs of ERM can be listed as follows:

i. Training content must be designed according to requirements of table A-III/1 and A-III/2 in STCW,

ii. STCW table A-III/1 and A-III/2 ERM training courses and IMO model course 2.07 are the different courses. ERM training courses is not a simulator using training, it is a seafarer's nontechnical skill training which includes, decision making, situation awareness, leadership, effective communication, assertiveness, allocation of resources etc.

iii. Shipping companies' ERM training procedures must be prepared,

iv. According to field work and ICOR analysis result, control leg of ERM concept must be enhanced,

v. Traditional training evaluation models must be abandoned, training evaluation stage must be organized as a multi-stage evaluation,

vi. The requirement about enhanced ERM concept in the maritime field was observed.

vii. When designing the needs of ERM, characteristics should be taken into account.

4.2 Training Content and Design

According to thesis objective of analyzing ERM course contents and outcomes, this chapter aims to design content of enhanced ERM training. Training content is reshaped by using to STCW table A-III/1 and A-III/2 requirements and previously organized needs analysis. Enhanced ERM training content includes resource allocation, assignment, prioritization and teamwork, effective communication, assertiveness and leadership, situational awareness, decision-making and team experience.

As seen in the IMTEE flowchart individual characteristics are very important while designing the course content. Training content must be shaped considering trainee's abilities, attitudes, experience and demographics such as age, nationality etc. If the training content is not suitable for trainee's individual characteristics, it must be prepared again. Additionally, as shown in the Figure 4.3, training reactions evaluation may be made before, during and after the training.

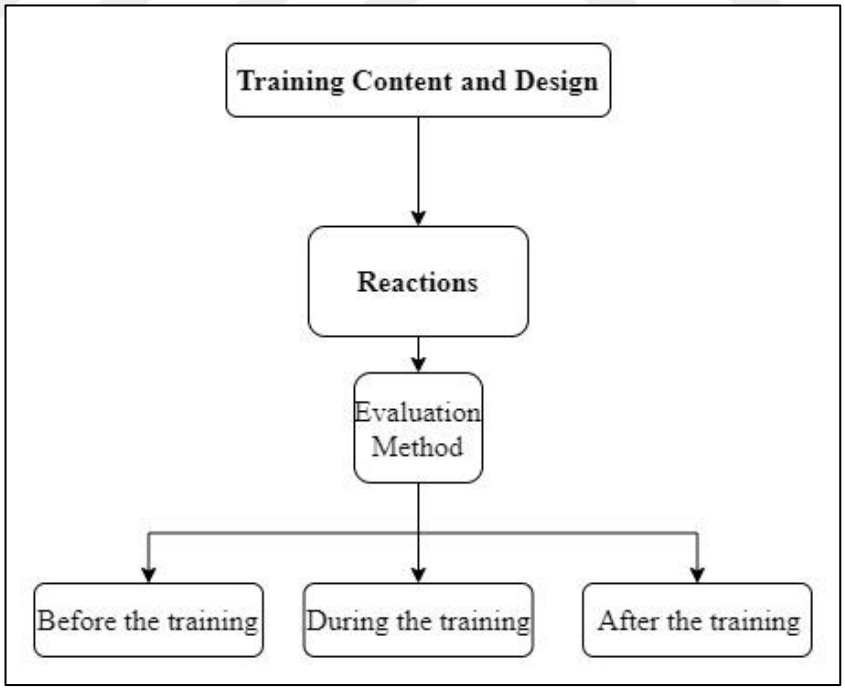

Figure 4.3 : Reactions evaluation.

4.2.1 Allocation of resources and teamwork

According to the STCW tables, allocation, assignment, prioritization of resources and teamwork must be provided. Additionally, considering maritime field, this content is about effective use of limited resources. These resources are human, equipment, consumable and information resources.

i. Human resources: Using the available human resources is very important for ERM concept. This type of resource is the main factor of ERM and it can be separated into two sections as quantity and quality of human resources. Generally, quantity of human resources is equal between commercial vessels (except for some kind of special vessels). As shown in the Figure 4.4, engine department contains chief engineer, first engineer, second engineer, third engineer, electrician, engine cadet, donkeyman, fitter and oilers. On the other hand, engine department personnel's skills and experience are about quality of human resources. On board experience and ability of crew such as effective time management, correct decision-making, using consumables effectively, team working ability, allocation of resources etc. are the important factors for safe and effective engine room operations onboard.

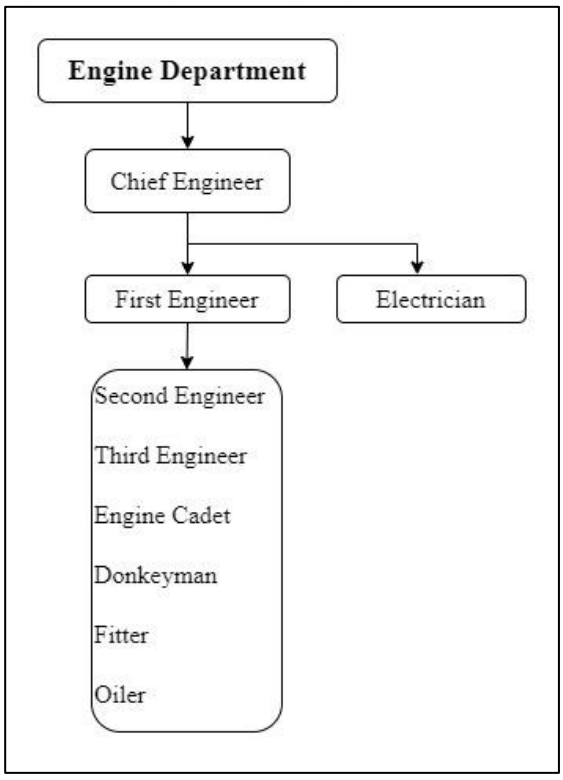

Figure 4.4 : Engine department.

Human resources contains following items.

- Team building: Participant must create the correct and effective teams with the available resources considering with the ship and engine room conditions. Additionally, while fulfilling the tasks, they must establish positive interpersonal relations with the other engine and deck personnel. It is important to considering quantity and quality factors of limited engine personnel while making effective teams in the engine room.
- Considering others: Participants must consider other engine personnel. Participation of all engine crew such as, engineers, electrician, oiler, engine cadet is very important. In addition to this, trainee must understand the other crew's individual conditions.
- Supporting others: Under suitable conditions, participants must help to others when they need assist.
- Management of workload: Workload management includes correct prioritization and allocation of operational works and tasks such as main engine cover overhaul exhaust gas boiler cleaning, diesel generator turbo charger overhaul etc. Based on planning, tasks must be distributed among the engine personnel by planning whole engine room condition. Indicators of stress and fatigue must take into account while workload management is carried out. These are performance-affecting factors and personnel's performance is very important in the engine room. All resources such as quality of crew, quantity of crew, time resource, information resource and consumable resource must be used in this section. Eventually, correct workload allocation is highly important in the engine room.

ii. Equipment and tool resources: According to the ERM training, trainee must use the available engine room equipment and tools effectively. Usage, allocation, assignment and prioritization of engine room equipment such as gauges, hand tools, measurement tools, overhaul tools etc. is one of the principles of ERM training content.

iii. Consumable resources: Trainee must use of consumable resources such as fuel oil, water and lubricating oil resources frugally and effectively.

iv. Information resources: Participant must use any kind of information resources such as instruction books, pressure and temperature values, drawings, any kind of books, tables etc. effectively.

As shown in the Figure 4.5, allocation, assignment, and prioritization of resources and teamwork markers are:

i. Effective use of human resources,

ii. Considering all persons of the team,

iii. Correct team building,

iv. Correct and effective tasks allocation of the crew,

v. Assessing the capabilities of other team members,

vi. Effective use of equipment and tool resources,

vii. Effective use of consumable resources,

viii. Effective use of information resources.

The following markers can be used in trainee performance evaluation form and suggested improvements section.

4.2.2 Effective communication

Maritime field includes broad range of different nationalities and cultures in the same ship environment. In this context, communication has a vital role onboard. Effective communication must be ensured in engine room, on board and to others.

i. Effective communication in engine room: Considering the diversity of ship personnel, communication is the one of the basic skills of ERM training. Maritime sector has a multinational structure. Therefore, correct communication is very important. Regardless the rank of personnel, it is necessary to communicate with all of them clearly.

ii. Effective communication on board: According to this section, effective communication should be established not only with in the engine room but also with the deck personnel.

iii. Effective communication to others: Effective communication to others such as port operator, company personnel, maritime agency, port state, any kind of inspector, barge personnel, other vessel's personnel etc. is very important in maritime operation. Course content must include effective communication to others.

As shown in the Figure 4.5, effective communication markers are:

i. Sharing information accurately and quickly,

ii. Keeping an apparent, constant information flow,

iii. Encouraging a constitutive communication environment,

iv. Appreciating and having respect for all engine personnel's opinions and listening to them,

v. Speaking fluently and plainly,

vi. Talking in calm manner in critical operations and emergency situations,

vii. To be a good listener, not to interrupt the speaker.

4.2.3 Assertiveness and leadership

Leadership includes, maintaining the procedures, standards and showing a calm attitude in emergency and stressful situations. Being assertive is a one of the core skills of ERM. According to assertiveness, trainee expressing himself or herself effectively, and he or she respect other individual's rights. This section includes authority, assertiveness, providing and maintaining standards, planning and coordination, conflict solving.

i. Authority: The authority must be balanced enough while speaking to other personnel. In addition, it is important to adjust authority for crewmember's profile. On the other hand, if required, it is expected participants to take a determined stance because; marine engineers must show authority in the diverse maintenance works in the engine room.

ii. Assertiveness: Participant must announce his or her decision plainly with certain manner and he or she must avoid uncertain assertiveness in an emergency.

iii. Providing and maintaining standards: Trainee must comply with required standards (STCW standards, company standards, national standards, training standards etc.).

iv. Planning and coordination: Participant must coordinate situations and engine personnel quickly and correctly. In order to attain high performance, an organized task sharing and authorization has to be established. Whole team must understand the plans, intentions and goals of the given task and they must reflect proper coordination.

v. Conflict solving: Participant must offer solutions and brings the discussing personnel together for a common purpose in order to provide safe and stable engine room atmosphere.

As shown in the Figure 4.5, assertiveness and leadership markers are:

i. Taking the initiative,

ii. Specifying intentions and goals,

iii. Applying company and international procedures correctly,

iv. Complying and controlling standards,

v. Helping other personnel instead of competing with them.

4.2.4 Situational awareness

Situation awareness is one of the ability of a person. It is about mentality of what is going on in there and making prescience. Considering the engine room, it contains various risky areas such as hot working surfaces, oily and dirty areas and high-pressured sections. Therefore, ERM training course participants should have a strong situational awareness ability. This training chapter includes awareness of engine systems, company and vessel requirements, maritime environment, time.

i. Awareness of engine systems: Participant must correctly perceive the elements in the situation in order to create a correct situation awareness. He or she must aware of engine systems such as, lubricating, steam, seawater, freshwater, fuel etc.

ii. Awareness of company and vessel requirements: Trainee must be aware of current vessel and company requirements.

iii. Awareness of maritime environment: Trainee must have knowledge of current and future position, weather, seawater temperature of area, Emission Control Area (ECA) and Sulphur Emission Control Area (SECA) restrictions etc.

iv. Awareness of time: Trainee must have time management skill.

As shown in the Figure 4.5, situational awareness markers are:

i. Monitoring changes of conditions and situations,

ii. Reporting changes of conditions and situations,

iii. Collecting all kind of information,

iv. Identifying potential dangerous situations,

v. Applying time management.

4.2.5 Decision making and team experience

Decision-making is the act of making a choice among available alternatives. It is one of the vital skills of ERM. According to the ERM, decision-making has a great importance in engine room. This training chapter includes problem description and identification, option generation, risk assessment and selection, team experience.

i. Problem description and identification: Trainee must define the problem process of taking decision or selecting an alternative option.

ii. Option generation: Trainee should propose alternative approaches to deal with the situation. He or she should consult with other team members and their experience throughout this process.

iii. Risk assessment and selection: Trainee should identify consequences and probability of risks. He or she must evaluate the risk in the alternative approaches and select a best situation.

iv. Team experience: Trainee should allocate and utilize available resources considering team experience in order to maintain safety.

Decision-making markers are:

i. Creating action plans,

ii. Generating different options,

iii. Fault finding,

iv. Considering and sharing with good decisions.

The markers which shown in the Figure 4.5, can be used in trainee performance evaluation form and suggested improvements section.

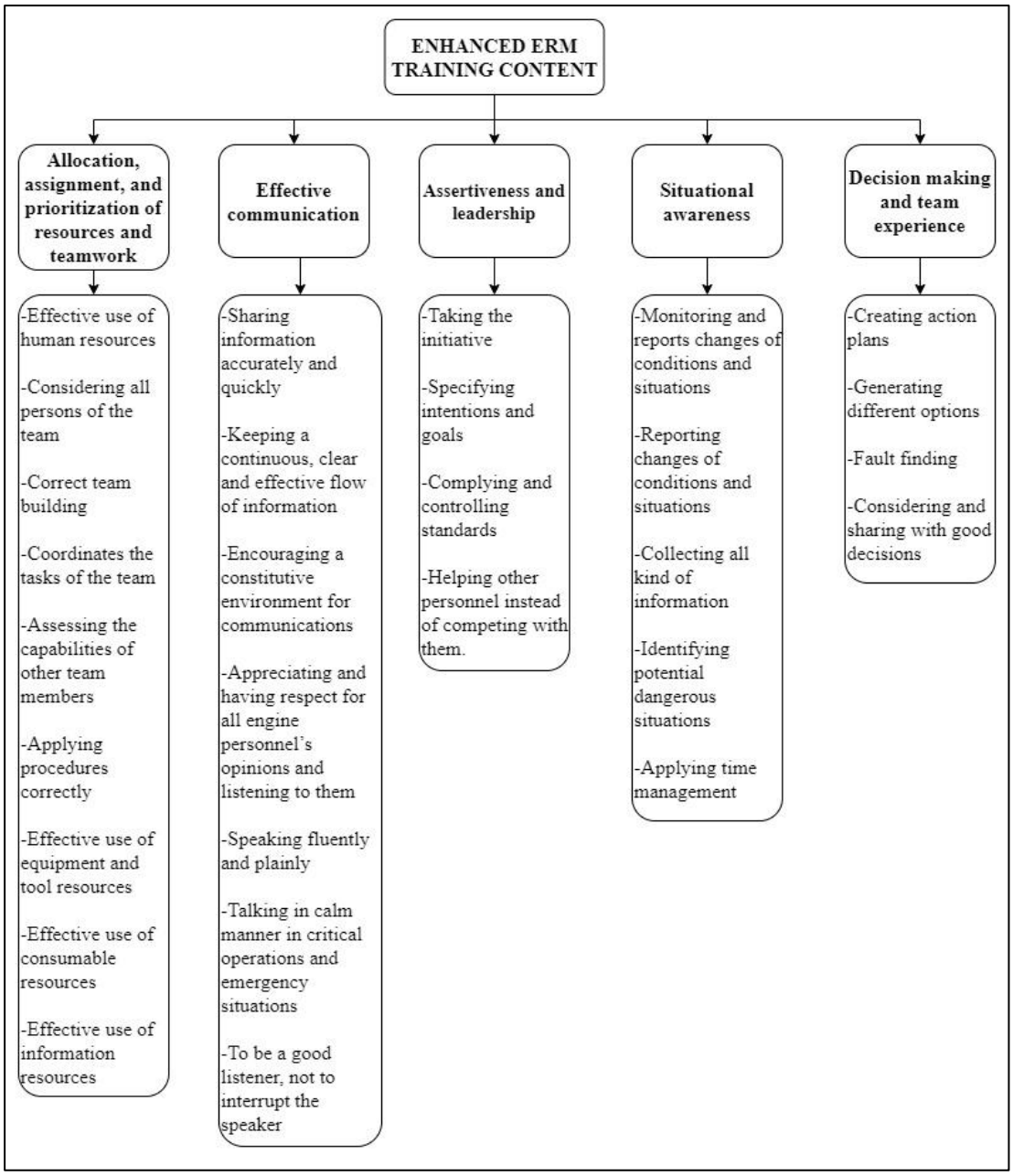

Figure 4.5 : Enhanced ERM concept training content.

4.3 Changes in Learners

According to the IMTEE model, there are three stakeholders in ERM concept. These are, training courses, trainees and organizations. In the second stage, changes in

learners includes training performance, posttraining self-efficacy and cognitive learning. Therefore, this section is about participant's learning criteria. Additionally, individual and training characteristics have an impact on changes in learners.

4.3.1 Posttraining self-efficacy

Posttraining self-efficacy, cognitive learning and training performance are all related to learning of trainees. Posttraining self-efficacy effects trainees' motivation to transfer and to use newly learned skills such as decision making, leadership etc. (Tannenbaum et al., 1993). Additionally, it specifies trainees' attitude change after training such as showing high situation awareness in main engine cylinder overhaul operations.

Posttraining self-efficacy performs two missions: firstly, it provides that, trainees reflect learning outcomes after the training. Secondly, posttraining self-efficacy knowledge enhances the trainee's voluntariness to perform (Zhao and Namasivayam, 2009).

Additionally, posttraining self-efficacy is positively connected to cognitive learning, transfer performance and training performance. IMTEE model explains the relationship between cognitive learning and posttraining attitudes as well as training performance and posttraining attitudes are reciprocal. However, posttraining self-efficacy affects transfer performance unilaterally (Alvarez et al., 2004).

Finally, posttraining self-efficacy is an after training event that evaluated by crew appraisal form or on job performance form as in the transfer performance section. As shown in the Figure 4.6, evaluation must be made after the training.

4.3.2 Cognitive learning

Cognitive learning is a kind of learning process, which is referring to getting training knowledge. This learning style fosters the trainees to use their skills effectively in training. In this context, cognitive learning is the cognitive obtaining of ERM knowledge such as situation awareness, time management. Additionally, according to training literature, cognitive learning term used frequently.

In the IMTEE model, there is a reciprocal relation in posttraining self-efficacy and cognitive learning. In addition to this, training and transfer performance are connected the cognitive learning. Training content design has an importance on cognitive learning. Therefore, cognitive learning must contain ERM principles, which was

explained in the training content chapter. Additionally, training and individual characteristics have great impact on cognitive learning. ERM cognitive learning stage and its evaluation method must be reshaped according to individual and training characteristics.

Cognitive learning is measured by ERM knowledge tests. In this section classical test or written paper-pencil measurement methods are used. It may be used that writing exams, multiple choice test or structural grid tests. As shown in the Figure 4.6, the exam must be made just after the training.

4.3.3 Training performance

Demonstrating new getting skills such as leadership, situation awareness etc. during the ERM training is about training performance. Before the transfer section, it is evaluated through visible evidence in trainee's attitudes which participant can implement ERM skills during training. Maximum performance is measured during the training by:

i. A certain awareness of being evaluated.

ii. An admission of clear instructions to maximize effort.

iii. Not very long evaluating period to allow concentrating the goal of training (Sackett et al., 1988).

Training performance is influenced by cognitive learning and it influenced by training performance unilaterally. Relation between training performance and posttraining self-efficacy are reciprocal. In addition, ERM training performance stage and its evaluation method must be reshaped according to individual and training characteristics.

Training performance evaluation must be applied during the training. On the other hand, transfer performance is about on job evaluation like posttraining self-efficacy. It must have applied after the training.

Training performance is measured by ERM training instructor by means of observation checklists. ERM observation checklists must be used in the evaluation stage. This checklist must include learning markers, which was explained in the training content chapter. As shown in the Figure 4.6, the evaluation checklist is applied during the training.

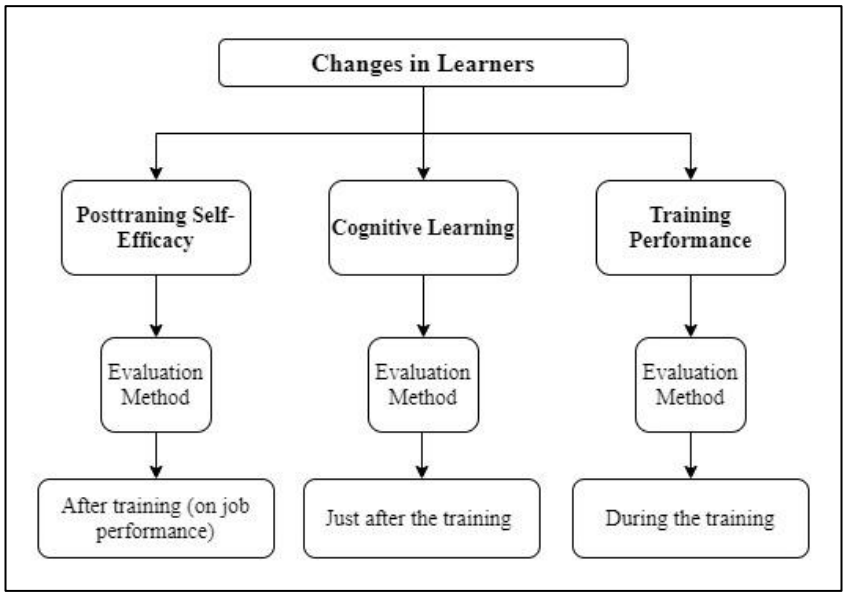

Figure 4.6 : Changes in learners evaluations.

4.4 Organizational Payoffs

Organizational payoffs are the other stakeholders of the concept like training courses and trainees of ERM. Individual, training and organizational characteristics effects the organizational stage. Therefore, all kind of characteristics must take into account while designing the organizational payoffs. This section includes transfer performance and results.

4.4.1 Transfer performance

Transfer performance section includes behavioral change on the job field (on board, in engine room) as a result of ERM training. In order to explain the difference between training and transfer performance, training performance is measured during the training but transfer performance is about on job performance. Therefore, transfer performance is evaluated after the training.

Considering the maritime field, engine room working environment is different from ERM training atmosphere. Trainee may able to focus on only one primary task during the training. On the other hand, considering the work field, trainee must manage many tasks at the same time such as personnel allocation, prioritization of overhauls, situation awareness of main engine conditions, decision making of emergency operations etc. In addition to this, trainee may not find enough time, suitable human resources, information resources, tools etc. or trainee may not find enough sport to

apply ERM skills on job. Therefore, training should be realistic and reflect the current work environment.

There is a positive connection between transfer performance and results. In addition to this, posttraining attitudes, training performance and cognitive learning effects transfer performance.

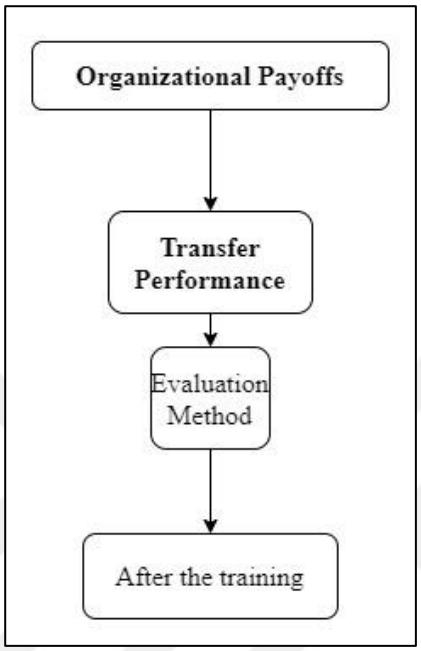

Figure 4.7 : Transfer performance evaluation.

Transfer performance is an after training event that evaluated by crew appraisal form or on job performance form as in the posttraining self-efficacy section. As shown in the Figure 4.7, evaluation must be made after the training such as on job performance.

4.4.2 Results

Results in the IMTEE model, refers to observable outcomes in the organization as a result of training. For example, considering the shipping company, increasing engine personnel's situation awareness about engine operations, decision making in emergency, providing effective communication, safe working environment, efficiency, morale, in addition to this reduction in accident and injury rates are the results of ERM training. Additionally, results are the final step of flowchart of IMTEE. Therefore, individual, training and organizational characteristics have an importance on results and all training framework.

There is a positive relationship between transfer performance and results. If the shipping company's engineers effectively transfer their ERM training knowledge to onboard (working environment of engine room) company results will be changed such as decreasing in near miss reports, deficiencies, accident reports. In addition to these increasing scores of annual crew evaluation may be observed. Thus, the company can improve the quality of its team through training.

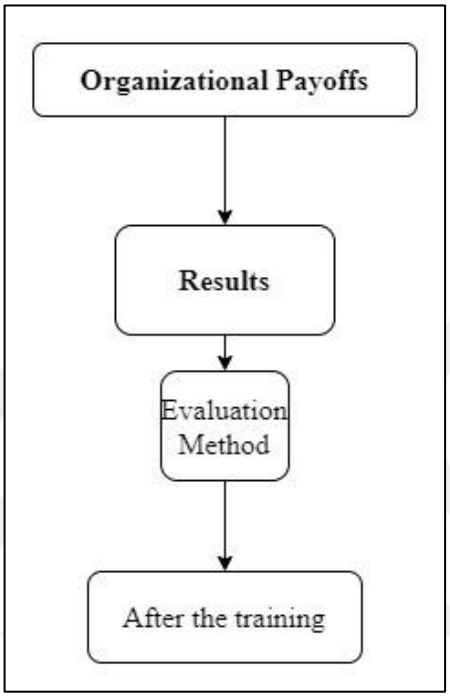

Figure 4.8 : Results evaluation.

Result is long-lasting process and it requires patience. Additionally, an after training event evaluated by near miss reports, deficiency reports, accident reports, annual crew evaluation reports etc. As shown in the Figure 4.8, result evaluation must be made after the training.

4.5 Multi Stage Training Evaluation

IMTEE consists of four stages. First section is needs analysis second section contains training content and design, changes in learners, organizational payoffs. Third section includes reactions, posttraining self-efficacy, cognitive learning, training performance, transfer performance and results. Multi-stage training evaluation will be carried in this stage.

According to IMTEE flowchart, individual, training and organizational characteristics have a vital role on designing the multi-stage evaluations. All training framework and also the evaluations must be shaped considering the trainee's demographics, abilities, experience and training's method, principles, equipment, instructors, content and organization's trainee selection process, working environment, support, resource availability, procedures. If the training's multi-stage evaluation is not suitable for individual, training and organizational characteristics, it must be reshaped again. Additionally, as shown in the Figure 4.12, evaluation methods are applied in this section.

4.5.1 Company training assessment

Company training assessment form is generally applied to the trainees to assess the training effectiveness. Assessment form may have applied before, during and after the training but ordinarily done after the training. Scoring questionnaire forms or written examination are used for evaluation section the training. Therefore, the IMTEE recommend that, reactions (affective reactions, utility, relevance, etc.) be used to measure the conformity of training content and design (Alvarez et al., 2004). The company can use the following questions when designing this form.

i. Are the main principles and key points of the training clearly defined?
ii. Has the lecturer is suitable to this training?
iii. Does the participation of trainees are encouraged?
iv. Are the presentation techniques enough for training?
v. Have you been satisfied about the training?
vi. Will this training be useful in the engine room?
vii. Is the total period of training enough?
viii. Is the content and program of training enough for required knowledge or skill?
ix. Are the resources enough?
x. Does the trainer well prepared?
xi. What did you like most about this training?
xii. Which aspects of the ERM training should be enhanced?

4.5.2 Trainee performance evaluation

Trainee performance evaluation forms are applied during the training and it is measured by ERM training instructor by means of observation checklists. ERM training markers was determined in the training content chapter. As shown in the Figure 4.5, trainee performance evaluation must reflect enhanced ERM training content. In addition to this markers, performance evaluation checklist may include list of participants and their demographic information, understanding, knowledge of marine engines and systems, team building ability, time management, workload management, leadership, creativity, management skill, public speaking, implementation and design ability, ethical and moral values, planning etc.

4.5.3 ERM knowledge module

This is the most used method to measure educational output today. Cognitive learning is the cognitive obtaining of training knowledge. As shown in the Figure 4.12 this type of learning is measured by ERM knowledge modules.

In ERM knowledge test modules, classical multiple-choice test, writing exams or written paper pencil measurement methods are used but multiple-choice test is the most used method. The assessment should be based on the course content (allocation, assignment, and prioritization of resources and teamwork, effective communication, assertiveness and leadership, situational awareness, decision-making and team experience) and it should measure each skill separately. This exam, which designed in modules, should demonstrate how successful the participant is in which skill of ERM. Additionally, the evaluation must be made just after the training.

Today, many researches has focused on solving the problem of evaluating the nontechnical skills. In future studies, detailed evaluation module on nontechnical skills of ERM can be studied. For this evaluation, communicational structural grid method may be more useful than multiple-choice tests.

4.5.4 Crew appraisal

Both posttraining self-efficacy and transfer performance are measured by crew appraisal forms, shown in the Figure 4.12. Multiple shipping companies use these forms to measure the performance of their bridge and engine crew. Chief engineer evaluates engine personnel and the master of ship evaluates the chief engineer. Then

the shipping company evaluate the masters. Although these forms are used by companies, no data related to ERM concept was found in the company crew appraisal forms. After the ERM training, two methods can be applied to measure the competence of crew. Either development of crew's ERM skills form should be designed, or the existing crew appraisal form might be revised.

When the company procedures are examined, it is seen that the personnel evaluation is done in six-month or annual periods. By adding the criteria that evaluating ERM skills to these forms, the condition of the crew can be monitored regularly after the training. For example, first engineer attended the ERM training course, succeeded in ERM knowledge test modules and got his ERM certificate then started working onboard. If his company enriches crew appraisal forms with ERM skills and company scores the ERM skills that he learned in the course, it can be followed whether the engineer transferred the knowledge to the on job environment. As this crew appraisal is carried out regularly, the company can also observe the change in crew knowledge over time. Therefore, it can also be decided whether the crew will attend the ERM training course again.

Chief engineers generally make the mentioned personnel assessment. However, by the nature of the maritime field, the ship's personnel are constantly changing and the person who perform the measurement will be changed too. Therefore, the same evaluation is done by different people and is expected to yield more reliable results than other shore based company evaluations.

The following questions can be added to company evaluation forms: knowledge of marine engineering, initiative, assertiveness, leadership skills, communication skills, body language, time management skill, personality and relationship to other personnel, endurance under stress, responsibility, allocation of resources, assignment of resources, prioritization of resource, situational awareness, decision making, considering team experience, ability to keep calm in emergency situations.

4.5.5 Company reports

The final stage of training measurement is results. This dimension refers to visible outcomes as a result of training. For instance, organizational advantages of transfer performance might contain increased safety precautions, work efficiency, personnel's

morale in addition to this reduction in accident and injury rates. When the forms and reports obtained from the companies were analyzed, many result-measuring forms were found. These forms and reports are:

i. Near-miss Report,
ii. Accident Report and Analysis Form,
iii. Company Observation-Nonconformity Report,
iv. Annual Evaluation Report,
v. Claim Report Form,
vi. Observation/Non-Conformity Reports and Follow Up Form,
vii. Customer Satisfaction Evaluation Form,
viii. Master Review Report,
ix. Chief Engineer's Monthly Report,
x. Master's Monthly Report,
xi. Superintendent Inspection Check List and Report,
xii. Internal Audit Check List Form,
xiii. Company Accident Investigation and Analysis Form,
xiv. Deficiency Report,
xv. Overhaul - Trouble Report,
xvi. Personnel Appraisal Form (Enhanced with ERM concept).

All these reports must be prepared according to ERM concept and results may be measured numerically after the trainings. This step is the most difficult to implement but the shipping company can only observe the effect of training thanks to these reports.

To sum up all these steps on an example, Shipping Company A supports its personnel to take ERM training course according to requirements of STCW table A-III/1 and A-III/2 in the B Training Company. Firstly, training assessment form must be applied to trainees to measure their reactions about ERM training. Secondly, training company's ERM trainer must use trainee performance evaluation checklist to measure trainee's

performance by looking at their actions, attitudes and participation during the ERM training. At the end of course, ERM knowledge test modules are used to evaluate trainee's knowledge about ERM. After the trainee performance evaluation and ERM test modules measurements, a certificate is given to the trainee who gets adequate point in these evaluations. The trainees who get the certificate can start working on the A Shipping Company's vessels. The company use crew appraisal form (enhanced with ERM concept) to evaluate personnel's posttraining self-efficacy and transfer performance ability. Finally, the company examines the forms mentioned above to figure out whether this entire process is reflected in the results. If the company engineers effectively transfer their ERM knowledge to working environment of engine room, company results will be changed such as decreasing in near miss reports, deficiencies and accident reports.

4.6 Characteristics

As shown in the Figure 4.12, fourth stage of IMTEE model contains individual, training and organizational characteristics. Individual characteristics are about reactions. Additionally, individual characteristics and training characteristics are related to training performance, posttraining self-efficacy and cognitive learning under the changes in learners section. Finally, individual characteristics, training, characteristics and organizational characteristics are related to transfer performance section. All training framework must be shaped considering the trainee's demographics, abilities, experience and training's method, principles, equipment, instructors, content and organization's trainee selection process, working environment, support, resource availability, procedures.

4.6.1 Individual characteristics

Individual characteristics consist of abilities, attitudes, experience, demographics in Figure 4.9. Example of abilities are cognitive ability, trainability, domain (marine engineering) knowledge, creativity, management, technical skills, public speaking, communication, implementation, design.

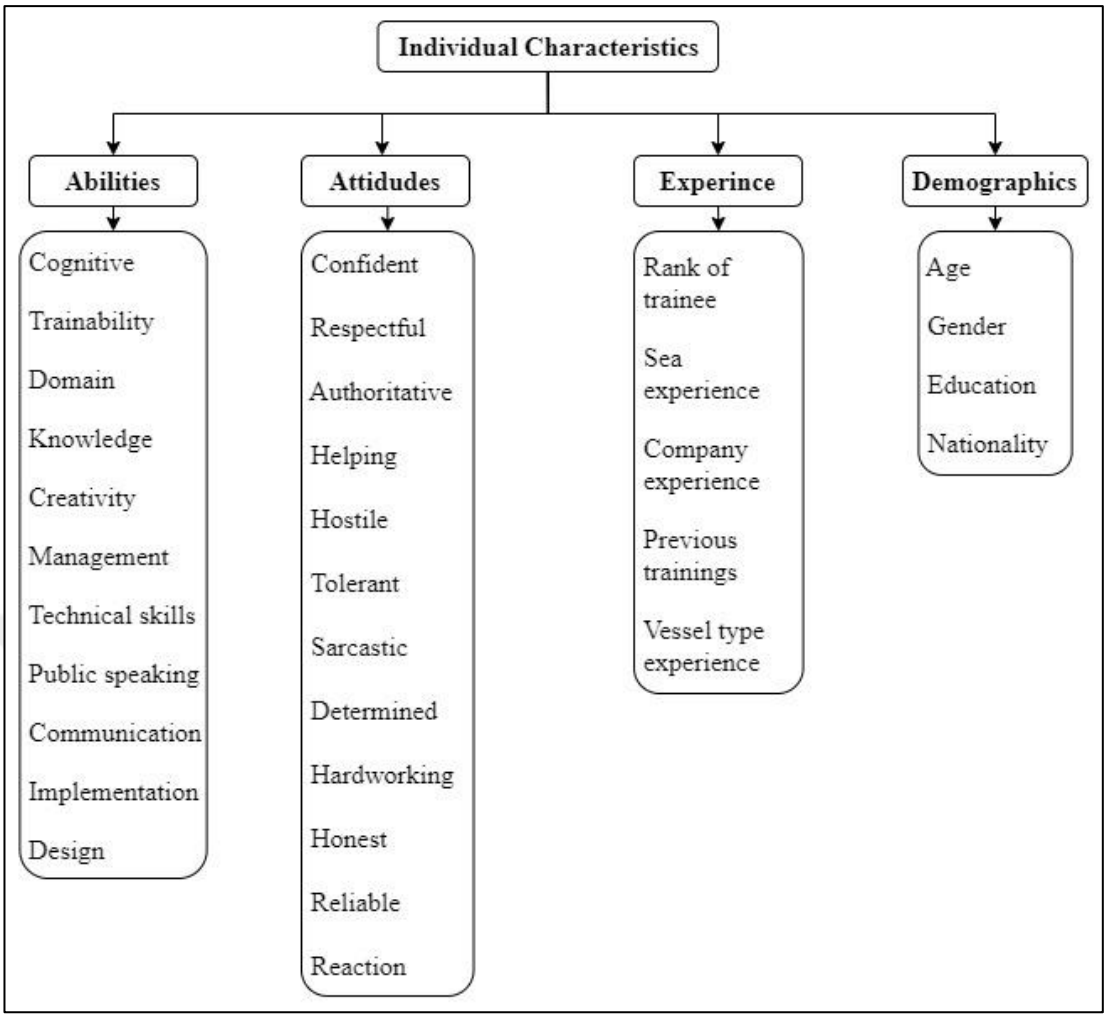

Figure 4.9 : Individual characteristics.

Confident, respectful, authoritative, helping, hostile, tolerant, sarcastic, determined, hardworking, honest, reliable, reaction (other trainees and instructor) attitudes are under the individual characteristics.

Experience includes rank of trainee, sea experience and experience with company, previous trainings, type of vessel experience (tanker, container, bulk carrier, liquefied gas, roro, passenger vessel experience).

Demographics of training are age, gender, education, nationality.

Individual characteristics effects reactions, training content, changes in learners and organizational payoffs then needs analysis of ERM. By looking at this model, the demographic structure, experience or abilities of the trainees can change the structure of the complete training by affecting the training content, evaluation methods and company structure.

4.6.2 Training characteristics

Training characteristics is about structure of training. It consists of training method, training principles, equipment and technology, content of training, instructors in Figure 4.10.

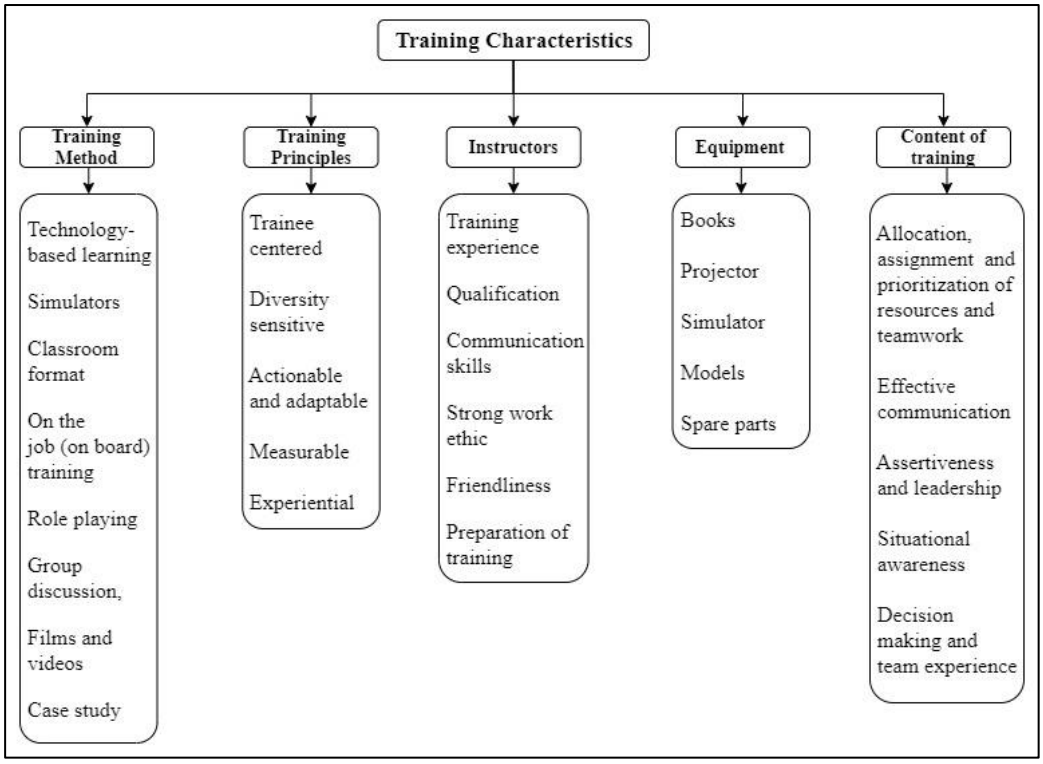

Figure 4.10 : Training characteristics.

Training methods are technology-based learning, simulators, classroom format, on the job (on board) training, role-playing, group discussion, films and videos, case study.

Training principles consist of trainee centered, diversity sensitive, actionable and adaptable, measurable, experiential. Trainee centered training is an environment that pays attention to the knowledge, skills, attitudes of participants. Therefore, training should be designed considering the participants of training. Diversity sensitive is about training knowledge. In fact, diverse participants bring different experiences and perspectives to a training. Actionable and adaptable training focus on knowledge, skills, and attitudes. It has a practical utility and it will help participants make an impact on job. Training must be measurable. Training evaluation can use learning objectives to develop appropriate evaluation plans and techniques that help extract learning, which can be applied to training design. Experiential training is a kind of learning by doing such as simulator trainings.

Instructors are important leg of the training characteristics. Training experience, qualification, communication skills, strong work ethic, friendliness, preparation of training content are the vital characteristics of instructors. Equipment and technology consist of equipment such as books, projector, simulator, models (such as 2-stroke engine model) and spare parts of engines. Content of training was analyzed in chapter 4.2. Training content should include all the elements of the concept.

4.6.3 Organizational characteristics

Organizational characteristics are highly important in training sections especially in posttraining self-efficacy and transfer performance. Company characteristics must encourage the trainee to apply ERM skills in the engine room of company vessels.

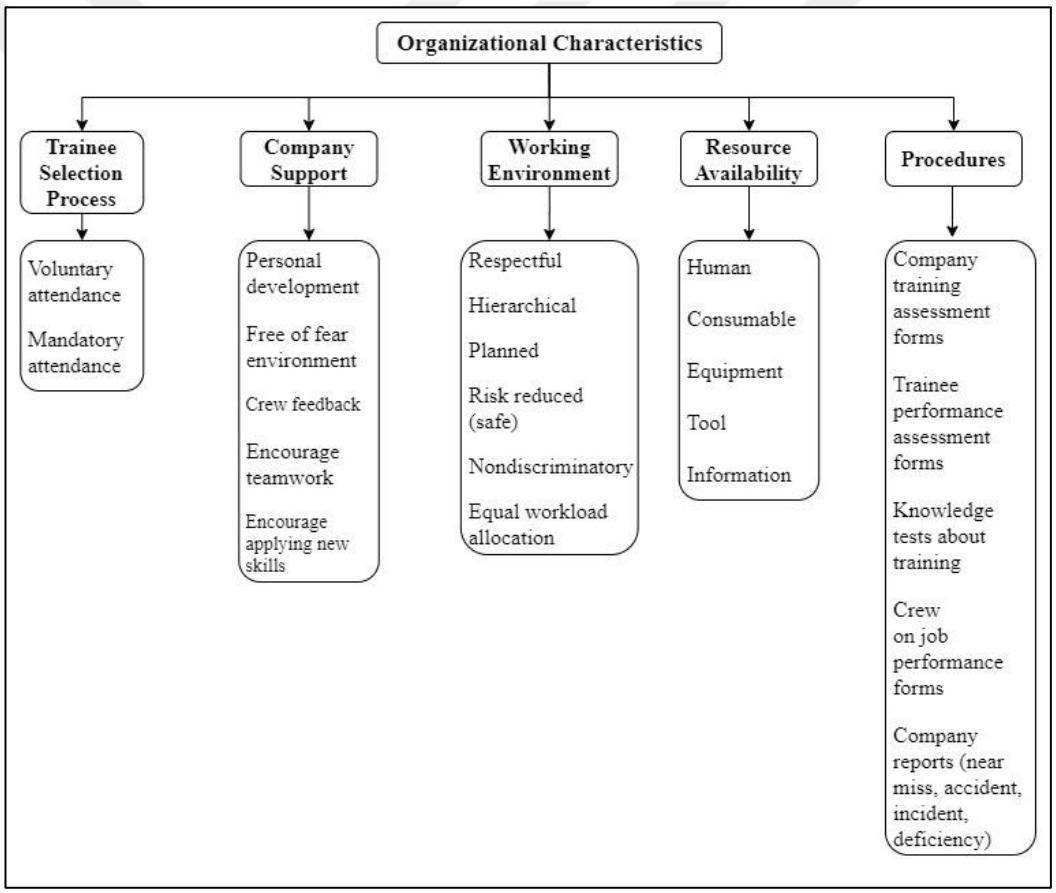

Figure 4.11 : Organizational characteristics.

As shown in Figure 4.11, organizational characteristics contain trainee selection process (voluntary attendance, mandatory attendance), company support, workload and working environment, resource availability, procedures.

Company must encourage their personal's development, provide a job environment without fear and dangers, listen to their crew's feedback, support teamwork among employees and applying newly acquired ERM skills on board. According to the maritime field's nature, working environment of vessel must be respectful, hierarchical, planned, risk reduced (safe), non-discriminatory. An equal and fair workload allocation should be provided among the engine crew. Finally, company procedures such as training evaluation forms, job performance forms etc. must be prepared according to ERM concept.

4.7 Overview of Suggested Improvements

Application requirements of IMTEE was identified in chapter 3.4. Flowchart improvements are separated and coded considered its stage and group. IMTEE has four levels: i) needs analysis ii) training content and design, changes in learners, organizational payoffs iii) reactions, posttraining self-efficacy, cognitive learning, training performance, transfer performance, results iv) individual characteristics, training characteristics, organizational characteristics. In addition to its' four level this model has six evaluation targets: reactions, posttraining self-efficacy, cognitive learning, training performance, transfer performance, results. Suggested improvements of enhanced IMTEE are listed below.

i2-t1: First improvement of training content and design at second stage of model, described improvements in allocation of resources and teamwork. According to the STCW tables, allocation, assignment, prioritization of resources and teamwork must be provided. Additionally, considering maritime field, this content is about effective use of limited resources. These resources are human, equipment, consumable and information resources. i2-t1 designed in the chapter 4.2.1 and its markers are listed in the same chapter.

i2-t2: Second improvement of training content and design at second stage of model, described improvements in effective communication. i2-t2 designed in the chapter 4.2.2 and its markers are listed in the same chapter. According to the i2-t2, effective communication must be ensured in engine room, on board and to others.

i2-t3: Third improvement of training content and design at second stage of model, described improvements in assertiveness and leadership. i2-t3 shaped in the chapter

4.2.3 and its markers are listed in the same chapter. This improvement includes authority, assertiveness, providing and maintaining standards, planning and coordination, conflict solving.

i2-t4: Fourth improvement of training content and design at second stage of model, described improvements in situational awareness. i2-t4 designed in the chapter 4.2.4 and its markers are listed in the same chapter. This improvement includes awareness of engine systems, company and vessel requirements, maritime environment, time.

i2-t5: Fifth improvement of training content and design at second stage of model, described improvements in decision-making and team experience. i2-5 and its markers designed in the chapter 4.2.5. The improvement includes problem description and identification, option generation, risk assessment and selection, team experience.

i3-c1: First improvement of changes in learners at third stage of model, described improvements in posttraining self-efficacy. i3-c1 designed in the chapter 4.3.1. Posttraining self-efficacy effects trainees' motivation to transfer and to use newly learned skills such as decision-making, leadership, situational awareness etc.

i3-c2: Second improvement of changes in learners at third stage of model, described improvements in cognitive learning. i3-2 improvement is in the chapter 4.3.2. Cognitive learning is a kind of learning process, which is referring to getting training knowledge. In fact, it is the cognitive obtaining of ERM knowledge such as situation awareness, allocation of resources, leadership etc.

i3-c3: Third improvement of changes in learners at third stage of model, described improvements in training performance. i3-c3 designed in the chapter 4.3.3. Demonstrating new getting skills during the ERM training is about training performance. Before the transfer section, it is evaluated through visible evidence in trainee's attitudes which participant can implement ERM skills during training.

i3-o1: First improvement of organizational payoffs at third stage of model, described improvements in transfer performance. i3-o1 improvement designed in the chapter 4.4.1. Transfer performance section includes behavioral change on the job field.

i3-o2: Second improvement of organizational payoffs at third stage of model, described improvements in transfer performance. i3-o2 designed in the chapter 4.4.2. It refers to observable outcomes in the organization as a result of training.

i3-m1: First improvement of multi-stage training evaluation at third stage of model, described improvements in company training assessment. i3-m1 and its questions designed in the chapter 4.5.1. Company training assessment form is applied to the trainees to assess the training effectiveness.

i3-m2: Second improvement of multi-stage training evaluation at third stage of model, described improvements in trainee performance evaluation. i3-m2, its markers (Figure 4.5) and additional terms discussed in the chapter 4.5.2. Trainee performance evaluation forms are applied during the training by instructor.

i3-m3: Third improvement of multi-stage training evaluation at third stage of model, described improvements in ERM knowledge module. i3-m3 explained in the chapter 4.5.3. Cognitive learning is the cognitive obtaining of training knowledge and this type of learning is measured by ERM knowledge modules. For this evaluation, communicational structural grid method may be more useful than multiple-choice tests.

i3-m4: Fourth improvement of multi-stage training evaluation at third stage of model, described improvements in crew appraisal. i3-m4 and its suggested questions designed in the chapter 4.5.4. Crew appraisal forms measure both posttraining self-efficacy and transfer performance.

i3-m5: Fifth improvement of multi-stage training evaluation at third stage of model, described improvements in company reports. i3-m5 and its forms, procedures designed in the chapter 4.5.5. This improvement refers to visible outcomes as a result of training.

i4-c1: First improvement of characteristics at fourth stage of model, described improvements in individual characteristics. i4-c1 designed in the chapter 4.6.1. Individual characteristics consist of abilities, attitudes, experience, demographics.

i4-c2: Second improvement of characteristics at fourth stage of model, described improvements in training characteristics. i4-c2 shaped in the chapter 4.6.2. It consists of training method, training principles, equipment and technology, content of training and instructors.

i4-c3: Third improvement of characteristics at fourth stage of model, described improvements in organizational characteristics. i4-c3 designed in the chapter 4.6.3. Organizational characteristics contain trainee selection process (voluntary attendance,

mandatory attendance), company support, workload and working environment, resource availability, procedures. All improvement codes are seen in the IMTEE flowchart (Figure 3.5).

4.8 Proposed Enhanced ERM Concept

Proposing an enhanced ERM concept is the final objective of the thesis. In this context, IMTEE was analyzed and applied to ERM. As mentioned before, IMTEE has four levels and this model has six evaluation targets. Its suggested improvements are listed and coded considering improvement's stage and group. Table 4.1 shows improvements in training content and design; Table 4.2 demonstrates improvements in changes in learners; Table 4.3 presents improvements in organizational payoffs; Table 4.4 indicates improvements in multi stage training evaluation; Table 4.5 represents improvements in characteristics. From trainee's demographic characteristics to need analysis, organizational working environment to results, trainee performance evaluations to cognitive learning, all components of the model have an impact on each other and these components are very important for the model. The framework has been drawn in order to express the working model more clearly. All studies in chapter four are shown in the Figure 4.12.

Table 4.1 : Improvements in training content and design.

Improvement	Description
i2-t1	Second stage-training content and design- improvement 1 Improvements in allocation of human, equipment, consumable, information resources and teamwork.
i2-t2	Second stage-training content and design- improvement 2 Improvements in effective engine room, on board and to others communication.
i2-t3	Second stage-training content and design- improvement 3 Improvements in assertiveness and leadership, which includes authority, assertiveness, providing and maintaining standards, planning and coordination, conflict solving.

Table 4.1 (continued) : Improvements in training content and design.

Improvement	Description
i2-t4	Second stage-training content and design- improvement 4 Improvements in situational awareness includes awareness of engine systems, company and vessel requirements, maritime environment, time.
i2-t5	Second stage-training content and design- improvement 5 Improvements in decision-making and team experience includes problem description and identification, option generation, risk assessment and selection, team experience.

Table 4.2 : Improvements in changes in learners.

Improvement	Description
i3-c1	Third stage-changes in learners- improvement 1 Improvements in posttraining self-efficacy.
i3-c2	Third stage-changes in learners- improvement 2 Improvements in cognitive learning.
i3-c3	Third stage-changes in learners- improvement 3 Improvements in training performance.

Table 4.3 : Improvements in organizational payoffs.

Improvement	Description
i3-o1	Third stage-organizational payoffs- improvement 1 Improvements in transfer performance includes behavioral change on the job field.
i3-o2	Third stage-organizational payoffs- improvement 2 Improvements in results refers to observable outcomes in the organization as a result of training.

Table 4.4 : Improvements in multi stage training evaluation.

Improvement	Description
i3-m1	Third stage-multi stage training evaluation-improvement 1 Improvements in company training assessment.
i3-m2	Third stage-multi stage training evaluation-improvement 2 Improvements in trainee performance evaluation.
i3-m3	Third stage-multi stage training evaluation-improvement 3 Improvements in ERM knowledge modules.
i3-m4	Third stage-multi stage training evaluation-improvement 4 Improvements in crew appraisal.
i3-m5	Third stage-multi stage training evaluation-improvement 5 Improvements in company reports refers to visible outcomes as a result of training.

Table 4.5 : Improvements in characteristics.

Improvement	Description
i4-c1	Fourth stage-characteristics-improvement 1 Improvements in individual characteristics (abilities, attitudes, experience, demographics).
i4-c2	Fourth stage-characteristics - improvement 2 Improvements in training characteristics (training method, training principles, equipment and technology, content of training and instructors).
i4-c3	Fourth stage-characteristics - improvement 3 Improvements in organizational characteristics (trainee selection process, company support, workload and working environment, resource availability, procedures).

After the improvements, enhanced ERM concept task and responsibility allocation must be prepared. At the first stage of model, needs analysis can be determined by training course. At the second stage, training content and design are reshaped by training course. In the third stage of model i3-m1 company training assessment must prepared and applied by the shipping company. The other third stage evaluation i3-m4 crew appraisal section applied by shipping company in the working field. i3-m3 ERM knowledge modules are implemented to trainees by training course.i3-m2 trainee performance evaluation are applied by training course instructors to trainee. Finally, i3-m5 company reports are followed by the shipping company. Company training assessment, trainee performance evaluation and ERM knowledge modules can be designed by company training department. Crew appraisal and company reports can be designed or reshaped by quality and documentation department. At the third stage of model, individual characteristics i4-c1 and training characteristics i4-c2 are applied by training courses. Organizational characteristics are applied by shipping company.

ERM training has been transferred to maritime from aviation field. Aviation community developed cockpit resource management concept to reduce the critical accidents in aviation field which caused by human element. The focus of cockpit resource management spreads outside to the cockpit for improving the safety culture. The concept of resource management firstly announced in the aviation industry and the training was progressively improved then enlarged to other groups.

The scientific evidence of studies and reports has emphasized that nontechnical skills act a significant role in human performance in broad range of fields such as, aviation, rail-road, health care, maritime sectors. Although their names change according to the field of study such as CRM, ERM, BRM, TRM, HRM, MRM, ETCC, RRM, TCRM the trainings have only one goal. The goal is to provide knowledge to trainees that will minimize the human faults in accidents.

When the studies about resource management in aviation, health-care, offshore, railway sectors are examined, it is observed that many researchers are working on videotape observations to detect trainee’s non-technical skills. Other researchers are used reaction checklists to measure resource management course effectiveness. Other studies use training questionnaires. Some group of researchers use the accident report to collected accident reports to identify factors affecting the crew's ability to maintain

non-technical skills. On the other hand, in the maritime field there are limited number of studies about ERM were found in the literature.

All resource management concept studies demonstrate us; this training has major positive effect on accidents that caused by human faults. For this reason, ERM concept, which is almost unstudied field, should be researched more in detail. With this study, it is aimed to contribute a new study in maritime field. In this context, it is believed that this thesis will expressed the ERM concept comprehensively and measurably. Enhanced, multi-stage and measurable ERM concept is suggested to all shipping companies, seafarers and especially training courses.

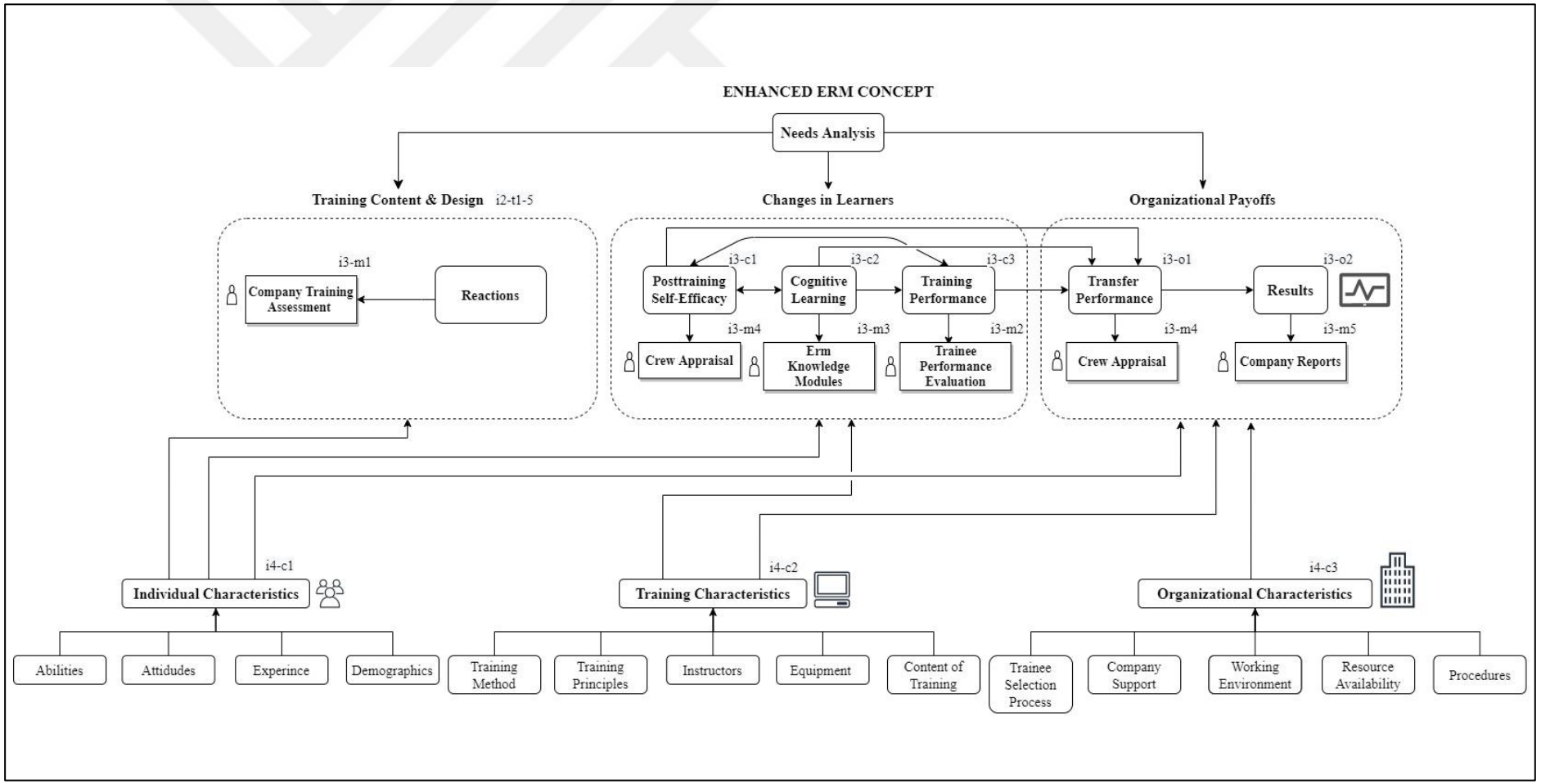

Figure 4.12 : Enhanced ERM concept adapted from IMTEE.

5. CONCLUSION

The scientific evidence of studies and reports has emphasized that nontechnical skills act a significant role in human performance in broad range of fields such as, aviation, railroad, health care and maritime. In this context, ERM training has been transferred to maritime from aviation field. According to studies about various sectors, training names was changed according to the field of study such as CRM, ERM, BRM, TRM, HRM, MRM, ETCC, RRM, TCRM but, the trainings have only one goal, providing knowledge to trainees that will minimize the human faults in accidents.

ERM training was introduced by IMO to reduce the human fault factor in maritime accidents by enhancing situational awareness, decision-making, teamwork, leadership etc. After this arrangement, all ship officers have to attend BRM and ERM trainings, learn the principles of BRM and ERM concepts. Then officers must get certificates to work onboard. Therefore, ERM and BRM training courses, which are very important in reducing human fault rate in maritime accidents, is also a compulsory training for working onboard. Due to these requirements, the studies, which carried out in this field, have a great importance. According to the studies, resource management trainings have positive effect on accidents which caused by human faults. However, it was seen that the ERM concept was not fully applied to maritime field. There is a big gap between the STCW table A-III/1, A-III/2 ERM concept and the current practices in maritime field.

This thesis contains study in both theoretical and practical level, the thesis is organized based on a literature review, industrial survey, methodology development, demonstration and enhanced concept proposal.

Literature review includes the detailed research on three key aspects: resource management concept applied in different fields, training evaluation models, practical field studies. In addition, it provides an industrial feedback survey and its critical review. Studies were selected from journals or conferences that related to maritime, aviation, healthcare, railway and offshore domains, much cited and recently written ones. Various databases were used to search. All these articles were coded and

separated according to their field. The methods used in the studies are grouped and examined in the same way.

In order to carry out industrial survey, firstly several technical visits to the number of six shipping company located in Turkey are completed. Structures and procedures of shipping companies were examined in detail. ERM concept was not found in the training procedure of companies. In addition to this, it was observed that, any company use the posttraining evaluation procedures. Consequently, the gap between the STCW table A-III/1 and A-III/2 ERM concept and the current ERM application in the organizations is determined.

To complete industrial survey, contents of the all ERM courses and their training evaluation methods were examined. It was found that there is a huge gap in the STCW ERM concept between current ERM training courses. Contents of ERM courses includes mainly usage of engine simulator (preparation of main engine, black out procedure, fault finding, usage of auxiliary systems etc.). However, IMO designed ERM concept aims for improving seafarers' nontechnical skills to reducing the human fault rate in accidents. Therefore, it was seen that many training courses, shipping companies, seafarers and all kind of organizations perceive STCW table A-III/1 and A-III/2 ERM training course as an IMO model course 2.07 (simulator using training course).

Additionally, Ceylan et al. (2019) separated ERM concept in to simple and more understanding parts by using ICOR analysis. Moreover, they constructed an ICOR control matrix. It was analyzed that, control stage of ERM concept is deficient.

Eventually, problems were determined about perceiving, learning, transferring and evaluating the concept of ERM. To overcome this problem, the objectives of the thesis was determined. The study has progressed with considering these objectives.

In the methodology development stage, various studies examined to find the suitable model for the ERM concept. The IMTEE combines the evaluation levels of reactions, self-efficacy and knowledge. In addition to this, it also aims to examine the variables (individual, training and organizational characteristics), which may affect the training effectiveness. In this way, IMTEE described the training results and formulated the advices to increase the training effectiveness. In addition, IMTEE is the newest and most cited study among other models. The most important factor in choosing IMTEE

model is that, this model is different from classical models and it is considered suitable for ERM concept since it is a multi-stage and integrated model. Application requirements of IMTEE and its flowchart was designed. According to the flowchart, improvements are separated and coded considered its stage and group. Afterward, overview of suggested improvements was explained. As a result, ERM concept was adapted Integrated Model of Training Evaluation and Effectiveness.

Firstly, needs of ERM concept were analyzed and listed. Then, training content was designed by the help of individual characteristic and trainee reactions. Then, changes in learners shaped by the help of individual, training characteristic and various evaluation methods such as, trainee performance evaluation form, ERM knowledge modules etc. Organizational payoffs were formed by using individual, training, organizational characteristics, crew appraisal forms and company reports. These components are valuable in the model structure and the model was constructed by designing all these components.

As a result, this model expressed the ERM concept comprehensively and measurably. The enhanced ERM concept will recommend a solution to all kind of maritime stakeholders. Enhanced, multi-stage and measurable ERM concept is suggested to all shipping companies, seafarers and especially training courses. Consequently, it is believed that the enhanced ERM concept will provide both academic and industrial benefits in the maritime sector.

In the fieldwork stage, the thesis suffers some limitations. Since obtaining company procedures, technical or operational data in maritime field is very challenging. Additionally, during the research, there are limited number of studies about ERM were found in the literature. With this study, it is aimed to contribute a new study in maritime field.

When the literature on maritime training is examined, it is observed that many researchers are working on nontechnical skills evaluation methods and developing suggestions to solve this problem. The further studies may include, training evaluation methods that is shortly specified in chapter 4.6. The study may also be extended with detailed training evaluation methods for nontechnical skills.

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