ISTANBUL TECHNICAL UNIVERSITY ★ INSTITUTE OF SCIENCE

SAFETY BASED DECISION SUPPORT SYSTEMS FOR MARINE STRUCTURES

M.Sc. THESIS,

Emre Koray GENÇSOY,

Department of Naval Architecture and Marine Engineering,

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Emre Koray GENÇSOY, a M.Sc. student of **ITU Institute of Science**, student ID **508981001,** successfully defended the thesis entitled "**SAFETY BASED DECISION SUPPORT SYSTEMS FOR MARINE STRUCTURES**", which he prepared after fulfilling the requirements specified in the associated legislations, before the jury whose signatures are below.

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DATE OF SUBMISSION: 11 AUGUST 2016

DATE OF DEFENCE: 15 AUGUST 2016

Dedicated to

my little son ***KUZEY***,

FOREWORD

My post graduate journey started on 1998, after two years of study; I was ready to start working on my thesis. Several attempts to choose a subject to study has fallen down by me. I desired to work on new applications for marine industry which may be a new step for further studies. After 16 years of working on different subjects, finally here I am.

First of all, I would like to thank to my beloved mother, she was my shining pole star that lightens my course. She is the reason of who I am.

Prof. Dr. A. Yücel Odabaşı is an important figure of my entire engineering career, I have learned a lot from him and used what I have learnt in every single engineering problem I face. I always feel myself lucky and proud of being his student.

These two important figures of my life are both passed away during all those years. I will always be grateful to them for enriching my life.

Assoc. Prof. Dr. Şebnem Helvacıoğlu; if she was not so encouraging, for sure, I will not able to be at this point. I do thank a lot for all of her patience, excellent guidance, advice and her support.

And my dear family;

My sister PhD. Elif Banu Gençsoy, thanks for all of her efforts that helped me to deal with procedures and regulations of the university.

My wife Özlem, for standing next to me during all those years of study with her patience.

And of course, my little son Kuzey, thank you for adding priceless values to my life, this is for you.

March, 2016 Emre Koray Gençsoy

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ABBREVATIONS

AHP	**:** Analytical hierarchy process
AIJ	**:** Aggregation of individual judgments
AIP	**:** Aggregation of individual priorities
ALARP	**:** As low as reasonable practical
ANP	**:** Analytic network process
BOCR	**:** Benefits, opportunities, costs, risks
CBA	**:** Cost - benefit analysis
CI	**:** Consistency index
CO2	**:** Carbon dioxide
CR	**:** Consistency ratio
ECA	**:** Emission control area
ELECTRE	**:** Elimination et choix traduisant la réalité
ESD	**:** Emergency shutdown device
ETC	**:** Et cetera (and other things)
FMEA	**:** Failure mode and effects analysis
FTA	**:** Fault tree analysis
HACCP	**:** Hazard analysis and critical control points
HAZID	**:** Hazard identification
HAZOP	**:** Hazard and operability study
HFO	**:** Heavy fuel oil
IEC	**:** International Electrotechnical Commission
IGF	**:** International code of safety of ships using gases or other low flashpoint fuels
IMO	**:** International maritime organization
ISO	**:** International Organization for Standardization
LNG	**:** Liquefied natural gas
LOPA	**:** Layer protection analysis
MADM	**:** Multiple attribute decision making
MARPOL	**:** International convention for the prevention of pollution from ships
MCDA	**:** Multiple criteria decision analysis
MDO	**:** Marine diesel oil
MODM	**:** Multiple objective decision making
MSC	**:** Maritime safety committee
N2	**:** Nitrogen (Inert gas)
NG	**:** Natural gas
NOx	**:** Nitrogen oxides
PHA	**:** Primary hazard analysis
SOLAS	**:** International convention for the safety of life at sea

Sox **:** Sulphur oxides
SWIFT **:** Structured what-if technique
TOPSIS **:** Technique for order of preference by similarity to ideal solution

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SAFETY BASED DECISION SUPPORT SYSTEMS FOR MARINE STRUCTURES

SUMMARY

Analyzing risk is an essential and very powerful tool to deal with uncertainties. New technologies, new developments and new methodologies always include uncertainties and thereby risks. There are many different methods to deal with risks. Qualitative and quantitative methods are both used for decades with success in many different industries. Quantitative studies require more statistical data then qualitative ones. Ability to use both tangible and intangible data in analyses enables to perform risk analysis at any stage of the project. Hazardous Identification (HAZID) and Hazardous and Operability (HAZOP) studies are powerful and widely used analysis methods. In these studies a group of experts make an effort to define and assess possible risks. Work groups may be problematic if group domination by one or more participants happens. And generally because of the consensus about the subject, it is hard to include fuzziness.

Risk assessment is a very important figure in analysis of new systems. Assessment has three main stages; risk identification, risk analysis and risk evaluation. Identification starts with questioning “when, what, who, how, where”, after finding answers to these questions analysis stage starts. Answers to questions at identification stage helps to understand the boundaries of the system. Analysis focuses on “how much, how often, how critical” type questions. These questions help analyst to understand the nature, period and level of risk. After analyzing the risk evaluation period starts; this point is the one where the action to the risk is selected, taking no action or transferring risk such as an insurance company might also be an alternative.

There are several techniques defined by ISO to deal with risk management. About 30 techniques are listed in the standard. Whatever the method is used, knowledge of experts, their understanding of problem and their position to view the risk will directly affect the result. In order to get proper assessment results, problem has to be thought from all sides of aspect. The success is methodology depended, however the main component of all analysis methods is human.

Whether or not be aware of it, decision making is something done in every daily life. Decisions made, draw the path of life, decisions shapes the life and every decision has it’s own consequences that has to be faced. Historically, human decisions theories have focused on outcome prediction. Modern decision making is based on ; understanding of decision making process, thoughts and application of technology tools to support process by human beings. Analytical Hierarchy Process (AHP) proved that using Eigen vectors to solve decision problems is possible. With this study Saaty opened slightly the door to the new studies. Difficulties about modeling real problems in a hierarchical structure are limiting the usage of AHP; therefore a better way of modeling in network structure with dependencies and feedback is presented by Saaty. This methodology is called Analytical Network Process (ANP). ANP is a successful and powerful tool to model complex decision problems. However modeling and solving ANP requires a lot of patience and effort. Fuzzy Multi-Criteria Decision Making using Fuzzy Set Theory has been recommended as an alternative method for overcome the complexity of ANP. Fuzzy sets contain uncertainty and they are easy to apply to all kinds of problems. There are also some

challenging difficulties with fuzzy sets. Definition of fuzzy sets, membership functions require experience. Changing defined rules is not so easy. Due to these problems in multi-criteria decision making, hybrid methods such as Fuzzy-AHP, Fuzzy-ANP, etc. are being used commonly. There are generated hybrid solution methodologies, thus applier, depending of the nature of the problem, may choose one of them and directly apply the solution method.

In this study, LNG bunkering operation was selected as case study. LNG is one of the most probable alternatives to current fuel oils. Bunkering operation is the most challenging part of LNG usage on board. HAZID/HAZOP studies for bunkering, classification societies bunkering guidelines were used to define the hazards. Hazards are grouped under clusters by using Fault Tree Analysis (FTA). Experts participating in the study were asked to fill in the questionnaire, according to pre-defined ANP network structure. Risk values for alternatives are calculated using likelihood and consequences. Final results obtained by using group decision making techniques such as aggregation of individual priorities (AIP), expert weights also calculated by using a separate ANP network.

As result LNG leaks have been found the most critical risk alternative for all calculation methodologies.

DENİZ YAPILARI İÇİN GÜVENLİK TABANLI KARAR DESTEK SİSTEMLERİ

ÖZET

Dünya yüzeyinin %71'i suyla kaplıdır ve insanlık tarihinin gelişimi boyunca insan bir şekilde suyla mücadele ederek ilerleme kaydetmiştir. Bu sayede medeniyetlerini yaymış, ticareti arttırmış ve gelişmeyi sağlamıştır. Olasılık teorisinin başarıyla çalıştığı ve risk alarak başarıya ulaşılan pek çok yer olabilir ancak tarihsel veriler şunu göstermektedir ki, denizcilik sektörü bunlardan birisi değildir. Alınan küçük risklerin çok büyük felaketlere sebep olduğu defalarca görülmüştür. Yaşanılan büyük kazalar sonrası alınan tedbirler ve Uluslararası Denizcilik Örgütü'nün kaza analizleri sonrası ortaya koymuş olduğu kural ve kaideler, insanoğlunun deniz ile mücadelesinde kazanımlar sağlamış olmasının en önemli nedenidir.

Risk analizi belirsizlikler ile başa çıkmak için önemli ve çok güçlü bir araçtır. Yeni teknolojiler, yeni gelişmeler ve yeni metodolojiler her zaman belirsizlikleri ve böylece riskleri içerir. Bu risklerle başa çıkmak için birçok farklı yöntem vardır. Niteliksel ve niceliksel yöntemler pek çok farklı sektörlerde başarı ile yıllardır kullanılmaktadır. Kantitatif çalışmalar daha fazla istatistiki verilere ihtiyaç duymaktadır. Analizlerde hem sayısal hem de sözel verilerin kullanılabilmesi projenin herhangi bir aşamasında risk analizi gerçekleştirmenizi sağlar. Tehlike Tanımlama (HAZID) ve Tehlike ve İşletilebilme (HAZOP) çalışmaları, güçlü ve yaygın olarak kullanılan analiz yöntemlerindendir. Bu çeşit çalışmalarda uzmanlardan oluşan bir grup riskleri tanımlamak ve olası riskleri değerlendirmek için çaba harcarlar. Grup içerisinde bir veya daha fazla katılımcı karar verme mekanizmalarında hakimiyete sahip olursa, bu tarz çalışma grupları sorunlu olabilir. Ve genellikle grup içerisinde konu hakkında baskın fikir birliği sebebiyle tanımlara belirsizliği dahil etmek zordur. Buna ragmen oldukça sık kullanılan bu yöntemler ile pek çok denizcilik uygulamasının risk değerlendirilmesininde karşılaşılmaktadır.

Riski tahmin etmek yeni sistemlerin analizi için hayati öneme sahip bir fonksiyondur. Tahmin sistemi üç aşamadan oluşmaktadır; riski tanımlar, riski analiz etme ve riski ortadan kaldırma. Bunlardan ilki riski tanımlama "ne zaman, ne, kim, nasıl ve nerede" sorularının cevaplarının aranmasıyla başlar. Bunlara cevap bulunup tanımlama işlemi tamamlandığında ikinci kısma yani analiz kısmına geçilir. Analiz bir derece daha olaya odaklanmıştır ve "ne kadar, ne sıklıkta ve ne kadar önemli" sorunlarının cevaplarını elde etmeyi amaçlar. Alınan cevaplar, analizi yapana riskin doğasını sıklığını ve seviyesini anlama imkanı sağlar. Analiz tamamlandıktan sonra, belirlenen riske karşılık ne tedbir alınacağının kararlaştırılması safhasına geçilir, bu safha değerlendirme safhasıdır. Bu aşamada analiz safhasında tespit edilen riskin etkisini düşürmek amacıyla neler yapılması gerektiği kararlaştırılır; riskin etkisine bağlı olarak karşı tedbir almamak veya riski bir sigorta firmasına transfer etmek de uygulanabilecek yöntemlerdendir.

Risk yönetimi için kullanılabilecek, ISO standartlarında tanımlanmış çeşitli teknikler mevcuttur. Standartta yaklaşık 30 farklı teknik tariflenmiştir. Hangi method kullanılırsa kullanılsın, karar vericilerin konuya hakimiyeti, bilgileri ve riske bakış açıları sonucu doğrudan etkileyecektir. Doğru bir analiz sonucu elde edebilmek için sorun her bakış açısından dikkatlice incelenmelidir. Başarı metodolojiye bağlı

olmasına ragmen, tüm analiz yöntemlerinin tek ortak ana parçası insandır ve sonucu doğrudan etkilemektedir.

Farkında olunsun ya da olunmasın, karar verme seçimleri ile her gün günlük hayatta karışılaşılmaktadır. Saaty Analitik Hiyerarşi Proses (AHP) ile karar verme problemlerini çözmebilmek için Eigen vektörlerini kullanılmanın mümkün olduğunu kanıtladı. Bu çalışması ile Saaty, yeni çalışmalara ve yöntemlere kapıyı aralamıştır. Pek çok başarılı uygulaması olmasına ragmen, gerçek problemleri hiyerarşik bir yapıda modelleme konusunda zorluklar, AHP kullanımını kısıtlamaktadır; bu sebeple Saaty bağımlılıkları ve geri bildirimi ile ağ yapısında bir modelleme yöntemi geliştirmiştir. Bu metodoloji Analitik Ağ Süreci (ANP) diye adlanrılmıştır. ANP başarılı bir şekilde karmaşık karar verme problemlerini modelleyebilmektedir. Ancak modelleme ve modelin çözümü AHP'ye kısayla çok fazla sabır ve çaba gerektirmektedir. Zira ağ modelin her bir bağlantısı için ikili karşılaştırma yöntemi kullanılması gerekmektedir. Bunun dışında bulanık küme teorisinden faydalanılarak, bulanık çok kriterli karar yöntemlerini (fuzzy) kullanmak, ANP'nin çözümlerine bulanık ortam etkilerini katmak için alternatif bir yöntem olarak tavsiye edilmiştir. Belirsizliği içeren bulanık kümeleri her türlü soruna uygulamak kolaydır. Bulanık setlerde de bazı zorluklar vardır. Bulanık küme tanımların yapılabilmesi için, üyelik fonksiyonlarını tanımlak da tecrübe gerektirir. Tanımlanmış kuralları da değiştirmek o kadar kolay da değildir, dolayısıyla system baştan detaylı düşünülmeli ve ona gore düzenlenmelidir. Bu tür sebeplerden dolayı nispeten uygulaması daha kolya olan Bulanık-AHP, Bulanık-ANP, vb. hibrid yöntemlerin kullanılması yaygındır. Pek çok hibrid çözüm metodolojileri geliştirilmiştir, böylece uygulayıcı, probleminin doğasına uygun olan yöntemi doğrudan seçip kullanabilir.

Bu çalışmada, LNG yakıt dolum operasyonu vaka çalışması olarak seçilmiştir. LNG mevcut yakıtlar arasında, Uluslararası Denizcilik Örgütü ve bir takım ülkelerin hava kirliliği ile mücadele kapsamında koymuş olduğu kurallara uyabilecek en olası alternatiflerden biridir. Yakıt dolumu LNG kullanımı işleminin en riskli parçasıdır. Yakıt dolumu ile ilgili HAZID / HAZOP çalışmaları, klas kuruluşlarının yakıt dolumu ile ilgili geliştirdileri prensipleri yakıt dolumu için olabilecek tehlikelerin tanımlanmasında kullanılmıştır. Tehlikeler ve riskler Hata Ağacı Analizi (FTA) kullanarak kümeler altında toplanmıştır ve bu kümelerden ANP ağ yapısı oluşturulmuştur.

Oluşturulan ANP ağ yapısı; ANP (logaritmik en küçük kareler) ve Bulanık-ANP yöntemleriyle çözülmüştür. Bu çözümler için eklerde sunulan excel kodları yazılmıştır. Bulanık-ANP çözümü için, pek çok geliştirilmiş olan çeşitli metodolojiler bulunmaktadır, çözüm için bunlardan bir tanesi kullanılmıştır.. Bu çalışmada bulanık ortam modellemesi için üçgen bulanık fonksiyonlar kullanılmıştır ve bunlar için Chang'ın geliştirmiş olduğu yöntem çözüm olarak kullanılmıştır.

Elde edilen sonuçları doğrulamak amacıyla "Superdecision" isimli programda aynı ağ yapısı oluşturulmuş ve program ile Eigen değerleri kullanılarak ANP çözümü elde edilmiştir. Elde edilen çözüm bulanıklık faktörünü içermemektedir. Tüm çalışmanın sonunda yapılan hesaplamalar ile çalışmada aynı ağ yapısı için üç farklı yönteme dair sonuçları karşılaştırma şansı elde edilmiştir.

Yapılan tüm hesaplamalardan sonra risk değerlerinin hesabı için; riskin gerçekleşme ihtimali ve olası sonuçlarının çarpımı hesapta kullanılmıştır.

Çalışmaya altı adet uzman davet edilmiştir, bunlardan iki tanesi klas kuruluşunda görevli, iki tanesi armatör firmada lng operasyonlarında çalışmış ve diğer iki tanesi ise lng sistemleri üreten bir firmada çalışmaktadırlar. Davet edilen tüm uzmanlar lng konusunda kendi bölümlerinde çalışmaktadırlar. Davet edilen uzmanlardan iki tanesi daveti olumlu cevaplandırmıştır. Bu uzmanlardan, oluşturulmuş olan ANP ağ yapısına göre önceden tanımlanmış anketleri doldurmaları istenmiştir. Her bir karar

verici için elde edilen final sonuçlar, Bireysel işlemlerin kümeştirilmesinde kullanılan AIP yöntemi ile tek bir karar vericiye indirgenmiştir.

Karar vericilerin kararları sonuç için birleştirilirken her bir karar vericinin sonuç üzerinde aynı derecede etkisi olmadığı yani ağırlıklarının farklı olduğu varsayılmıştır. Bu da her bir kullanıcı için elde edilen farklı ağırlıklar kullanılarak aynı yöntem içerisinde çözülmüştür. Karar vericilerin ağırlıklarını hesaplayabilmek için ufak bir ayrı ANP yapısı oluşturulmuş ve bu yapı çözülerek her bir karar vericinin ağırlığı elde edilmiştir.

ANP yapısının her bir küme ve küme elemanı için sonuçları incelendiğinde; ANP (logaritmik en küçük kareler yöntemi) ile ANP (Superdecisions) sonuçlarının birbirlerine çok yakın olduğu görülmektedir. Bunun sebebi Saaty ve Vargas'ın 1984 yılındaki çalışmalarında belirttikleri gibi muhtemelen tutarlılık oranının 0.1'in altında tutulmuş olmasından kaynaklanmaktadır. Daha büyük tutarlılık oranlarında çalışma tekrarlanıp değişim incelenebilinir. Ancak 0.1 altındaki değerlerde sonuçlar birbirine çok yakındır.

Bulanık-ANP sonuçları, logaritmik en küçük kareler ve eigen değerleri ile hesaplanan ANP sonuçlarından biraz farklılık göstermiştir. Ancak gözüken farklılık sonucu değiştirecek derecede büyük değildir. Bulanıklık fonksiyonların kullanılmasının sebebi bu farklılığın görülmesidir, ki bu beklenen bir sonuçtur. Burada dikkat edilemesi gereken bulanıklığın sonucu ne kadar oranda değiştirebildiğidir. Yapılan uygulamada üçgen bulanık fonksiyonlar kullanılmıştır, ileriki çalışmalarda daha farklı fonksiyonlar ile yeni hesaplamalar yapılarak diğer yöntemlerdeki sonuçlar ile olan farklılıklar karşılaştırılabilinir.

Yapılan çalışmalarda LNG kaçaklarının diğer belirlenmiş olan risk alternatiflerine gore daha tehlikeli olduğu gözükmektedir. Bunun sebebi LNG kaçaklarının diğer kaçak ve yangın risklerini içerisinde barındırmasından kaynaklanmaktadır.

1 INTRODUCTION

Our planet's 71% of the surface is covered by water. One of the main targets of the human being for development has always been dealing with the sea. There are places for gambling or taking a bit of a risk where probability theory works fine, but for sure the sea is not one of them. It is obvious that the sea is not a place for human to live and maritime history is full of many preventable catastrophic accidents. However historical evidences, beside all those accidents and failures, prove that human challenge the sea for a very long time with a remarkable success. This has been achieved by taking lessons from the failures and accidents.

Primary objective in marine industry has always been to select the lowest cost alternative, but the trends have changed towards the trade-off among safety, cost, environment and technical performance. The last decade many environmental regulations have entered into the force for maritime transportation and many are prepared for the next decade. Air pollution is one of the main environmental items, there is a couple of "Emission Control Area (ECA)"s around the world and many new of them are on the agenda. Using conventional marine fuels such as Heavy Fuel Oil (HFO), Marine Diesel Oil (MDO) in most of the ECA ports is forbidden, instead new MDO with low sulfur content has already been in the market for a while. New rules and regulations put into the force new restrictions on fossil fuels. Liquefied Natural Gas (LNG) has come up as a good and applicable solution for marine transportation. LNG is a cheaper and environmental friendly solution beside current marine fuel types. LNG has already been used for decades as marine fuel in big LNG carriers, by using their own cargo's boil-off gases, those ships normally perform their loading and discharging operations away from public life. However, using LNG in other type of ships, travelling all around the ports close to public life, is a new challenge for public, governments, International Maritime Organization (IMO), classification societies, designers and ship owners. As per IMO "International convention for the safety of life at sea" using fuels with low flashpoints are prohibited. After many research projects, in 2015, IMO Maritime Safety Committee (MSC) adopted new "International Code of Safety of Ships Using Gases or Other Low Flashpoint Fuels" (IGF Code), expected to enter into the force on 1sth of January, 2017 with new SOLAS amendments. However, several ships are sailing in

international waters and many of them are under construction with special exemptions from flag authorities using LNG or dual-fuel (LNG and HFO/MDO). Specific risk study methods have been applied to convince the flag authorities. Risk studies are very well known and often used in offshore industry, however marine industry is not very familiar with them. Most of the classification societies have rules, regulations and guidelines to implement risk based inspection techniques, unfortunately they are rarely used during ship inspections.

It is quite clear that LNG will be the future fuel for marine transportation and marine industry, therefore the systems for LNG should be developed according to the new conditions. In 2016 three oil/chemical tankers, one asphalt carrier and two roll on – roll off ferries with dual-fuel engines are under construction in Turkiye. With the permission and attendance of the flag authority representatives, hazardous identification (HAZID) and hazard and operability studies (HAZOP) have already been performed. According to those studies it has been concluded that the most challenging part of using and carrying LNG is the bunkering.

1.1 Scope and Limitations

Based on the risk studies; “LNG bunkering operation” is selected as the risk problem for this study. Six experts (2 from LNG systems manufacturer company (Italy), 2 experts from classification society (France), 2 owner representative (Canada)) who have experience on LNG systems on board and have attended the LNG studies for ongoing projects, are asked to participate. HAZID/HAZOP study results are present as group decision, the risk items are not exactly unique however by using questionnaire for each expert, it has been also possible to observe the difference between the group’s and each individual experts’ decision. Due to the limited statistical data, qualitative risk analysis method is used to review the problem. Fuzzy-Analytical Network Process (ANP) decision making method is chosen to calculate the priorities of experts and aggregate the total solution.

There may be three cases for bunkering operation, those are;

- Ship to ship transfer
- Truck to ship transfer
- Shore facility to ship transfer

Ship to ship LNG transfer is a new concept and needs some more time to develop new rules and regulations. Today there are very limited number of LNG bunkering (ship to ship) vessels under construction. LNG transportation and LNG

loading/discharging from shore facility has been done for decades and it has already proved its reliability. Today most of the LNG bunkering for non LNG carriers are done by trucks. That is why, truck to ship transfer bunkering case is considered in this study.

Several decision making methods examined and fuzzy-ANP method has selected. ANP is a reliable method to model complex problems while fuzzy sets are flexible for defining pairwise comparisons.

2 LITERATURE REVIEW

Decision making is not only human problem that everyday can be faced all life forms and decision making results people to live or die. Historically, human decision theories have focused on outcome prediction. Modern decision making is based on; understanding of decision making processes, thoughts and application of technology tools to support process by human beings.

In earlier times, society leaders consulted their elders for the result of choices, elders replaced by the fortune tellers, wizards, astrologists, religious figures in time and nowadays they may be called as manager consultants. People used dices, bones, stones and many other objects to predict the results of their choices. Julius Caesar's famous words, taken from Menander (Greek comedy writer), "the die is cast" or may be a better translation "the die has been cast" on his armies way to Rome before they pass the River Rubicon (Tranquillus, AD 121). He selected his choice from his alternatives, most probably it was checked by his dices and now die is cast and fortune is set. Dices luckily is not needed as well as bones, fortune tellers or any other figures. The better decisions can be made by couple of researchers and thousands of applications.

2.1 Risk Management

ISO 31000 Risk management – Principles and guidelines; is a standard to provide principles for managing risks (ISO, 2009). According to this document, risk is the effect of uncertainty on objectives and risk management is the coordinated activities to direct and control an organization with regard to risk.

The main element of risk management is stakeholders; communicating and consulting stakeholders is generally done by using brainstorming, Delphi or similar methodologies in order to increases the efficiency of the process. Managing risk starts with scope and context definition, this stage draws the borders of the study, includes internal and external contexts. After finalizing scope definition, risk assessment is the next stage that is defined in detail under Section 2.2. Risk treatment is the last step of risk management, uses the output of risk assessment, especially risk matrix. Treatment stage is decision stage, here results of analysis are

compared to the risk criteria. Risks may be positive or negative, depending on the nature of the system.

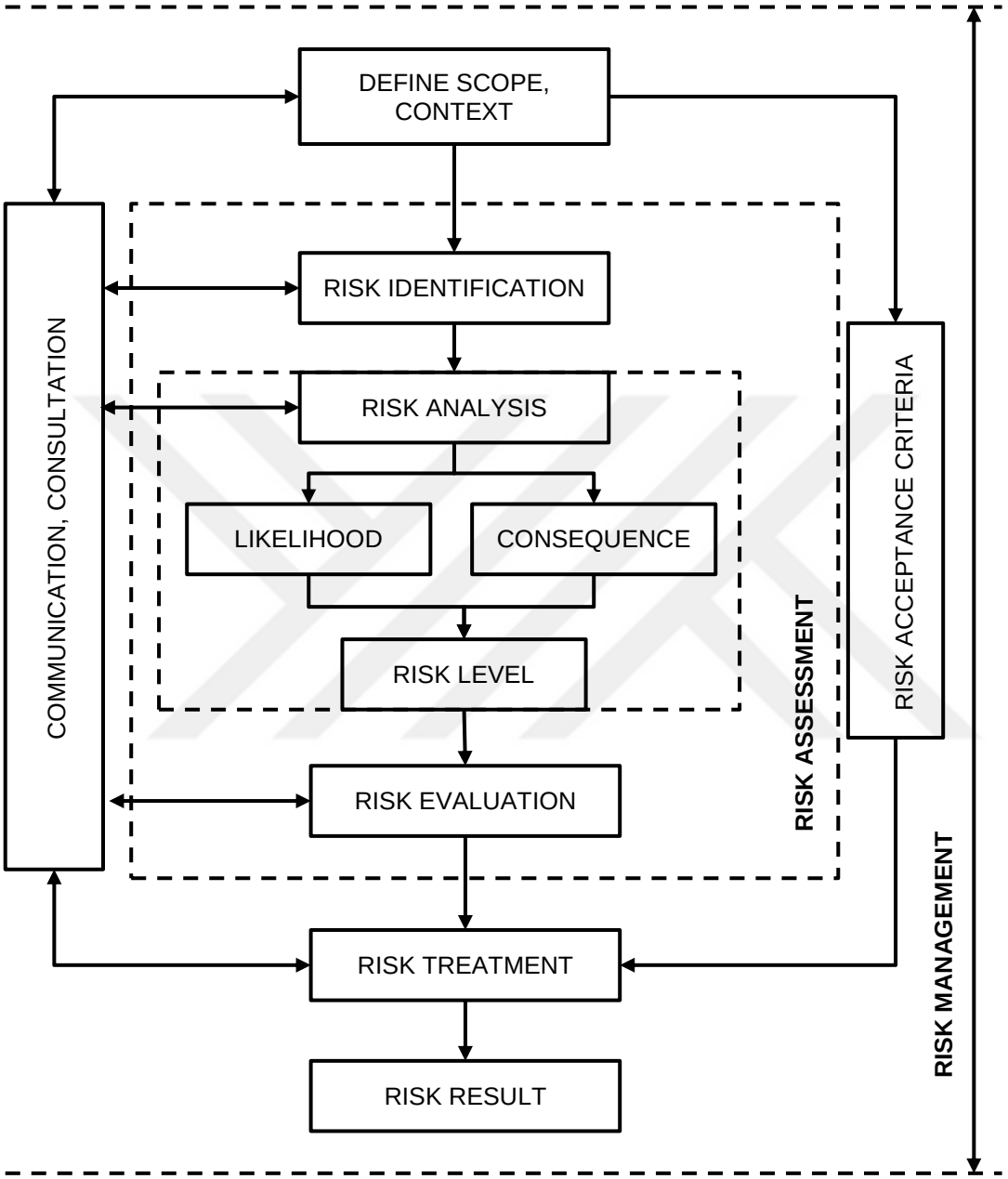

Figure 2.A: Risk Management Steps.

Risk management process should be monitored and reviewed in time, to eliminate new emerging risks.

Ineffectual methods may even be touted as “best practices” and, like a dangerous virus with a long incubation period, are passed from company to company with no early indicators of ill effects until it’s too. Main question is; would anyone in the organization even know if risk management method didn’t work? A weak risk

management approach is effectively the biggest risk in the organization (Hubbard, 2009). That is why, the risk management process has to be tailor made in order to cope with each particular case and project in an organization. Best practices are not always, even good ones.

2.2 Risk Assessment

“Risk is a construct, before risk there was fate” (Bernstein, 1996). During the transformation from ancient to the modern world; fate has transformed to a calculable value in terms of risk. Today risk may be defined as potential of gaining or losing something in value and because of this potential is uncertain, it may also be defined as measurable of uncertainty.

Life itself is full of uncertainty, in every single moment of life, decisions are being made to shape the life itself. Risks are not always negative, there may be some cases, especially in marketing or financial business, for positive risks, because the nature of these risks include hazards and opportunities at the same time. In this study only negative risks are dealt with. Understanding the risks, by using risk assessment is the main step of managing the risk. ISO/IEC 31010:2009 Risk management – Risk assessment techniques is a supporting standard for ISO 31000 Risk management – Principles and guideline. ISO/IEC 31010:2009 is a generic risk management standard, containing guidance on how to select and apply systematic techniques for risk assessment. This document contains more than 30 techniques, some are; brainstorming, interviews, checklists, Structured what-if technique (SWIFT), scenario analysis, fault tree analysis, bow tie analysis, Delphi method, Hazard and operability study (HAZOP), Failure mode and effects analysis (FMEA), event tree analysis, cause and effect diagrams, human reliability analysis, Monte Carlo simulation, risk index etc.

The success is methodology depended, however the main component of all analysis methods is human. Whatever the method is used, knowledge of experts, their understanding of problem and their position to view the risk will directly affect the result. In order to get proper assessment results, problem has to be thought from all sides of aspect.

The reason of the importance of the design of the solution set is not only because of the human factor but also modeling the reality of the problem. The model shall reflect the truth and based on the model, the chosen method shall reflect the true decisions of the decision makers.

Risk assessment consists of three main parts as shown in Figure 2.B.

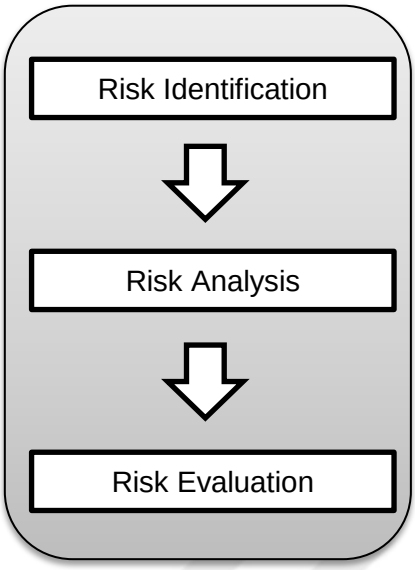

Figure 2.B: Risk Assessment.

Questions that define risk assessment items are also shown in Figure 2.C.

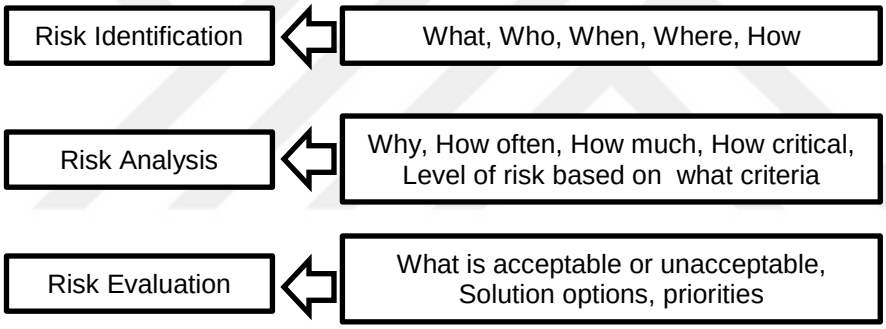

Figure 2.C: Defining Risk Assessment Items.

2.2.1 Risk identification

Risk identification phase tries to recognize and record risks by asking them main question “what might happen?”. After the answer is given to the main question, causes and sources of risks are identified by using other questions mentioned in Figure 2.C. Evidence methods such as historical data, checklists, expert methods such as brainstorming, Delphi or inductive reasoning techniques such as HAZOP, Primary hazard analysis (PHA), event tree, etc. All these methods may all be used depending on the nature of the problem.

A table of risk assessment techniques based on ISO/IEC 31010:2009 Risk management – Risk assessment techniques, which may be applied for risk identifications is listed as Table 2.1. Table indicates the methods as “strongly applicable” and “applicable”.

Table 2.1: Risk identification methods.

Methods listed as "strongly applicable" by the standard

- Brainstorming
- Structured or semi-structured interviews
- Delphi
- Checklists
- Primary hazard analysis
- Failure mode effect analysis
- Reliability centered maintenance
- Consequence/probability matrix
- Hazard and operability studies (HAZOP)
- Hazard analysis and critical control points (HACCP)
- Environmental risk assessment
- Structure what if (SWIFT)
- Scenario analysis
- Cause and effect analysis
- Human reliability analysis

Methods listed as "applicable" by the standard

- Business impact analysis
- Fault tree analysis
- Event tree analysis
- Cause and consequence analysis
- Layer protection analysis (LOPA)
- Sneak circuit analysis
- Markov analysis
- FN curves
- Risk indices
- Cost / benefit analysis
- Multi-criteria decision analysis (MCDA)

2.2.2 Risk analysis

Risk analysis is the second phase of risk assessment, helps us to develop and understand risk. Nature, sources and causes of risks are analyzed in order to define or estimate the level of consequence and likelihood for each defined risk hazard. Each consequence and likelihood are then combined to define the level of risk. Analysis may be done by qualitative, semi-quantitative or quantitative methods, method should be selected depending on the nature of the problem and available data. Different methods may be used to define likelihood, consequence and level of risk. As an example; fault tree analysis may be used while defining likelihood, while consequences may be defined by FMEA.

At the end of the analysis phase, the strength and weakness of the system and process will be defined.

2.2.3 Risk evaluation

In evaluation phase, risk criteria, defined at the beginning within context, is compared with risk level results from risk analysis phase. Risk is understood in analysis phase and in evaluation phase decisions for future action is made. Main item to decide is; whether risk level need treatment or not. Cost - benefit analysis (CBA) or more detailed Benefits, opportunities, costs, risks (BOCR) analysis are used to support the decision. It is usually not cost-effective to treat all risks that is why prioritization of chose treatments is needed. Risk evaluation is the last step of

risk assessment, output of this phase are; risk levels and items to be treated including their priority order. Choice will be done in next step, risk treatment section.

2.3 Risk Treatment

Risks are not always negative, there may be some cases that risks may cause opportunities, however in this study only negative risks are considered. List of items that needs to be treated, their priority order are inputs coming from risk assessment and risk criteria defined within the context, at the beginning of the study is another input for this phase. Selected treatment alternatives based on agreement of the experts are to be implemented. Treatment of risks can be done by one of the following four methods;

- Accepting risk; done by taking no action. In this method risk and it's consequences accepted. Generally performed for small risks.
- Avoiding risk; for major risks, changing the game plan to avoid the defined risk is one of the best way to follow.
- Transferring risk; not used commonly. Idea is to transfer the impact and management of risk to someone else, insurance is a good example for this method.
- Mitigating risk; the most common way to deal with risks. Taking precautions to reduce the likelihood or severity of loss is all risk mitigation.

2.4 Multiple Criteria Decision Making Methods

Decisions made draw the path of life, decisions shapes the life. Every decision has its own consequences. There are many decision making methods in the open literature.

Multiple criteria decision analysis is a discipline that finds solution to the problems structured on multiple criteria. Depending on the nature of the problem one of the two sub-disciplines of Multiple criteria decision analysis (MCDA) has to be used, these are;

- Multi attribute decision making (MADM)
- Multi objective decision making (MODM)

Multi attribute decision making deals with the problems that makes decision among some pre-defined alternatives in the presence of multiple, generally conflicting attributes.

Multiple objective decision making deals with the design problems that cope with finding the best alternative by considering a set of interacting design constraints, no decision alternative is present in the model which also means number of alternatives is effectively infinite.

Multi attribute decision making is the most well-known branch of multiple criteria decision making method. MADM problems are assumed to have a predetermined, limited number of alternatives. Solving a MADM problem involves in sorting and ranking of alternatives.

Some of the MADM methods are; Maximin, Maximax, Weighted Product, Technique for order of preference by similarity to ideal solution (TOPSIS), Elimination et choix traduisant la réalité (ELECTRE), Analytical Hierarchy Process (AHP), Analytic Network (ANP), etc.

One of the first critical work about decision making was published by Saaty (1977). In this paper, method of scaling ratios using the principal Eigen vector and pairwise comparison matrix is described. Consistency of the matrix data is defined and measured by an expression involving the average of the non-principle Eigen values. 1 to 9 scale numbers are introduced together with a discussion of how it compares with other scales. Application of some examples for which the answer is known, presented for validating the approach. The hierarchy of multiple criterion decision making, properties of hierarchies and the Eigen value approach application to scaling hierarchically structured complex problems are also presented in this study. Saaty and Vargas (1984) published two different papers about dealing with the inconsistency and rank reversal situations. In these studies conditions for rank preservation in a positive reciprocal matrix that is inconsistent are provided and three methods; the Eigen value, the logarithmic least squares, and the least squares, examined to derive estimates of ratio scales from a positive reciprocal matrix. It is shown that only the principal Eigen vector directly deals with the question of inconsistency and captures the rank order inherent in the inconsistent data.

Another game changing method has also been presented by Saaty (1996), in this study, instead of hierarchical structure a network system used to define the decision problem.

In Table 2.2 a review of AHP and ANP as decision making tools are given.

Table 2.2: List of main AHP/ANP Studies.

Year	Researcher	Concept of the study
1977	T.L. Saaty	Method of scaling ratios using the principal Eigen vector, pairwise comparison matrix is described and consistency of the matrix data is defined
1979	B.G. Merkin	Defines mathematical structure of consistent matrices and eigenvector's ability to generate true or approximate weights
1980	T.L. Saaty	The Analytical Hierarchy Process defined
1984	T.L. Saaty & L.G. Vargas	Comparison of Eigenvalue, Logarithmic Least Squares and Least Squares Methods in Estimating Ratios
1984	T.L. Saaty & L.G. Vargas	Inconsistency and Rank Preservation
1986	T.L. Saaty	Axiomatic Foundations of the Analytical Hierarchy Process
1987	T.L. Saaty	Rank Generation, Preservation and Reversal in the Analytical Hierarchy Decision Process
1996	T.L. Saaty	The Analytic Network Process defined
1998	T.L. Saaty & L.G. Vargas	Bayes' Theorem and the Analytical Hierarchy Process
2003	T.L. Saaty	Dynamic decision making; defines using functions for the paired comparisons and derive functions from them. This describes a new powerful tool.
2005	T.L. Saaty & M.S. Özdemir	Dictionary of Decisions using ANP
2009	T.L. Saaty & B. Cillo	Dictionary of Complex Decisions using ANP

In the study named "Fuzzy Sets", Zadeh (1965) introduced fuzzy sets as an extension of the classical notion of sets. Later this idea is used in many methods to model and solve fuzzy problems. Zimmerman, Zadeh and Gaines (1984), Zimmermann (1986, 1987) issued studies about using fuzzy sets in decision making problems. Using hybrid methods idea first came up with Van Laarhoven and Pedrycz (1983) triangular membership functions used to describe fuzzy ratios which have been used to make comparisons in AHP. Buckley (1985), Mon and Cheng (1985) and Chang (1986) introduced formed important methodologies to solve hybrid fuzzy AHP problems.

In Table 2.3 some of the important fuzzy and fuzzy AHP/ANP hybrid studies are listed.

Table 2.3: List of Fuzzy Logic and Fuzzy-AHP/ANP Studies.

Year	Researcher	Concept of the study
1965	L.A. Zadeh	Description of fuzzy sets
1970	R.E. Bellman & L.A. Zadeh	Decision making in a fuzzy environment
1977	M.S. Baas & H. Kwakernaak	Rating and Ranking of Multiple-Aspect Alternatives Using Fuzzy Sets
1978	R.R. Yager	Mathematical solution method for fuzzy
1978	W.J.M. Kickert	Fuzzy theories to use for decision making
1983	P.J.M. Van Laarhoven & W. Pedrycz	Adopting fuzzy methods for Saaty's theory
1984	H.J. Zimmermann & L.A. Zadeh & B.R. Gaines	Use of fuzzy sets in decision making analysis
1985	J.J.Buckley	Method to use fuzzy ratios instead of exact ratios in AHP, uses geometrical mean to calculate mean fuzzy ratios
1986	H.J. Zimmermann	Solving fuzzy set models for crisp environments
1987	H.J. Zimmermann	Extend of his previous issue
1995	D.L. Mon & C. Cheng	Definition and application of Cheng's method for fuzzy AHP problem
1996	D.Y. Chang	Definition and application of Chang's method for fuzzy AHP problem

In this study ANP and hybrid fuzzy model fuzzy-ANP are described and used.

2.4.1 Pairwise comparison

Pairwise comparisons using ratio scales was developed by Saaty (1980). According to Saaty's study decision problems are structured into smaller parts in a hierarchical structure and each small structure is handled by pairwise comparison matrices. Pairwise comparisons are always a more precise way of establishing priorities for alternatives than rating them at once and real data and statistics representing probabilities and likelihood can also be used in relative form instead of making pairwise comparisons in the ANP as they are in AHP (Saaty,2005). The

mathematician and cognitive neuropsychologist Stanis Dehaene states in his book “The number of sense, how the mind creates mathematics” that introspection suggests that we can mentally represent the meaning of numbers 1 through 9 with acuity (Saaty, 2005). Table 2.4 indicates the comparison scale with definition. These symbols seem equivalent to us and this makes them easy to work with. However there may be a problem in pairwise comparisons; inconsistency. In life, inconsistency helps us to change our minds in case a new information that contrast with previously known consistent knowledge. This helps the human to move forward. Unfortunately too much inconsistency unsettles human thinking. According to Saaty this means that; inconsistency must be large enough to allow for change in our consistent understanding, but small enough to make it possible to adapt our old beliefs to new information. 10% of the total concern with consistent measurement will provide enough inconsistency for pairwise comparisons. Calculation of inconsistency is described under Section 2.4.3.

Pairwise comparisons are always a more precise way of establishing priorities for alternatives that rating them one at time (Saaty, 2005).

Table 2.4: Fundamental Scale for Pairwise Comparison.

Intensity of importance	Definition
1	Equal importance between two objectives
3	Moderate importance of one objective over the other
5	Strong importance of one objective over the other
7	Very strong importance of one objective over the other
9	Extreme importance of one objective over the other
2, 4, 6, 8	Intermediate values

2.4.2 Solving matrices

Different methods have been defined to solve pairwise comparison matrices. Saaty (1977) defined a method to solve the pairwise matrix, eigenvectors are suggested. It is concluded that if inconsistency is allowed in a positive reciprocal pairwise comparison matrix, the principal eigenvector is necessary for representing the

priorities associated with that matrix, providing that the inconsistency is less than or equal to a desired value (Saaty, 2003).

Suggested methods for solving matrices are listed as follows;

- Eigenvector method
- Least squares method
- Logarithmic least squares method

Saaty and Vargas (1984) presented a study for comparing the results of these methods. It is concluded in this study that when consistency obtains, three methods produce identical solutions, however when there is inconsistency in the data, the best solution is to use eigenvector method. In order to use other methods mentioned either inconsistency should be accepted or reduced by improving the quality of information as described under Section 2.4.1.

2.4.3 Dealing with inconsistency

In reality consistency helps us to change our minds in terms of new information. Too much consistency is undesirable because we are dealing with human judgments.

Evaluation of rating inconsistency is done by calculating Consistency Ratio (CR), to measure how consistent the judgments have been relative to large samples of purely random judgments which are calculated and indexed by Saaty (1980) given in Table 2.5. In order to calculate CR, Consistency Index (CI) is divided by mean random CI.

$$CR = \frac{CI}{mean\ random\ CI} \quad [1]$$

λ_{max} is the maximum eigenvector of pairwise comparison matrix and n is the size of the matrix then the CI is calculated as below:

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad [2]$$

Table 2.5 represents the mean random consistency index values calculated by Saaty, first row represents the size of the matrix while second row is the corresponding index of consistency for random judgments.

Table 2.5: Mean Random Consistency Index.(Saaty, 1980)

3	4	5	6	7	8	9	10	11	12	13	14
0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57

Saaty(1980) represents the acceptable threshold value for CR as 0.10, according to his studies values over this threshold values indicates that comparison is inconsistent and has to be re-evaluated.

In a complex system having too many pairwise comparison may result to lose the consistency. Psychologists suggest to ranking criteria before making pairwise comparison, and believe that this might reduce inconsistency.

2.4.4 Rank reversal

Rank reversal phenomenon occurs when a decision maker, makes decision from a set of alternatives and, is confronted with new alternatives that were not thought about when the selection process was initiated. For instance three alternatives are considered in a decision making problem; X, Y, Z. And according to pairwise comparisons it has been figured out that X is better than Y, Y is better than Z. If a new alternative, T, which is not better than Z is replaced with alternative Y, it has been observed that under some circumstances the previously ranked as best alternative X, is not still the best one. This condition is known as rank reversal, this example only describes one type of rank reversal, there are some others in the literature.

Decision making community has no consensus on rank reversal, whether or not it shall be prevented.

There are two different modes used in common;

- Ideal mode using weighted product method
- Distributed Synthesis mode using weighted sum method

Ideal mode introduced by Forman (1993) as an alternative synthesis to Saaty's original AHP which is proved that allowing rank reversal.

2.4.5 Group decision making

In group decision two things may happen, either members engage in discussion to get a consensus or express their own preferences. These conditions are named, in order;

- Aggregation of individual judgments (AIJ)
- Aggregation of individual priorities (AIP)

When synthesizing the judgments of n judges below listed conditions shall be considered.

- Pareto principle (unanimity condition); if members of a group prefers alternative A to B, then the synthesized judgment shall prefer A to B.

$$f(x, x, \dots, x) = x \quad [3]$$

- Homogeneity condition; if each members of a group judge a ratio Y times as big as another ratio, then the synthesized judgment shall also be Y times bigger.

$$f(Y * x_1, Y * x_2, \dots, Y * x_n) = Y * f(x_1, x_2, \dots, x_n) \quad [4]$$

Where $Y > 0$

- Reciprocity requirement; synthesized value of the reciprocal of the individual judgments shall be the reciprocal of the synthesized value of the original judgments.

$$f\left(\frac{1}{x_1}, \frac{1}{x_2}, \dots, \frac{1}{x_n}\right) = \frac{1}{f(x_1, x_2, \dots, x_n)} \quad [5]$$

Aggregation of individual judgments (AIJ);

If the group members are not willing to act on their own preferences and instead members are willing to pool their judgments, then the group becomes a new individual and behaves like one, having a common decision. Thus, Pareto principle is irrelevant. Since the group becomes a new individual and behaves like one, the reciprocity requirement for the judgments has to be satisfied, in that case geometric mean must be used instead or arithmetic mean.

In that case, each group member performs own pairwise comparison then using the below formula, a unique group matrix and priorities vector are produced. By solving this matrix solution for the group decision has been found.

$$a_{ij}^{[G]} = \prod_{k=1}^{r} \left(a_{ij}^{k}\right)^{\beta_k} \quad [6]$$

$$w^{[G]} = \prod_{j=1}^{n} \left(a_{ij}^{[G]}\right)^{1/n} \quad [7]$$

$a_{ij}^{[G]}$ the group matrix

a_{ij}^{k} pairwise comparison matrix of "k"th member

r number of group members

β_k is weight of the "k"th group member

$i, j \in \{1, n\}$ is matrix size

$w^{[G]}$ group priority vector

Aggregation of individual priorities (AIP);

If the group members are willing to act on their own preferences without pooling their judgments. In this case the problem is solved for each member individually to get their own priorities. Both arithmetic and geometric means may be used, neither method will violate Pareto principle. Formulation is given below.

$$w_i^{[k]} = \prod_{j=1}^{n} \left(a_{ij}^{[k]}\right)^{\frac{1}{n}} \quad [8]$$

$$w_i^{[G]} = \prod_{k=1}^{r} \left(w_i^{k}\right)^{\beta_k} \quad [9]$$

$w_i^{[G]}$ group priority vector, r number of group members,

$i, j \in \{1, n\}$ is matrix size

a_{ij}^{k} pairwise comparison matrix of "k"th member,

β_k is weight of the "k"th group member

$w_i^{[k]}$ priority vector of "k"th member

Geometric and arithmetic means with expert weights;

f(X) is the decision function, subscript *A* and *G* represents arithmetic and geometric means in order, β_k is the expert weight, n is the number of experts and X_i is the

decision of each expert. Arithmetic and geometric means with expert weights are calculated as given below.

$$\sum_{k=1}^{n} \beta_k = 1 \; and \; \beta_k > 0 \qquad [10]$$

$$f(X_1, X_2, X_3, \dots, X_n)_A = X_1 * \beta_1 + X_2 * \beta_2 + \cdots + X_n * \beta_n \qquad [11]$$

$$f(X_1, X_2, X_3, \dots, X_n)_G = X_1^{\beta_1} * X_2^{\beta_2} * X_3^{\beta_3} * \dots * X_n^{\beta_n} \qquad [12]$$

2.4.6 AHP versus ANP

AHP and ANP are two models introduced by Saaty (1980 and 1996). Both models may contain qualitative and quantitative components. Unlike ANP, AHP has hierarchical structure and only applicable to a hierarchical problems that have uni-directional (top to bottom) relation between decision levels. Pairwise comparisons are used to measure the relative importance of the model components. ANP is a generic form of AHP but provides more accurate model to define more general decision problems than AHP. The reason for that is the network structure used which allows feedback and dependence at the same time and provides bi-directional relation.

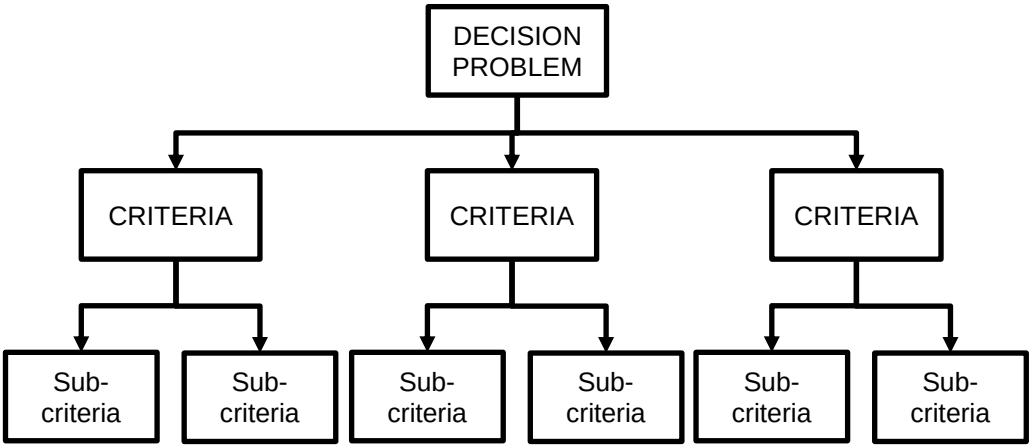

Figure 2.D: AHP Structure

Figure 2.D is a sample AHP structure, top to bottom decision problem, criteria for the problem and sub-criteria for the each criteria indicated. In the hierarchical structures like that each criteria are to be pairwise compared with other criteria with respect to the decisions. Sub-criteria for each criteria are to be pairwise compared

with respect to the criteria itself. Final priorities are to be calculated according to section 2.4.5, depending on the nature of the decision problem.

Network structures help the user to define the decision structure more accurately. According to Saaty; the world is far more interdependent than we know how to deal with using our existing ways of thinking and acting. The ANP is our logical way to deal with dependence. A general ANP network structure is presented in Figure 2.E. Clusters, nodes, inner and outer dependences are illustrated. Inner dependence means nodes in a cluster are depended to other nodes in the same cluster. Similarly outer dependence means one cluster (nodes under this cluster) is depended on other the cluster (nodes in the depended cluster).

It is important to realize that the decision problem should be understood well in order to form a realistic hierarchy or network structure, whatever the method is used results will be based on the structure.

Outline steps of ANP are listed below;

1. Describe the problem in detail, understand the objectives
2. Determine the control criteria
3. Create the general network of clusters, organize clusters and nodes
4. Determine inner and outer dependencies
5. Perform pairwise comparisons based on dependencies with respect to relevant control criteria
6. Calculate priorities of each comparison
7. Form super matrix using priorities
8. Use cluster weights to form weighted super matrix
9. Limit the weighted super matrix

Table 2.6: Pros and Cons of ANP over AHP

PROS	CONS
More creative, more flexible, no restriction to form the structure in a hierarchical order	Problem is more complex, providing correct network structure needs expertise
Model is more natural, more complex, includes more realistic influences	Takes more time and effort to determine the system variable and their relations
Permits to apply inner dependencies, feed back	
More objective results	Require more calculation

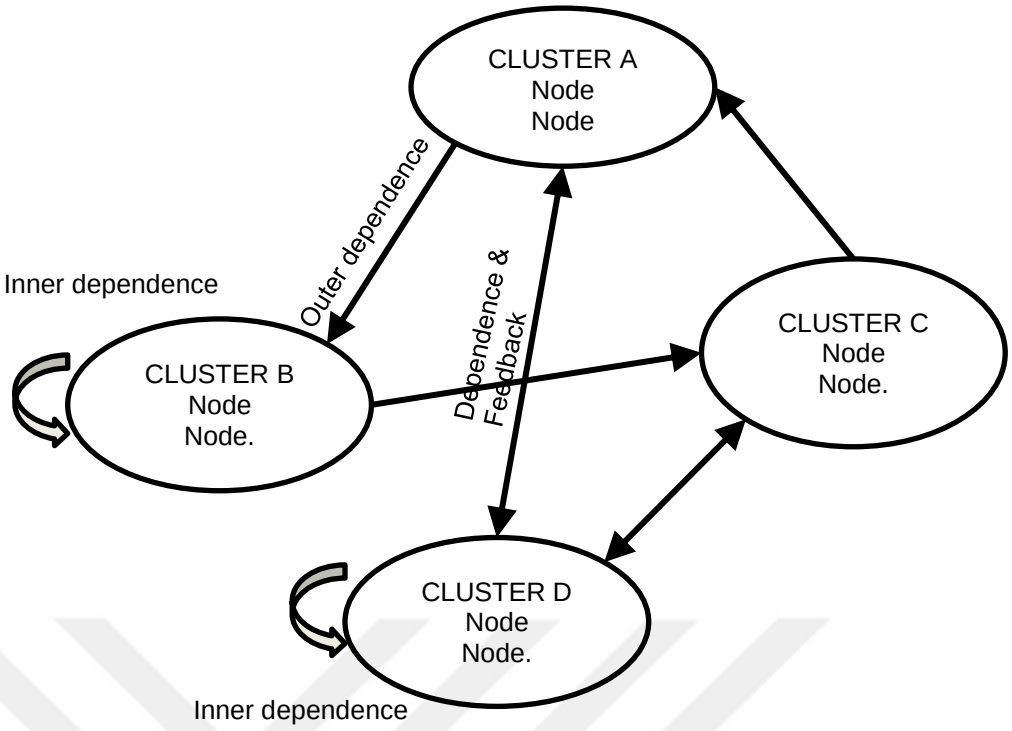

Figure 2.E: ANP Network Structure

Table 2.6 indicates some basic advantages and disadvantages of ANP over AHP.

2.4.7 Fuzzy-ANP and ANP comparison

Probability theory is a sub-set of Fuzzy Logic theory. Fuzzy logic's concept is to define how much a variable is in a set. Notwithstanding, probability uses the concept of subjective definitions to define how probable the variable is in a set. Traditional risk models are based on probability and classical set theory. They are widely used for assessing market, credit, insurance and trading risk. In contrast, fuzzy logic models are built upon fuzzy set theory and fuzzy logic, and they are useful for analyzing risks with insufficient knowledge or imprecise data. The fundamental difference between traditional set theory and fuzzy set theory is the nature of inclusion of the elements in set. In traditional sets, an element is either included in the set or is not. In a fuzzy set, an element is included with a degree of truth normally ranging from 0 to 1. Fuzzy logic systems include rules that explicitly explain the linkage, dependence and relationships among modeled factors. It is helpful for identifying risk mitigation solutions. A key feature of fuzzy sets is that there are no hard rules about how their membership functions are defined. Both mathematical form of the function and the parameters depend on the input from the experts. As long as the membership functions are consistent, on a comparative basis, the conclusion based on fuzzy sets is still meaningful (Shang K., Hossen Z., 2013).

The reason behind the usage of fuzzy-ANP instead of ANP is to avoid uncertainty in judgments. Fuzzy set theory has the capability of representing vague data. It is not always easy to transform judgments, during pairwise comparisons into numerical values. The idea is to use references within a reasonable interval instead of restricted comparison value.

However when decision data are precisely known, they should not be placed into a fuzzy format in the decision analysis (Karaman, 2008).

2.4.8 Fuzzy-ANP methodology

Several algorithms developed to incorporate Saaty's methods with fuzzy comparison ratios. Important ones are listed below as reference. All of them are providing solutions for fuzzy-AHP, because of the methodology all can be applied to fuzzy-ANP as well.

- Van Laarhoven and Pedrycz's approach (1983)
- Buckley's Fuzzy-AHP (1985)
- Chang's extent analysis method (1992)
- Cheng's entropy-based Fuzzy-AHP (1996)

Steps to solve a Fuzzy-ANP model is as follows;

1. Understand the problem and structure the network, define clusters and sub-clusters
2. Identify dependencies (inner and outer)
3. Define fuzzy membership function and conversion scale
4. Establish pairwise comparisons using fuzzy judgment
5. Check consistency index of each comparison
6. Using selected algorithm calculate relative important weights
7. Create un-weighted super matrix
8. Using weights generate weighted super matrix
9. Limiting the super matrix
10. Aggregating the weights of criteria and scores of alternatives to get final priority vector

2.4.9 Chang's extent analysis methodology

This methodology is based on taking each object and perform extent analysis for each goal. Method uses triangular function definition as fuzzy number sets. Two decisions are shown as fuzzy number sets in Figure 2.F.

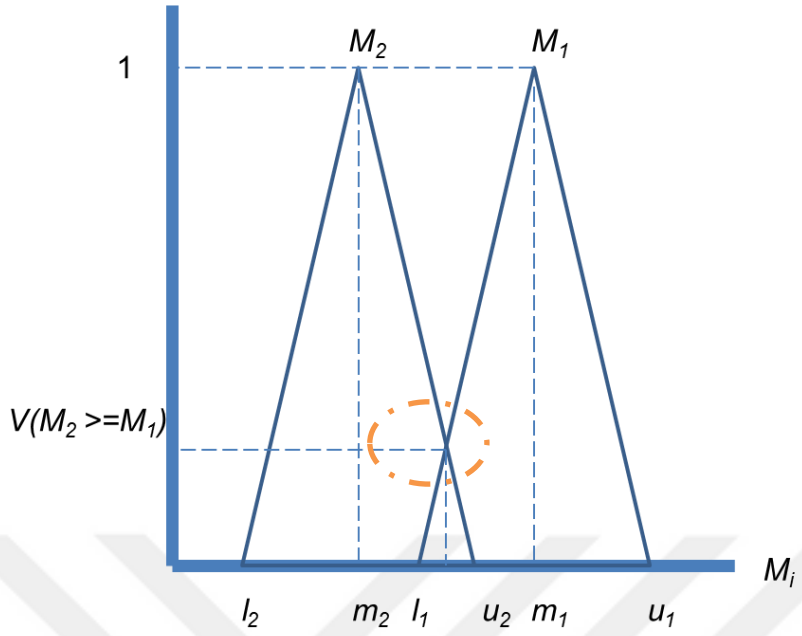

Figure 2.F Triangular fuzzy number intersection

M_1 and M_2 are fuzzy numbers for each fuzzy function where *l, m, u* are the values for triangular fuzzy scale. The highest intersection point between two membership functions $f(M_1)$ and $f(M_2)$ is marked on the figure. The values of degrees of possibilities $V(M_2>=M_1)$ and $V(M_1>=M_2)$ are to be calculated to compare fuzzy numbers M_1 and M_2. The degree of possibility (height of the intersection point); $M_2(l_2, m_2, u_2) >= M_1(l_1, m_1, u_1)$ is then defined as below;

$$V(M_2 \geq M_1) = \begin{cases} 1 & if\ m_2 \geq m_1 \\ 0 & if\ l_1 \geq u_2 \\ \dfrac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_{1)}} & else \end{cases} \quad [13]$$

The minimum degree of possibility for a fuzzy number *M* is to be greater than *n* fuzzy numbers M_k *(k=1,2,..n).* Normalized vector of these fuzzy numbers will be the non-fuzzy value.

$$V(M \geq M_1, M_2, M_3, .., M_n) = V(M \geq M_1)\ and\ V(M \geq M_2) \ldots V(M \geq M_n) = minV(M \geq M_k) \quad [14]$$

Assuming that weighted vector

$$d'(AT_k) = minV(M \geq M_k) \quad [15]$$

Then normalized non-fuzzy value will be

$$W = (W_1, W_2, \ldots, W_k)^T \quad [16]$$

2.4.10 Scales used in comparisons

Scales used in ANP, Fuzzy-ANP for both likelihood and consequences are shown in Table 2.7.

Table 2.7: Scales for pairwise comparison

LIKELIHOOD SCALE	CONSEQUENCES SCALE	ANP SCALE	TRIANGULAR FUZZY SCALE
EXTREMELY STRONG	EXTREMELY STRONGER	9.0000	7,8,9
VERY STRONGLY	VERY STRONGER	7.0000	5,7,9
STRONGLY	STRONGER	5.0000	3,5,7
MODERATE STRONGLY	MODERATE STRONGER	3.0000	1,3,5
EQUALLY	EQUAL	1.0000	1,2,3
MODERATE WEAKLY	MODERATE WEAKER	0.3333	0.2,0.3333,1
WEAKLY	WEAKER	0.2000	0.1429,0.2,0.3333
VERY WEAKLY	VERY WEAKER	0.1429	0.1111,0.1429,0.2
EXTREME WEAKLY	EXTREME WEAKER	0.1111	0.1111,0.125,0.1429

3 CASE STUDY

Risk analysis of LNG bunkering operation from truck to ship is selected as case study. Bunkering operation work breakdown structure created and this structure has been checked with American Bureau of Shipping (ABS, LNG Bunkering advisory), Bureau Veritas (BV, Guidelines on LNG bunkering) and Det Norske Veritas (DNV, LNG bunkering study) bunkering operation guidelines. Main risks defined and grouped according to the HAZID/HAZOP studies, carried out for LNG powered dual-fuel ships that are under construction in Turkiye.

Six experts; two from LNG system manufacturer, two from owner side LNG operation responsible and two from classification society LNG expert engineers selected as expert group. They are asked to fill in the questionnaire presented in APPENDICES D: .

Risk matrix is created by using likelihood and consequences of each risk factor. Data from the questionnaires used in two different ways to generate this matrix; the first one is ANP and the second one is fuzzy ANP. ANP method is solved using Saaty's "Super Decisions" software, two exactly similar models used to calculate likelihood and consequences. Priorities of fuzzy ANP method is calculated by using excel macros and functions. Thus, it is possible to compare two different methods with the same input data. At the end HAZID/HAZOP group study result has also been compared with these results obtained from questionnaires.

3.1 Safety and Environmental Issues of LNG

LNG is natural gas in liquid form. Natural gas is cooled down to its boiling value minus 162˚C to get liquid form. In liquid form 600 cubic meters of natural gas is stored in 1 cubic meters. LNG is composed almost exclusively of methane. It weighs about 45% that of water, so it floats on water. LNG is odorless, colorless, non-corrosive and non-toxic. LNG will not burn in liquid form. When LNG vaporizes, it burns in concentrations of approximately 5% to 15% gas in air, if the fuel concentration is lower than 5 percent, it cannot burn because of insufficient fuel and if the fuel concentration is higher than 15 percent, it cannot burn because there is insufficient oxygen. While LNG vapor is initially heavier than air, after LNG vapors

(90% methane) become warmer than minus 106.7°C, they become lighter than air and will rise and disperse rather than collect near the ground. LNG provides for efficient storage and transportation of natural gas, and is vaporized for use by consumers.

LNG emission reduction percentages versus typical marine diesel engines is presented in Figure 3.A below. However unlike LNG engines running on gas only, dual fuel two stroke (slow speed) engines running on LNG, fuel mixture even with no methane slip can still not comply with nitrogen oxides (NOx) Tier III regulations of International Convention for the Prevention of Pollution from Ships (MARPOL). Development in new technologies for two stroke engines are still in progress.

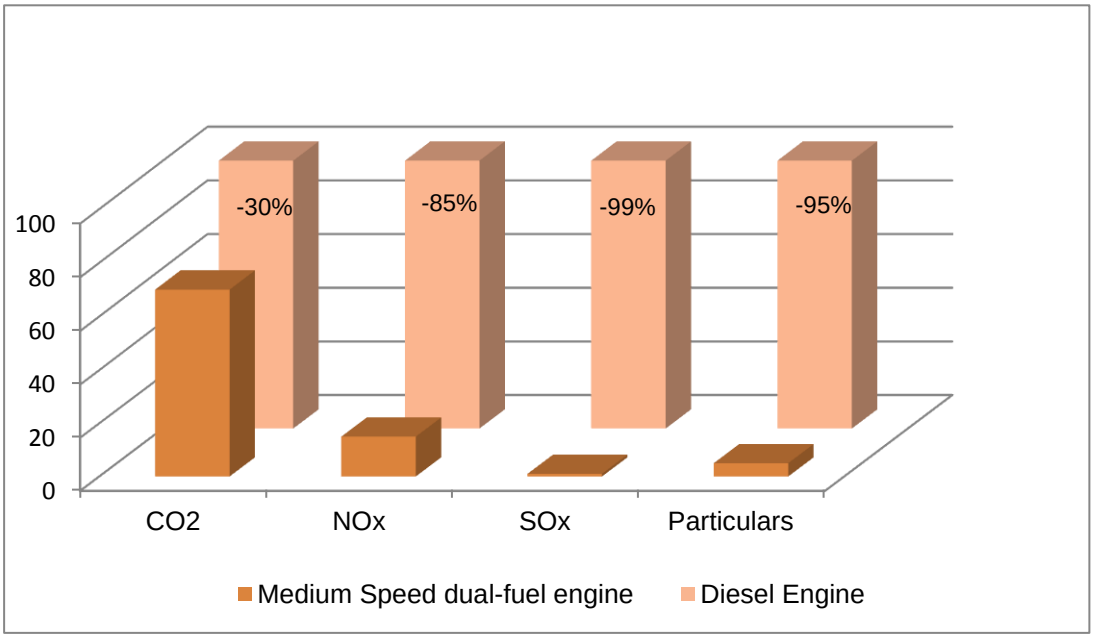

Figure 3.A: Emission Reduction Percentage Obtained by gas

(Wartsila, 2016)

3.2 Bunkering Operation (Truck to Ship)

Bunkering operation schema and operation sequence generated from DNV “Step by step bunkering guide” is presented in Appendix A.1.

3.3 Risks of Bunkering Operation

Risks of bunkering operation are combined by using fault tree analysis (FTA) from HAZID/HAZOP studies performed for ongoing projects and classification societies bunkering guidelines (ABS, BV and DNV, 2014).

3.3.1 Fault tree analysis (FTA)

Fault Tree Analysis is a deductive analysis that graphically models (using Boolean logic). It is logically representing many events and component failures that may combine to cause one critical event / failure.

Logic gates are used to show how basic events may combine to cause the critical top events.

FTA is a powerful technique, suitable for detailed analysis of individual systems. It is generally used in many applications to investigate fault analysis.

Potential areas to use FTA are listed as below;

- Frequency analysis; It is commonly used to quantify the likelihood of the top event occuring, based on estimates of failure rates of each component
- Risk presentation; It may also used to show how the various risk contributors combine to produce the overall risk
- Hazard identification;It may also used qualitatively to identify combinations of basic events that are sufficient to cause the top event, know as cut sets.

PROs of FTA are;

- Clear logical form.
- Widely used and well accepted.
- Suitable for many hazards in QRA that rise from combination of adverse circumstances, technical faults and human errors.

CONs of FTA are;

- Not easy to use on large systems.
- Events are generally assumed independent.
- Analysts should have a high level of expertise to not to overlook failure modes and fail to recognise common failures.

In Figure 3.B: FTA Symbols are presented.

Bunkering operation hazards are divided into four main groups. These are;

- Natural Gas (NG) leaks
- LNG leaks
- Fire on ship
- Fire on pier or bunker vessel

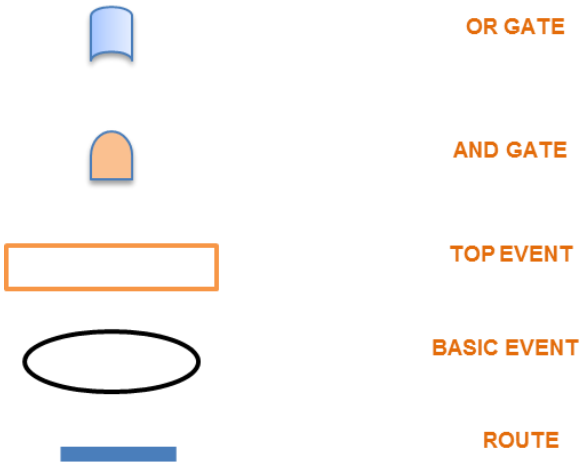

Figure 3.B: FTA Symbols

Main hazards are presented in Figure 3.C.

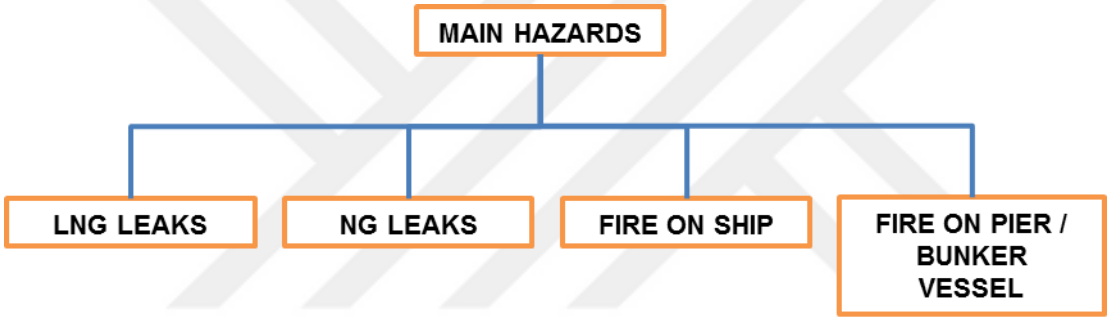

Figure 3.C: Main Hazards

Similarly hazards of NG, LNG leak hazards, fire on ship and fire on pier/bunker vessel are presented respectively below in Figure 3.D, Figure 3.E, Figure 3.F and Figure 3.G respectly.

All FTAs are presented here are confirmed by the decision makers who attended to this study.

Five main NG leak hazards defined are;

- Incorrect sequence
- Mishandling
- Inappropriate inerting of hose and/or bunker line
- Failure of communication or emergency shutdown device (ESD)
- LNG Leaks

Sub hazards can be seen from the Figure 3.D.

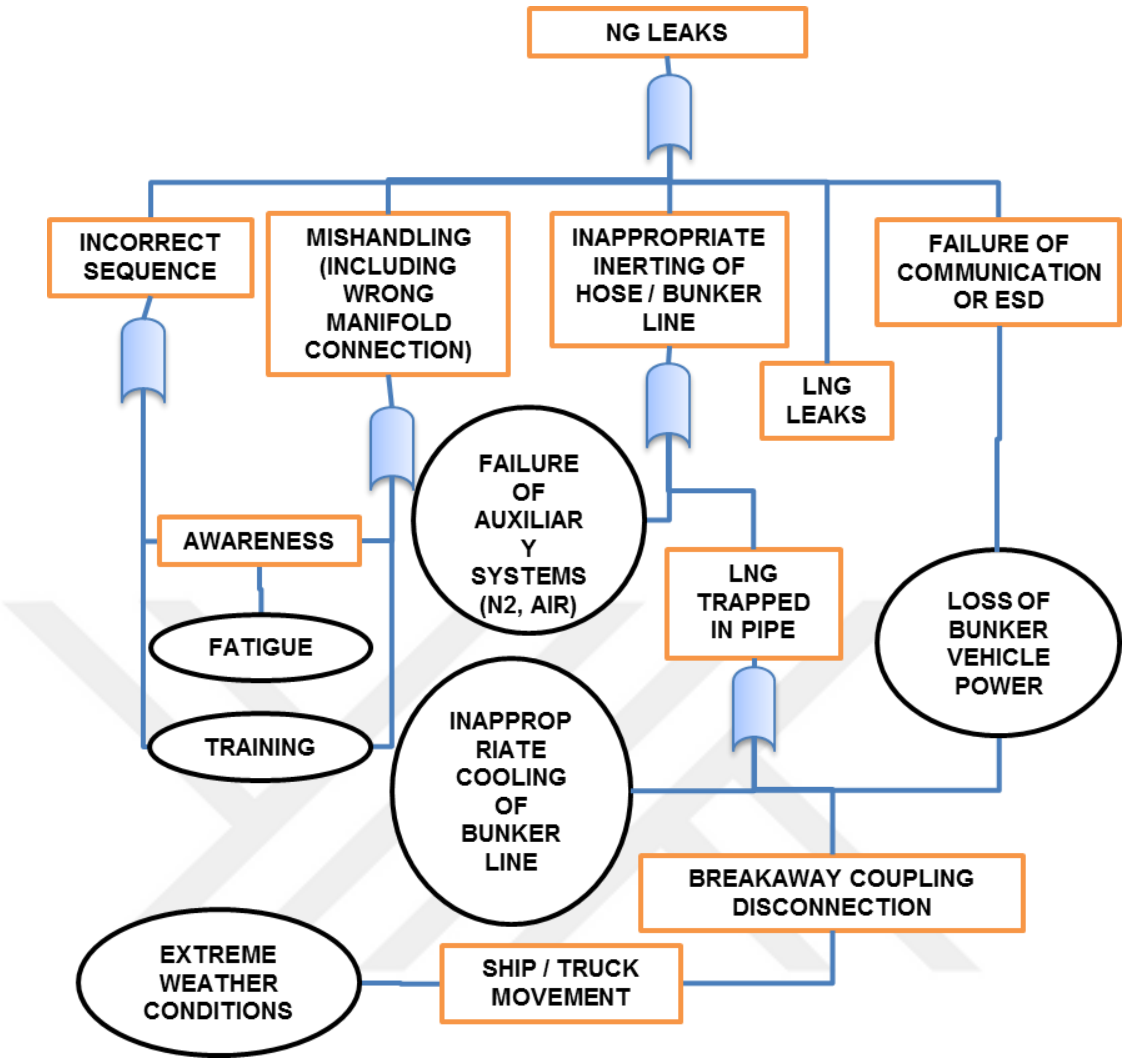

Figure 3.D: NG Leak Hazards

LNG leak hazards are grouped into five main hazards which are listed as below;

- Incorrect sequence
- Mishandling
- Hose rupture
- Dry coupling disconnection

Figure 3.E indicates sub hazards for LNG leaks.

Fire on ship and fire on pier / bunker vessel hazards are figured on the next pages.

As per the study probable reasons for these hazards are so similar to each other. Basically there are no sufficient statistical accident studies for LNG bunkering operation.

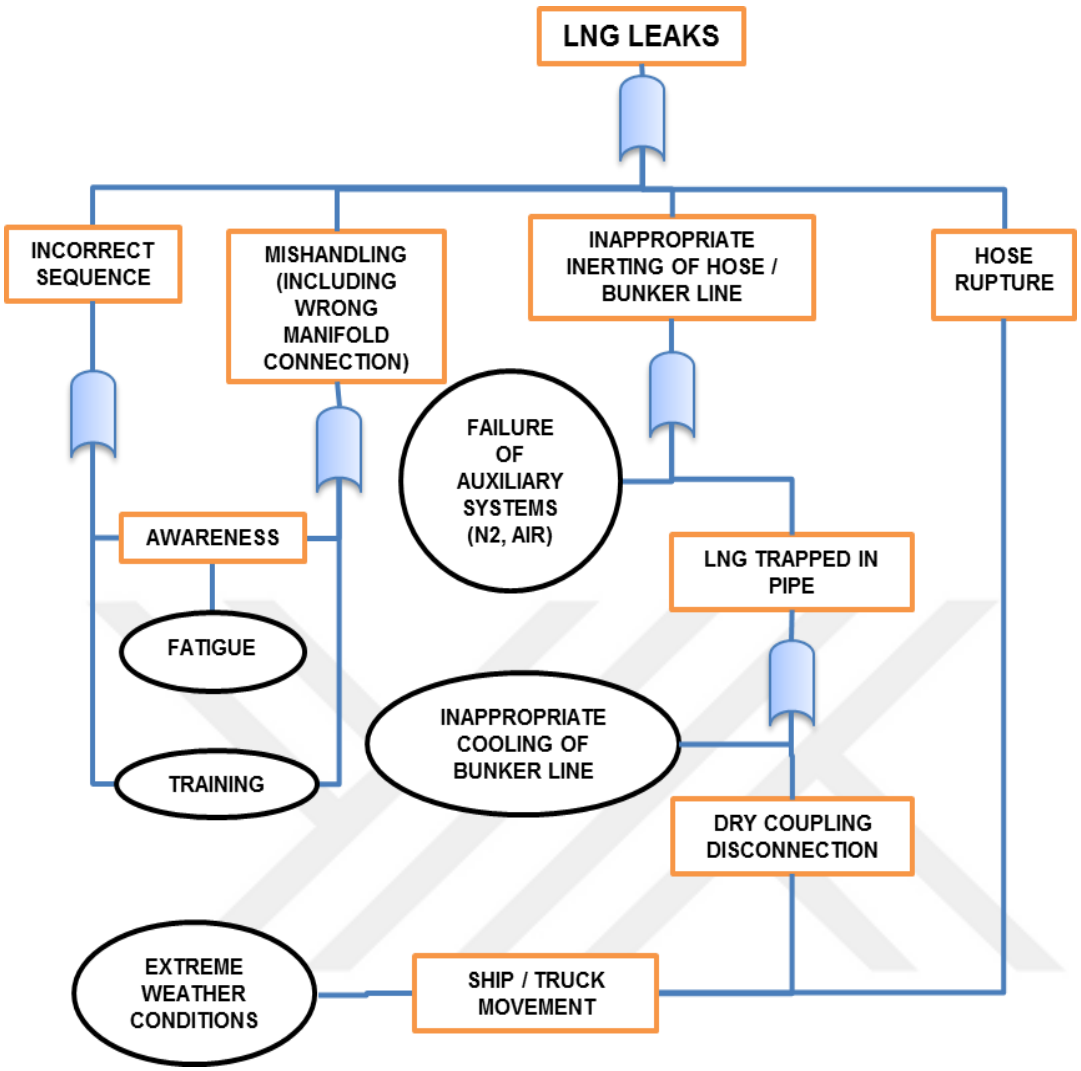

Figure 3.E: LNG Leak Hazards

Fire on ship hazards are grouped into four main hazards;

- NG Leaks
- LNG Leaks
- Electrical equipments
- Simultanous operations

Similarly Fire on pier/bunker vessels hazards are grouped into five main hazards;

- NG Leaks
- LNG Leaks
- Electrical equipments
- Simultanous operation
- Unauthorized traffic in security zone

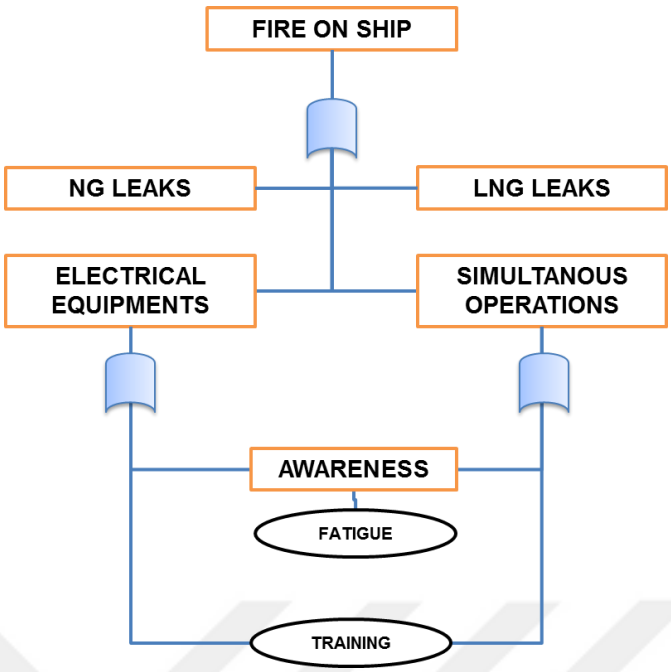

Figure 3.F: Fire on Ship

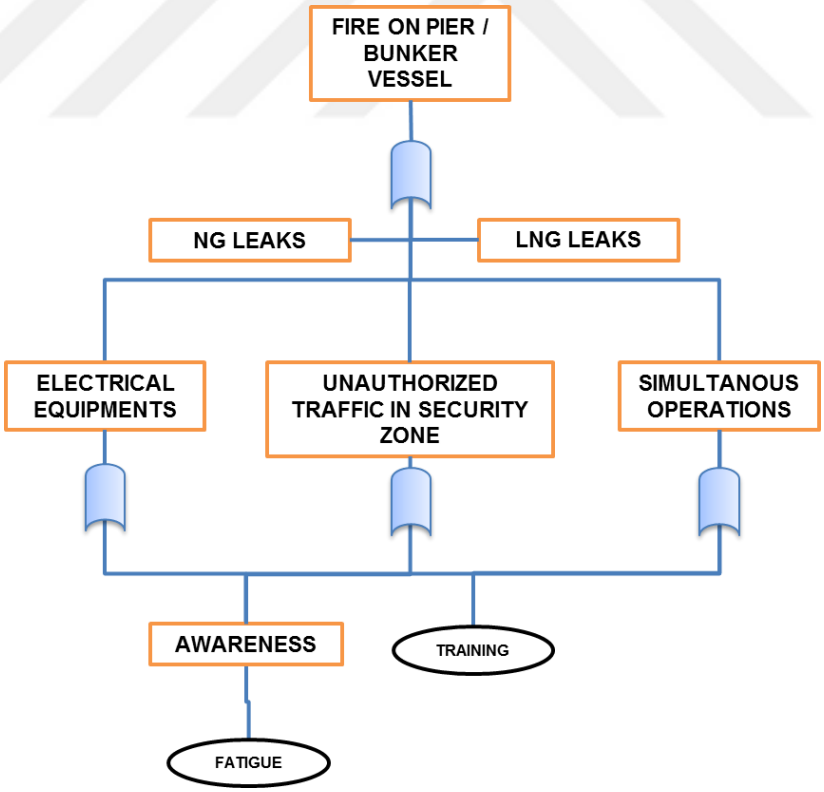

Figure 3.G: Fire on Pier/Bunker Vessel

Definition of each hazards are explained in APPENDICES B: .

3.3.2 Analytical network process (ANP) structure

Risk likelihood and consequences are derived from experts' choice analysis by using ANP method. Priorities are calculated by two different methods; Saaty's "Super Decisions" software is used to calculate ANP priorities and excel macro and functions used to derive fuzzy-ANP priorities.

Ideal mode and aggregation of individual priorities (AIP) method is used to calculate ANP solution.

Fuzzy-ANP is solved by using Chang's extent analysis method, this method uses triangular fuzzy set definition functions. Steps of Chang's method are relatively easier than other fuzzy approaches.

Control criteria for both likelihood and consequences created to model the problem using ANP. Defined control criteria are represented in Figure 3.H, below.

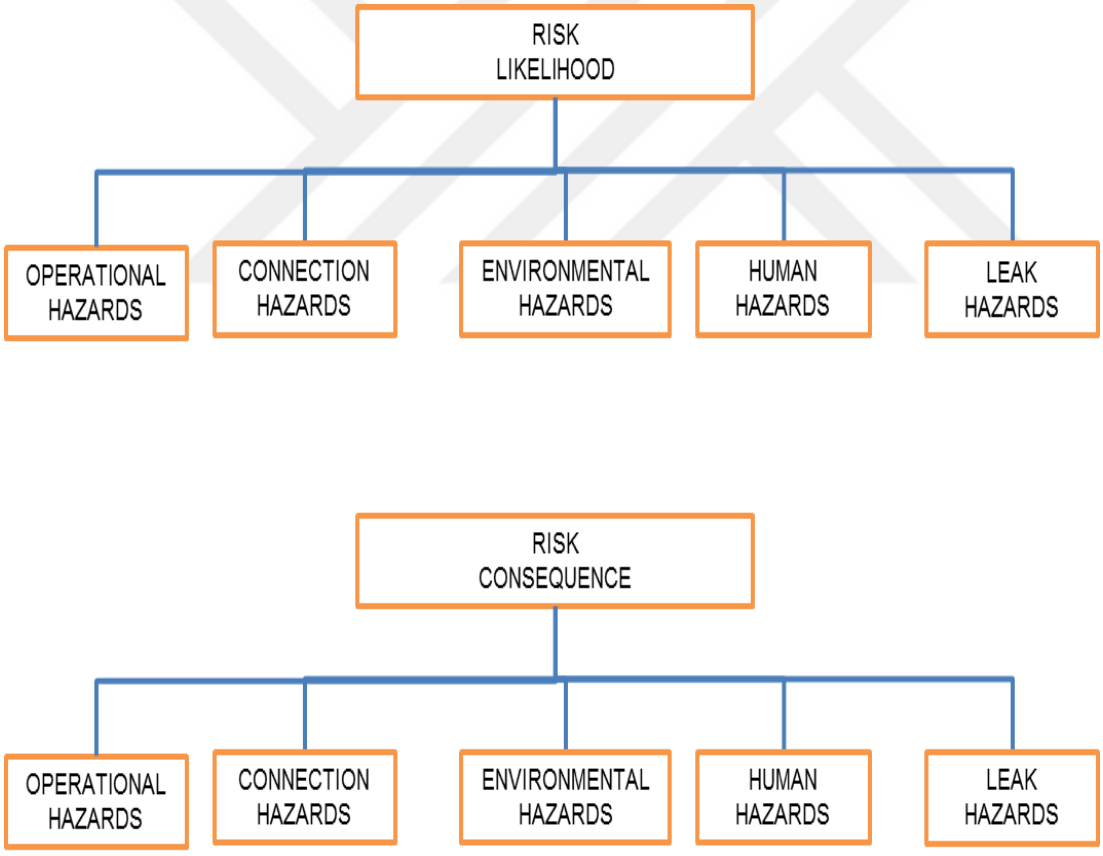

Figure 3.H: Control Criteria

Each risk hazard is grouped under four defined control criteria for both likelihood and consequence.

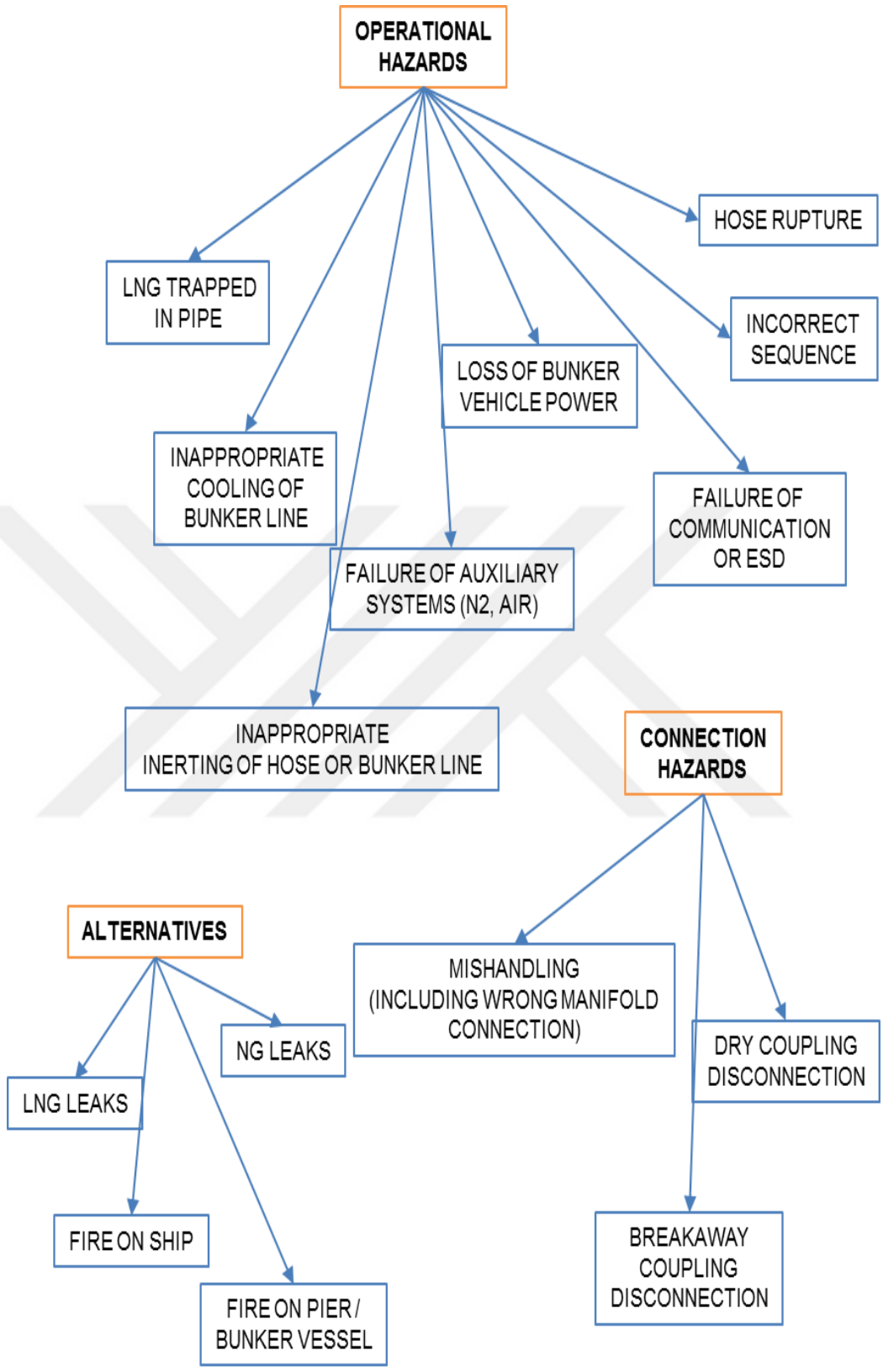

Figure 3.I: Grouped Hazards - 1

Figure 3.I and Figure 3.J indicate hazards grouped under control criteria.

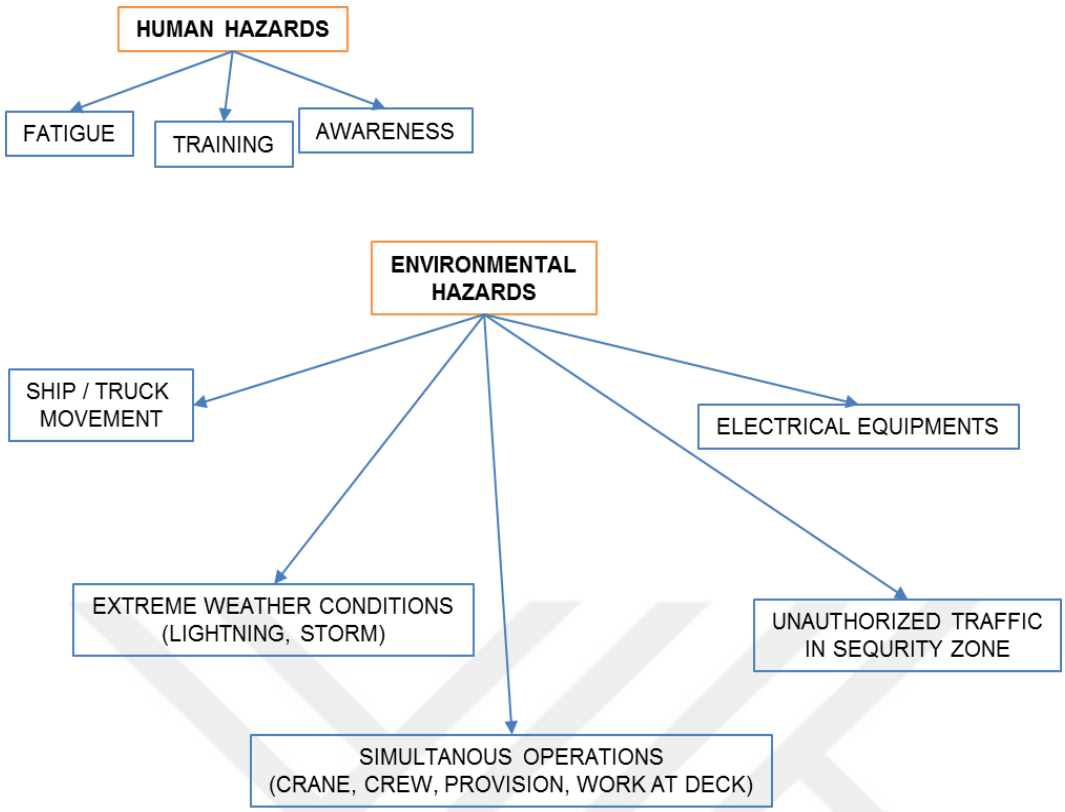

Figure 3.J: Grouped Hazards - 2

Based on the relations of clusters in APPENDICES C: , ANP network structure presented in Figure 3.K below. Circular arrows defines inner dependencies while direct arrows defines outer dependencies of cluster to the directed cluster.

3.3.3 Questionnaire

Questionnaire based on ANP network structure figured in Figure 3.K has been prepared and sent to 6 different experts; two ship owner representatives dealing with LNG operations on board, two experts from classification society and two experts from the company supplying LNG systems. The selected group was almost a perfect sampling cluster; operator side, classification society side and system manufacturer side. Unfortunately, only two experts replied to the questionnaire; results are presented in APPENDICES D: . Questionnaire is based on one single risk calculation method according to ISO 31000 (2009); likelihood and consequences. Experts are asked to reply questions for both consequences and likelihood for all scenarios depending on the network structure. In order to calculate risk values for each expert below formulation is used.

$$Risk = Consequences * Likelihood \quad [17]$$

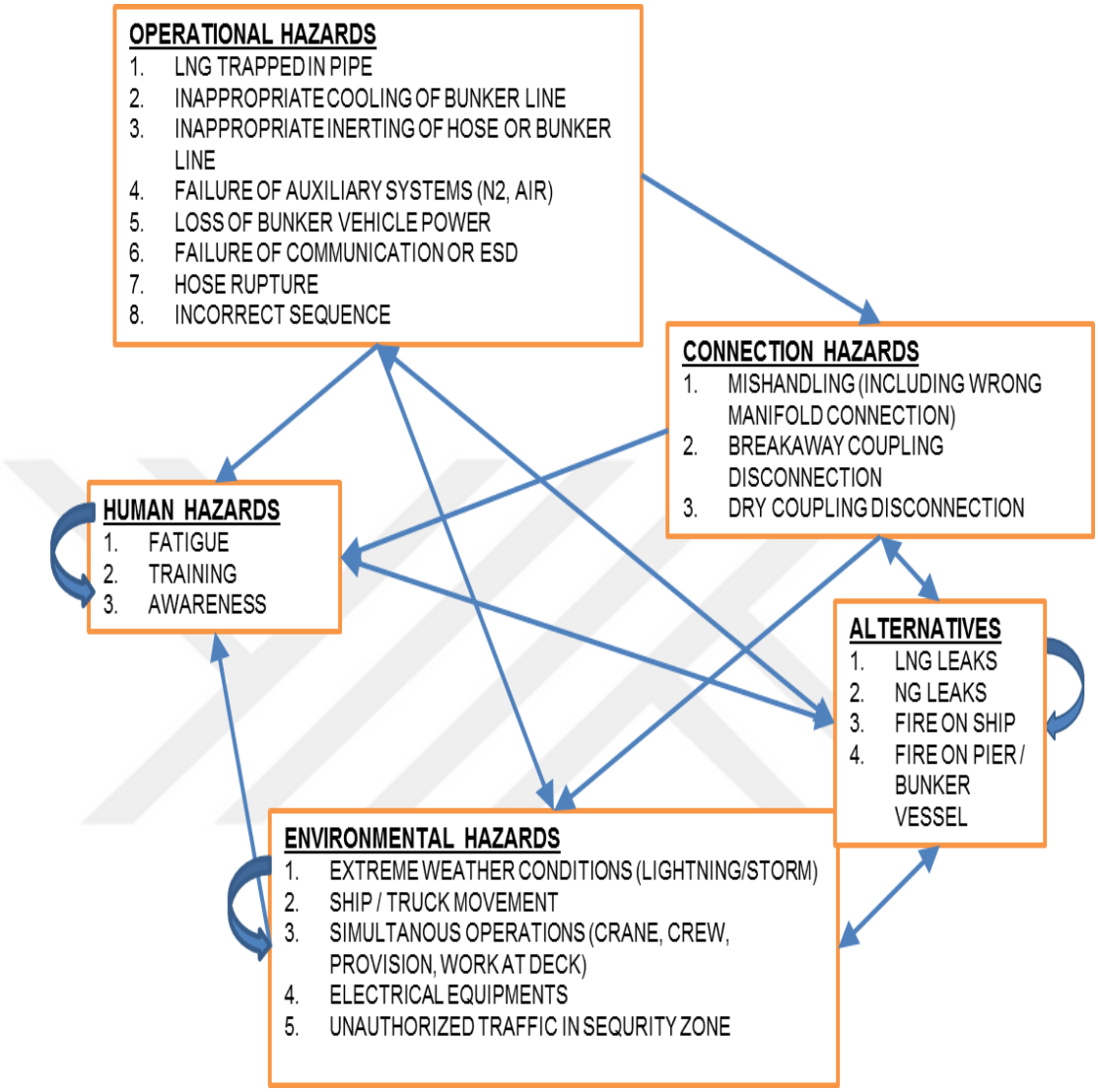

Figure 3.K: ANP Network Structure

Same network structure is used for both likelihood and consequences networks, two different questionnaires were presented to the experts. Experts were asked to fill the questionnaires for each group. Details of results are given in Appendix D.1, D.3 for consequences and D.2, D.4 for likelihood.

As per ANP methodology first clusters then nodes pairwise compared according their relations in the network structure.

Results of each comparison for both decision makers are shown in tables below. When values calculated differ from other calculated methods' values, they are highlighted on the table. As seen on the results, there isn't any major deviation between different calculation methods.

Table 3.1: Decision Maker 1 Consequences results comparison

		FUZZY-ANP	ANP LOGARITHMIC LEAST SQUARE	ANP EIGEN (SUPERDECISIONS)
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0352	0.0276	0.0279
	FIRE ON SHIP	0.0467	0.0311	0.0319
	LNG LEAKS	0.2071	0.2515	0.2601
	NG LEAKS	0.1383	0.1104	0.1131
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0293	0.0211	0.0200
	DRY COUPLING DISCONNECTION	0.0226	0.0165	0.0170
	MISHANDLING	0.0323	0.0523	0.0537
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0274	0.0205	0.0202
	EXTREME WEATHER CONDITIONS	0.1123	0.1246	0.1037
	SHIP / TRUCK MOVEMENT	0.1098	0.1164	0.1180
	SIMULTANOUS OPERATIONS	0.0119	0.0046	0.0046
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0010	0.0010	0.0010
HUMAN HAZARDS	AWARENESS	0.0305	0.0182	0.0185
	FATIGUE	0.0459	0.0347	0.0353
	TRAINING	0.0718	0.0971	0.0985
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0045	0.0055	0.0059
	FAILURE OF COMMUNICATION OR ESD	0.0005	0.0005	0.0005
	HOSE RUPTURE	0.0365	0.0399	0.0423
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0055	0.0045	0.0052
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0045	0.0029	0.0029
	INCORRECT SEQUENCE	0.0178	0.0146	0.0152
	LNG TRAPPED IN PIPE	0.0058	0.0032	0.0033
	LOSS OF BUNKER VEHICLE POWER	0.0029	0.0012	0.0013

Table 3.2: Decision Maker 1 Likelihood results comparison

		FUZZY-ANP	ANP LOGARITHMIC LEAST SQUARE	ANP EIGEN (SUPERDECISIONS)
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0225	0.0260	0.0263
	FIRE ON SHIP	0.0461	0.0391	0.0397
	LNG LEAKS	0.2141	0.2401	0.2552
	NG LEAKS	0.1820	0.1635	0.1571
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0044	0.0070	0.0063
	DRY COUPLING DISCONNECTION	0.0045	0.0108	0.0117
	MISHANDLING	0.0923	0.1173	0.1227
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0150	0.0124	0.0127
	EXTREME WEATHER CONDITIONS	0.0596	0.0459	0.0234
	SHIP / TRUCK MOVEMENT	0.0627	0.0469	0.0491
	SIMULTANOUS OPERATIONS	0.0105	0.0073	0.0075
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0039	0.0025	0.0025
HUMAN HAZARDS	AWARENESS	0.0427	0.0299	0.0330
	FATIGUE	0.0852	0.0954	0.0890
	TRAINING	0.0522	0.0434	0.0523
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0340	0.0334	0.0325
	FAILURE OF COMM. OR ESD	0.0060	0.0048	0.0043
	HOSE RUPTURE	0.0038	0.0050	0.0051
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0034	0.0021	0.0019
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0035	0.0021	0.0025
	INCORRECT SEQUENCE	0.0396	0.0548	0.0556
	LNG TRAPPED IN PIPE	0.0021	0.0017	0.0016
	LOSS OF BUNKER VEHICLE POWER	0.0100	0.0087	0.0083

Table 3.3: Decision Maker 2 Consequences results comparison

		FUZZY-ANP	ANP LOGARITHMIC LEAST SQUARE	ANP EIGEN (SUPERDECISIONS)
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0513	0.0416	0.0419
	FIRE ON SHIP	0.0547	0.0497	0.0497
	LNG LEAKS	0.2202	0.2671	0.2783
	NG LEAKS	0.1356	0.1123	0.1155
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0184	0.0136	0.0122
	DRY COUPLING DISCONNECTION	0.0400	0.0585	0.0606
	MISHANDLING	0.0297	0.0228	0.0233
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0269	0.0221	0.0215
	EXTREME WEATHER CONDITIONS	0.1094	0.1181	0.0934
	SHIP / TRUCK MOVEMENT	0.0636	0.0727	0.0747
	SIMULTANOUS OPERATIONS	0.0174	0.0148	0.0144
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0077	0.0037	0.0036
HUMAN HAZARDS	AWARENESS	0.0178	0.0143	0.0146
	FATIGUE	0.0836	0.0879	0.0903
	TRAINING	0.0390	0.0219	0.0220
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0039	0.0051	0.0054
	FAILURE OF COMMUNICATION OR ESD	0.0063	0.0039	0.0040
	HOSE RUPTURE	0.0278	0.0366	0.0391
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0019	0.0011	0.0015
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0075	0.0071	0.0073
	INCORRECT SEQUENCE	0.0266	0.0192	0.0205
	LNG TRAPPED IN PIPE	0.0076	0.0040	0.0042
	LOSS OF BUNKER VEHICLE POWER	0.0034	0.0020	0.0022

Table 3.4: Decision Maker 2 Likelihood results comparison

		FUZZY-ANP	ANP LOGARITHMIC LEAST SQUARE	ANP EIGEN (SUPERDECISIONS)
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0293	0.0297	0.0296
	FIRE ON SHIP	0.0564	0.0424	0.0426
	LNG LEAKS	0.1892	0.2216	0.2228
	NG LEAKS	0.1641	0.1333	0.1333
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0134	0.0127	0.0107
	DRY COUPLING DISCONNECTION	0.0056	0.0120	0.0125
	MISHANDLING	0.1180	0.1306	0.1354
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0257	0.0239	0.0242
	EXTREME WEATHER CONDITIONS	0.0813	0.0625	0.0624
	SHIP / TRUCK MOVEMENT	0.0718	0.0543	0.0553
	SIMULTANOUS OPERATIONS	0.0176	0.0138	0.0140
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0069	0.0049	0.0049
HUMAN HAZARDS	AWARENESS	0.0130	0.0121	0.0120
	FATIGUE	0.0296	0.0531	0.0528
	TRAINING	0.0373	0.0344	0.0345
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0375	0.0388	0.0370
	FAILURE OF COMMUNICATION OR ESD	0.0141	0.0120	0.0118
	HOSE RUPTURE	0.0000	0.0046	0.0044
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0009	0.0021	0.0020
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0160	0.0189	0.0179
	INCORRECT SEQUENCE	0.0436	0.0590	0.0563
	LNG TRAPPED IN PIPE	0.0149	0.0095	0.0093
	LOSS OF BUNKER VEHICLE POWER	0.0138	0.0139	0.0146

3.3.4 Ranking of decision makers

Decision makers who replied to the questionnaire have different skills; one of them has good site experience about LNG operations on board and on the other hand the

other one has good theoretical knowledge. In this case it is considered that both decision makers can not have the same effect on the final results which means their weight are to be different from each other.

In order to identify the ranks of the decision makers a sub-ANP network system shown below is created.

Pairwise comparisons done to solve the network structure. Weight of experience has been compared based on the previous experiences such as number of similar projects they participated and number of years dealing with LNG operation. On the other hand weight of theoretical knowledge has been compared based on interviews performed by each decision maker separately.

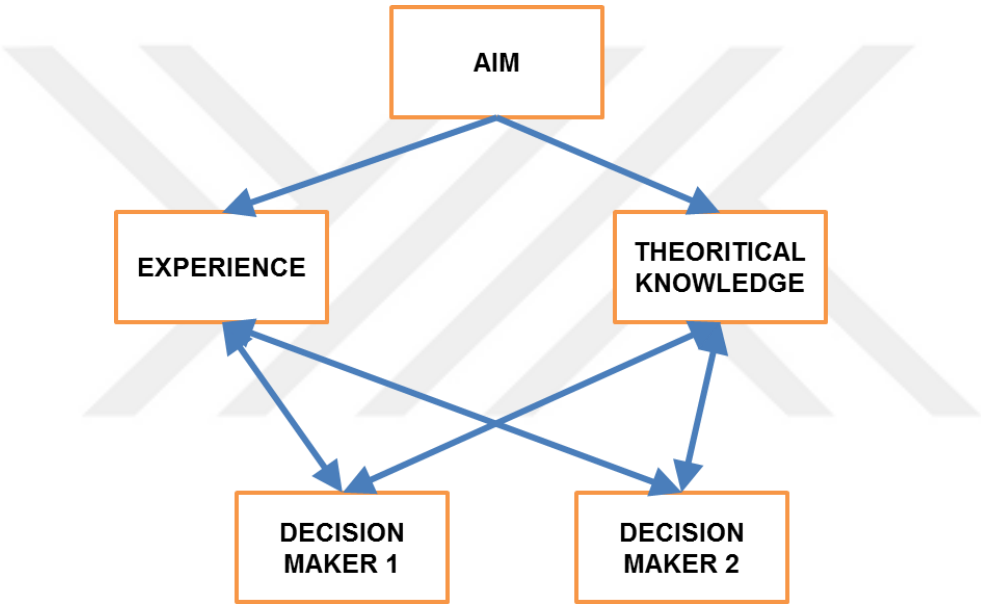

Figure 3.L: Network structure for decision makers

Calculation details are given in APPENDICES I. Based on this calculation ranks of the decision makers are so close.

- Decision maker 1: 0.4735
- Decision maker 2: 0.5254

3.3.5 Calculating group decision

In order to calculate the group decision, “Aggregation of Individual Priorities (AIP)” methodology has been used. As described in 2.4.5 when decision makers are not willing to pool their judgment, AIP method shall be used to calculate the group decision. Formulation numbered [9] and weight of decision makers calculated in 3.3.4 have been used for calculations.

Table 3.5: Group Decision - Consequences

		FUZZY -ANP	ANP LOGARITHMIC LEAST SQUARE	ANP EIGEN (SUPERDECISIONS)
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0429	0.0342	0.0346
	FIRE ON SHIP	0.0507	0.0398	0.0403
	LNG LEAKS	0.2139	0.2596	0.2695
	NG LEAKS	0.1369	0.1114	0.1143
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0230	0.0168	0.0154
	DRY COUPLING DISCONNECTION	0.0305	0.0322	0.0332
	MISHANDLING	0.0309	0.0338	0.0346
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0271	0.0213	0.0209
	EXTREME WEATHER CONDITIONS	0.1108	0.1211	0.0981
	SHIP / TRUCK MOVEMENT	0.0824	0.0908	0.0928
	SIMULTANOUS OPERATIONS	0.0145	0.0085	0.0083
HUMAN HAZARDS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0029	0.0020	0.0019
	AWARENESS	0.0229	0.0161	0.0163
	FATIGUE	0.0629	0.0566	0.0579
	TRAINING	0.0521	0.0443	0.0448
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0042	0.0053	0.0056
	FAILURE OF COMMUNICATION OR ESD	0.0019	0.0014	0.0015
	HOSE RUPTURE	0.0316	0.0381	0.0406
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0031	0.0021	0.0027
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0059	0.0046	0.0047
	INCORRECT SEQUENCE	0.0220	0.0169	0.0177
	LNG TRAPPED IN PIPE	0.0067	0.0036	0.0038
	LOSS OF BUNKER VEHICLE POWER	0.0031	0.0016	0.0017

Table 3.6: Group Decision - Likelihood

		FUZZY-ANP	ANP LOGARITHMIC LEAST SQUARE	ANP EIGEN (SUPERDECISIONS)
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0258	0.0279	0.0280
	FIRE ON SHIP	0.0512	0.0408	0.0412
	LNG LEAKS	0.2007	0.2302	0.2376
	NG LEAKS	0.1723	0.1468	0.1441
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0079	0.0096	0.0083
	DRY COUPLING DISCONNECTION	0.0051	0.0114	0.0121
	MISHANDLING	0.1050	0.1241	0.1292
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0199	0.0175	0.0178
	EXTREME WEATHER CONDITIONS	0.0702	0.0540	0.0392
	SHIP / TRUCK MOVEMENT	0.0673	0.0507	0.0522
	SIMULTANOUS OPERATIONS	0.0138	0.0102	0.0104
HUMAN HAZARDS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0052	0.0035	0.0036
	AWARENESS	0.0229	0.0186	0.0194
	FATIGUE	0.0488	0.0701	0.0676
	TRAINING	0.0437	0.0384	0.0420
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0358	0.0361	0.0348
	FAILURE OF COMMUNICATION OR ESD	0.0094	0.0078	0.0073
	HOSE RUPTURE	0.0000	0.0048	0.0047
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0017	0.0021	0.0020
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0077	0.0067	0.0070
	INCORRECT SEQUENCE	0.0416	0.0570	0.0559
	LNG TRAPPED IN PIPE	0.0059	0.0042	0.0041
	LOSS OF BUNKER VEHICLE POWER	0.0118	0.0111	0.0111

3.3.6 Calculation of risk value for alternatives

In section 3.3.5 group decisions for all nodes are calculated separately for consequences and likelihood. By using formulation numbered [17], risk values has calculated for all methodologies as shown below.

Table 3.7: Risk Values

	FUZZY-ANP	ANP LOGARITHMIC LEAST SQUARE	ANP EIGEN (SUPERDECISIONS)
FIRE ON PIER / BUNKER VESSEL	0.0011	0.0010	0.0010
FIRE ON SHIP	0.0026	0.0016	0.0017
LNG LEAKS	0.0429	0.0597	0.0640
NG LEAKS	0.0236	0.0164	0.0165

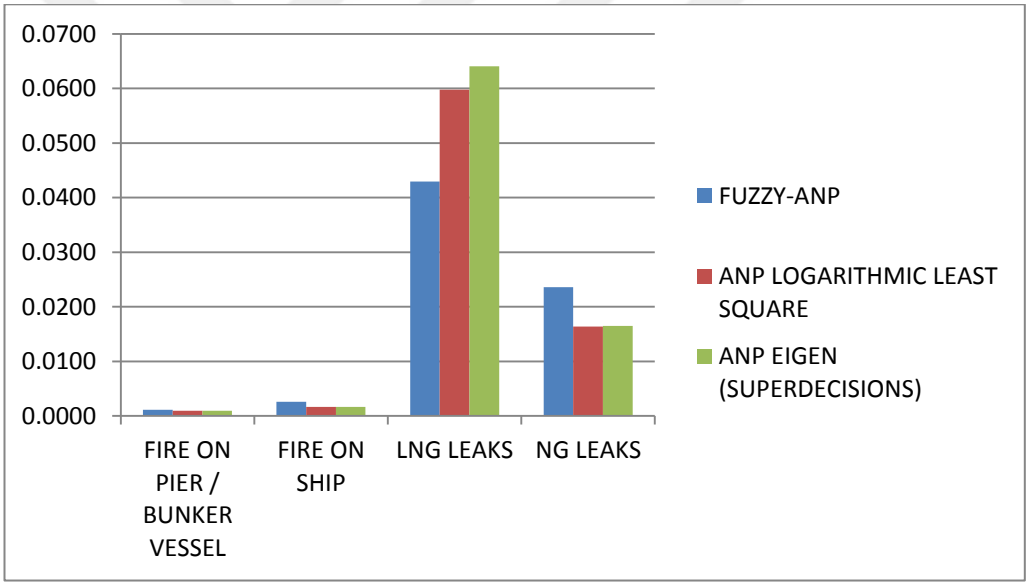

Figure 3.M: Risk Values

4 CONCLUSION

In this study, multi-criteria and multi expert decision making methods used to obtain the priorities of likelihood and consequences for LNG bunkering operation and by using these figures risk values for alternatives calculated.

LNG bunkering operation is regarded as one of the major risky operations for ships using LNG as fuel. Hazards for bunkering operation are considered; using the opinions of a LNG expert group for LNG dual-fuel projects under construction in Turkiye and bunkering guidelines of classification societies listed in references. Based on the Fault Tree Analysis (FTA) all hazards are grouped in cluster, nodes under clusters and inner, outer dependencies are created by using FTA.

FTA resulted clusters and nodes were used to generate ANP network structure. ANP network structure solved by using two different methods; ANP (using logarithmic least square method) and Fuzzy-ANP. The idea is to find out the effect of fuzziness and compare results with different methodologies. ANP solutions also obtained from “Super Decisions” software which uses “eigen values” for calculation. Excel macros and functions were used to get results for Fuzzy-ANP method. Main algorithm methods studied (Kahraman, 2008) and triangular functions selected and used as fuzzy membership functions. Chang’s extended analysis method (1996) used for the solution.

According to Figure 3.M; in all calculation methodologies the most risky alternative is LNG leaks. According to FTA structure this seems reasonable because, LNG leaks cause NG leaks, fire on ship and occasionally fire on pier / bunker vessel. Similarly, NG leaks are the second risky alternative cause they do not cause LNG leak but cause fire on ship, fire on pier / bunker vessel. While considering measures for risks during bunkering operations, special attention should be paid to LNG leak causes.

Calculation methodologies for ANP, logarithmic least square and eigen values have very similar results. The reason for this might be the consistency index, in this study special attention paid to keep consistency index less than 0.10. It has been shown that using logarithmic least squares method also provides enough precision, with consistency index less than 0.10. Additional applications may be performed to measure the limit for consistency while using logarithmic least squares method.

Fuzzy-ANP results slightly differs from classical ANP results. Using fuzzy sets is a powerful tool, in this study triangular functions used to create sets. Triangular functions are easy to use with Chang's methodology, further studies with different sets have to be performed to understand the effectiveness on this kind of problems.

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APPENDICES A: BUNKERING

A.1 Bunkering Operation Diagram

Diagram is presented on the next page.

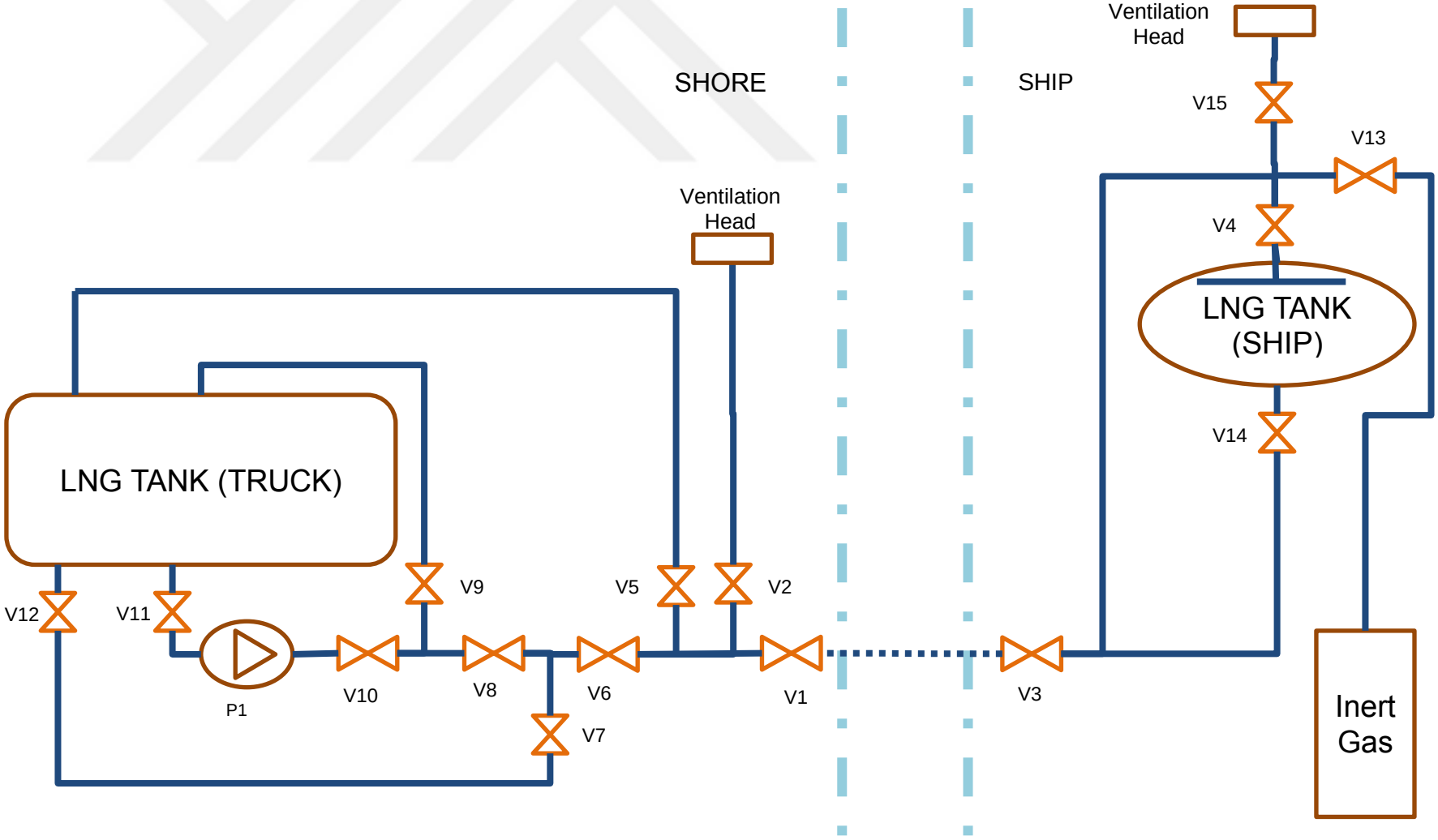

Figure A.1: : LNG Bunkering Operation Schema
(Generated from DNV step by step bunkering guide)

Table A.1 : LNG Bunkering Operation

(Generated by DNV step by step bunkering guide)

SHORE SIDE OPERATIONS			**SHIP SIDE OPERATIONS**		
Order	**Explanation**	**Open Valve position**	**Order**	**Explanation**	**Open Valve position**
1	Precooling of filling lines	V5, V6, V7, V12	4	Inert line	V1, V2, V3, V13
2	Initial cooling of transfer pump (P1)	V9, V10, V11	5	Purge connected system with natural gas	V1, V3, V4
3	Connect hose	-	8	Liquid line inerting	V1, V2, V3, V13
6	Filling sequence	V1, V3, V6, V8, V10, V11, V14	9	Disconnect hose	
7	Liquid line stripping	V3 (open-close-open)			

APPENDICES B: HAZARD DEFINITIONS

Incorrect Sequence; bunkering operation has to be done in order. This hazard is defined to cover sequence order mistakes.

Mishandling; carrying, connecting hose, opening the correct valve at the correct time.

Hose rupture; rupture of hose due to external effects. Hoses are periodically tested that why fatigue or abrasion is not considered.

Dry coupling disconnection; one of the two connection types for bunkering

Failure of auxiliary systems; failure of gas supplying systems for inerting and air or hydraulic supply for remote control valves.

Awareness; human factor based on studies, crew may lose awareness of the risks and hazards of the periodically done works.

Training; crew training operational and safety.

Fatigue; bunkering operation is a critical operation and to be done as soon as possible. Crew fatigue due to limited time and extreme bunkering timing.

Ship / Truck movement; normally ships are moored before operation however ship movement because of improper mooring, weather conditions and accidental truck movement.

Extreme weather conditions; sea weather conditions causing ship to move while bunkering.

In appropriate cooling of bunker line; LNG is cryogenic, pipes and pumps are to be cooled down slowly in order not to damage systems.

Loss of bunker vehicle power; bunkering is done by pump on truck, in case loss of power operation will be stopped.

Failure of communication or ESD; ESD is the emergency shutdown to use in case of emergency, communication systems are used to monitor and provide communications to monitor bunkering operation from both ship and shore side.

Breakaway coupling disconnection; easily breakable coupling with special non-return valve system, preventing rupture of hose.

LNG trapped in pipe; LNG is liquid form of NG, supplied in very cold temperature. 1 cubic meter of LNG is approximately is equal to 600 cubic meter of NG. During normal bunkering operation LNG in pipes are swept back in tank by using NG. If the cold end of the system is closed or blocked (e.g. in case of breakaway coupling disconnection), LNG will be trapped in pipe and will expand when exposed to normal air temperature.

APPENDICES C: CLUSTERS INNER AND OUTER RELATIONS

Table C.1: Alternatives Cluster 1

Main Control Cluster	Related Control Criteria	Related Cluster
1) LNG leaks	Operational Hazards	4, 7, 8
	Connection Hazards	1, 3
	Human Hazards	1, 2, 3
	Environmental Hazards	1, 2
2) NG leaks	Operational Hazards	1, 2, 3, 4, 5, 6, 8
	Connection Hazards	1, 2
	Human Hazards	1, 2, 3
	Environmental Hazards	1, 2

Table C.2: Alternatives Cluster 2

Main Control Cluster	Related Control Criteria	Related Cluster
1) Fire on ship	Alternatives	1, 2
	Environmental Hazards	3, 4
2) Fire on pier / bunker vessel	Alternatives	1, 2
	Environmental Hazards	3, 4, 5

Table C.3: Human Cluster

Main Control Cluster	Related Control Criteria	Related Cluster
1) Fatigue	Alternatives	1, 2, 3, 4
2) Training	Alternatives	1, 2, 3, 4
3) Awareness	Alternatives	1, 2, 3, 4
	Human Hazards	1

Table C.4: Operations Cluster

Main Control Cluster	Related Control Criteria	Related Cluster
1) LNG trapped in pipe	Operational Hazards	2, 5
	Connection Hazards	2
	Alternatives	1, 2, 3, 4
	Environmental Hazards	1, 2
2) Inappropriate cooling of bunker line 4) Failure of auxiliary systems (N2, Air) 5) Loss of bunker vessel power	Alternatives	1, 2, 3, 4
3) Inappropriate inerting of hose or bunker line	Operational Hazards	1, 4
	Alternatives	1, 2, 3, 4
6) Failure of communication	Operation Hazards	5
	Alternatives	1, 2, 3, 4
7) Hose rupture	Environmental Hazards	1, 2
	Alternatives	1, 2, 3, 4
8) Incorrect sequence	Human Hazards	1, 2, 3
	Alternatives	1, 2, 3, 4

Table C.5: Connection Cluster

Main Control Cluster	Related Control Criteria	Related Cluster
1) Mishandling	Human Hazards	1, 2, 3
	Alternatives	1, 2, 3, 4
2) Breakaway coupling disconnection	Environmental Hazards	1, 2
	Alternatives	1, 2, 3, 4
3) Dry coupling disconnection	Environmental Hazards	1, 2
	Alternatives	1, 2, 3, 4

Table C.6: Environmental Cluster

Main Control Cluster	Related Control Criteria	Related Cluster
1) Extreme weather conditions	Alternatives	1, 2, 3, 4
2) Ship / truck movement	Environmental Hazards	1
	Alternatives	1, 2, 3, 4
3) Simultanous operations	Human Hazards	2, 3
	Alternatives	1, 2, 3, 4
4) Electrical equipments	Human Hazards	2, 3
	Alternatives	1, 2, 3, 4
5) Unauthorized traffic in sequrity zone	Human Hazards	2, 3
	Alternatives	1, 2, 3, 4

APPENDICES D: QUESTIONNAIRE AND EXPERT REPLIES

D.1 Questionnaire for clusters - Consequences

Consequences Matrix 01	DECISION MARKER 2	DECISION MAKER 1	
CONNECTION HAZARDS CONSEQUENCES			
Consequences of ENVIRONMENTAL HAZARDS that cause connection hazards are	**MODERATE STRONGER**	**STRONGER**	than HUMAN HAZARDS
Consequences of ENVIRONMENTAL HAZARDS that cause connection hazards are	**EQUAL**	**MODERATE STRONGER**	than ALTERNATIVES
Consequences of HUMAN HAZARDS that cause connection hazards are	**MODERATE WEAKER**	**EQUAL**	than ALTERNATIVES

Consequences Matrix 02			
ENVIRONMENTAL HAZARDS CONSEQUENCES			
Consequences of ENVIRONMENTAL HAZARDS that cause environmental hazards are	**EQUAL**	**MODERATE WEAKER**	than HUMAN HAZARDS
Consequences of ENVIRONMENTAL HAZARDS that cause environmental hazards are	**MODERATE WEAKER**	**MODERATE STRONGER**	than ALTERNATIVES
Consequences of HUMAN HAZARDS that cause environmental hazards are	**MODERATE WEAKER**	**STRONGER**	than ALTERNATIVES

Consequences Matrix 03			
ALTERNATIVES			
Consequences of CONNECTION HAZARDS that cause alternatives are	**EQUAL**	**EQUAL**	than ENVIRONMENTAL HAZARDS
Consequences of CONNECTION HAZARDS that cause alternatives are	**EQUAL**	**EQUAL**	than HUMAN HAZARDS
Consequences of CONNECTION HAZARDS that cause alternatives are	**EQUAL**	**EQUAL**	than OPERATIONAL HAZARDS
Consequences of CONNECTION HAZARDS that cause alternatives are	**EQUAL**	**EQUAL**	than ALTERNATIVES
Consequences of ENVIRONMENTAL HAZARDS that cause alternatives are	**EQUAL**	**EQUAL**	than HUMAN HAZARDS
Consequences of ENVIRONMENTAL HAZARDS that cause alternatives are	**EQUAL**	**EQUAL**	than OPERATIONAL HAZARDS
Consequences of ENVIRONMENTAL HAZARDS that cause alternatives are	**EQUAL**	**EQUAL**	than ALTERNATIVES
Consequences of HUMAN HAZARDS that cause alternatives are	**EQUAL**	**EQUAL**	than OPERATIONAL HAZARDS
Consequences of HUMAN HAZARDS that cause alternatives are	**EQUAL**	**EQUAL**	than ALTERNATIVES
Consequences of OPERATIONAL HAZARDS that cause alternatives are	**MODERATE WEAKER**	**MODERATE WEAKER**	than ALTERNATIVES

Consequences Matrix 04

OPERATIONAL HAZARDS

Consequences of CONNECTION HAZARDS that cause operational hazards	**EQUAL**	**EQUAL**	than ENVIRONMENTAL HAZARDS
Consequences of CONNECTION HAZARDS that cause operational hazards	**EQUAL**	**EQUAL**	than HUMAN HAZARDS
Consequences of CONNECTION HAZARDS that cause operational hazards	**EQUAL**	**EQUAL**	than OPERATIONAL HAZARDS
Consequences of CONNECTION HAZARDS that cause operational hazards	**EQUAL**	**EQUAL**	than ALTERNATIVES
Consequences of ENVIRONMENTAL HAZARDS that cause operational hazards	**EQUAL**	**EQUAL**	than HUMAN HAZARDS
Consequences of ENVIRONMENTAL HAZARDS that cause operational hazards	**EQUAL**	**EQUAL**	than OPERATIONAL HAZARDS
Consequences of ENVIRONMENTAL HAZARDS that cause operational hazards	**EQUAL**	**EQUAL**	than ALTERNATIVES
Consequences of HUMAN HAZARDS that cause operational hazards	**EQUAL**	**EQUAL**	than OPERATIONAL HAZARDS
Consequences of HUMAN HAZARDS that cause operational hazards	**EQUAL**	**EQUAL**	than ALTERNATIVES
Consequences of OPERATIONAL HAZARDS that cause operational hazards	**MODERATE WEAKER**	**MODERATE WEAKER**	than ALTERNATIVES

D.2 Questionnaire for clusters - Likelihood

Likelihood Matrix 01	**DECISION MARKER 2**	**DECISION MAKER 1**	
CONNECTION HAZARDS LIKELIHOOD			
ENVIRONMENTAL HAZARDS are	**VERY STRONGLY**	**STRONGLY**	probable to cause a connection hazard than HUMAN HAZARDS
ENVIRONMENTAL HAZARDS are	**MODERATE STRONGLY**	**MODERATE STRONGLY**	probable to cause a connection hazard than ALTERNATIVES
HUMAN HAZARDS are	**WEAKLY**	**MODERATE WEAKLY**	probable to cause a connection hazard than ALTERNATIVES

Likelihood Matrix 02			
ENVIRONMENTAL HAZARDS LIKELIHOOD			
ENVIRONMENTAL HAZARDS are	**VERY STRONGLY**	**WEAKLY**	probable to cause an environmental hazard than HUMAN HAZARDS
ENVIRONMENTAL HAZARDS are	**VERY STRONGLY**	**MODERATE WEAKLY**	probable to cause an environmental hazard than ALTERNATIVES
HUMAN HAZARDS are	**EQUALLY**	**EQUALLY**	probable to cause an environmental hazard than ALTERNATIVES

Likelihood Matrix 03

ALTERNATIVES LIKELIHOOD

CONNECTION HAZARDS are	**VERY STRONGLY**	**MODERATE STRONGLY**	probable to cause an alternative than ENVIRONMENTAL HAZARDS
CONNECTION HAZARDS are	**VERY STRONGLY**	**MODERATE STRONGLY**	probable to cause an alternative than HUMAN HAZARDS
CONNECTION HAZARDS are	**EQUALLY**	**EQUALLY**	probable to cause an alternative than OPERATIONAL HAZARDS
CONNECTION HAZARDS are	**MODERATE STRONGLY**	**EQUALLY**	probable to cause an alternative than ALTERNATIVES
ENVIRONMENTAL HAZARDS are	**MODERATE STRONGLY**	**MODERATE WEAKLY**	probable to cause an alternative than HUMAN HAZARDS
ENVIRONMENTAL HAZARDS are	**MODERATE WEAKLY**	**MODERATE WEAKLY**	probable to cause an alternative than OPERATIONAL HAZARDS
ENVIRONMENTAL HAZARDS are	**MODERATE STRONGLY**	**EQUALLY**	probable to cause an alternative than ALTERNATIVES
HUMAN HAZARDS are	**WEAKLY**	**EQUALLY**	probable to cause an alternative than OPERATIONAL HAZARDS
HUMAN HAZARDS are	**MODERATE WEAKLY**	**EQUALLY**	probable to cause an alternative than ALTERNATIVES
OPERATIONAL HAZARDS are	**STRONGLY**	**EQUALLY**	probable to cause an alternative than ALTERNATIVES

Likelihood Matrix 04

OPERATIONAL HAZARDS LIKELIHOOD

CONNECTION HAZARDS are	**STRONGLY**	**MODERATE STRONGLY**	probable to cause an alternative than ENVIRONMENTAL HAZARDS
CONNECTION HAZARDS are	**STRONGLY**	**MODERATE STRONGLY**	probable to cause an operational hazard than HUMAN HAZARDS
CONNECTION HAZARDS are	**EQUALLY**	**MODERATE WEAKLY**	probable to cause an operational hazard than OPERATIONAL HAZARDS
CONNECTION HAZARDS are	**STRONGLY**	**EQUALLY**	probable to cause an operational hazard than ALTERNATIVES
ENVIRONMENTAL HAZARDS are	**STRONGLY**	**EQUALLY**	probable to cause an operational hazard than HUMAN HAZARDS
ENVIRONMENTAL HAZARDS are	**MODERATE WEAKLY**	**MODERATE WEAKLY**	probable to cause an operational hazard than OPERATIONAL HAZARDS
ENVIRONMENTAL HAZARDS are	**MODERATE STRONGLY**	**EQUALLY**	probable to cause an operational hazard than ALTERNATIVES
HUMAN HAZARDS are	**WEAKLY**	**MODERATE WEAKLY**	probable to cause an operational hazard than OPERATIONAL HAZARDS
HUMAN HAZARDS are	**EQUALLY**	**EQUALLY**	probable to cause an operational hazard than ALTERNATIVES
OPERATIONAL HAZARDS are	**STRONGLY**	**EQUALLY**	probable to cause an operational hazard than ALTERNATIVES

D.3 Questionnaire for nodes - Consequences

MISHANDLING CONSEQUENCES	**DECISION MARKER 2**	**DECISION MAKER 1**	
Consequences of FATIGUE that cause MISHANDLING is	**STRONGER**	**VERY WEAKER**	than TRAINING
Consequences of FATIGUE that cause MISHANDLING is	**VERY STRONGER**	**MODERATE WEAKER**	than AWARENESS
Consequences of TRAINING that cause MISHANDLING is	**MODERATE STRONGER**	**WEAKER**	than AWARENESS

BREAKAWAY COUPLING DISCONNECTION CONSEQUENCES			
Consequences of EXTREME WEATHER CONDITIONS are that cause BREAKAWAY COUPLING DISCONNECTION is	**EQUAL**	**WEAKER**	than SHIP / TRUCK MOVEMENT
DRY COUPLING DISCONNECTION CONSEQUENCES			
Consequences of EXTREME WEATHER CONDITIONS are that cause DRY COUPLING DISCONNECTION is	**EQUAL**	**WEAKER**	than SHIP / TRUCK MOVEMENT
FIRE ON SHIPS CONSEQUENCES			
Consequences of SIMULTANOUS OPERATIONS are that cause FIRE ON SHIPS is	**WEAKER**	**WEAKER**	than ELECTRICAL EQUIPMENTS
FIRE ON PIER / BUNKER VESSEL CONSEQUENCES			
Consequences of SIMULTANOUS OPERATIONS are that cause FIRE ON PIER / BUNKER VESSELS is	**MODERATE STRONGER**	**WEAKER**	than ELECTRICAL EQUIPMENTS
Consequences of SIMULTANOUS OPERATIONS are that cause FIRE ON PIER / BUNKER VESSELS is	**MODERATE STRONGER**	**MODERATE STRONGER**	than UNAUTHORIZED TRAFFIC IN SECURITY ZONE
Consequences of ELECTRICAL EQUIPMENTS are that cause FIRE ON PIER / BUNKER VESSELS is	**EQUAL**	**VERY STRONGER**	than UNAUTHORIZED TRAFFIC IN SECURITY ZONE
SIMULTANOUS OPERATIONS CONSEQUENCES			
Consequences of TRAINING that cause SIMULTANOUS OPERATIONS is	**EQUAL**	**STRONGER**	than AWARENESS
ELECTRICAL EQUIPMENTS CONSEQUENCES			
Consequences of TRAINING that cause ELECTRIC EQUIPMENTS is	**VERY STRONGER**	**STRONGER**	than AWARENESS
UNAUTHORIZED TRAFFIC IN SECURITY ZONE CONSEQUENCES			
Consequences of TRAINING that cause UNAUTHORIZED TRAFFIC IN SECURITY ZONE is	**STRONGER**	**STRONGER**	than AWARENESS

LNG LEAKS CONSEQUENCES

Consequences of MISHANDLING that cause LNG LEAKS is	**WEAKER**	**MODERATE STRONGER**	than DRY COUPLING DISCONNECTION
Consequences of EXTREME WEATHER CONDITIONS are that cause LNG LEAKS is	**EQUAL**	**VERY WEAKER**	than SHIP / TRUCK MOVEMENT
Consequences of FATIGUE that cause LNG LEAKS is	**VERY STRONGER**	**MODERATE WEAKER**	than TRAINING
Consequences of FATIGUE that cause LNG LEAKS is	**VERY STRONGER**	**MODERATE STRONGER**	than AWARENESS
Consequences of TRAINING that cause LNG LEAKS is	**EQUAL**	**STRONGER**	than AWARENESS
Consequences of FAILURE OF AUXILIARY SYSTEMS are that cause LNG LEAKS is	**VERY WEAKER**	**EXTREME WEAKER**	than HOSE RUPTURE
Consequences of FAILURE OF AUXILIARY SYSTEMS are that cause LNG LEAKS is	**WEAKER**	**MODERATE WEAKER**	than INCORRECT SEQUENCE
Consequences of HOSE RUPTURE that cause LNG LEAKS is	**MODERATE STRONGER**	**STRONGER**	than INCORRECT SEQUENCE

NG LEAKS CONSEQUENCES

Consequences of MISHANDLING that cause NG LEAKS is	**EQUAL**	**VERY WEAKER**	than BREAKAWAY COUPLING DISCONNECTION
Consequences of EXTREME WEATHER CONDITIONS are that cause NG LEAKS is	**EQUAL**	**VERY WEAKER**	than SHIP / TRUCK MOVEMENT
Consequences of FATIGUE that cause NG LEAKS is	**STRONGER**	**MODERATE WEAKER**	than TRAINING
Consequences of FATIGUE that cause NG LEAKS is	**VERY STRONGER**	**MODERATE STRONGER**	than AWARENESS
Consequences of TRAINING that cause NG LEAKS is	**MODERATE STRONGER**	**STRONGER**	than AWARENESS
Consequences of LNG TRAPPED IN PIPE that cause NG LEAKS is	**MODERATE STRONGER**	**WEAKER**	than INAPPROPRIATE COOLING OF BUNKER LINE
Consequences of LNG TRAPPED IN PIPE that cause NG LEAKS is	**VERY WEAKER**	**EQUAL**	than INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE
Consequences of LNG TRAPPED IN PIPE that cause NG LEAKS is	**STRONGER**	**MODERATE STRONGER**	than FAILURE OF AUXILIARY SYSTEMS
Consequences of LNG TRAPPED IN PIPE that cause NG LEAKS is	**VERY STRONGER**	**MODERATE STRONGER**	than LOSS OF BUNKER VEHICLE POWER
Consequences of LNG TRAPPED IN PIPE that cause NG LEAKS is	**WEAKER**	**STRONGER**	than FAILURE OF COMMUNICATION OR ESD
Consequences of LNG TRAPPED IN PIPE that cause NG LEAKS is	**WEAKER**	**MODERATE WEAKER**	than INCORRECT SEQUENCE
Consequences of INAPPROPRIATE COOLING OF BUNKER LINE that cause NG LEAKS is	**VERY WEAKER**	**EQUAL**	than INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE
Consequences of INAPPROPRIATE COOLING OF BUNKER LINE that cause NG LEAKS is	**EQUAL**	**MODERATE STRONGER**	than FAILURE OF AUXILIARY SYSTEMS (N2, AIR)
Consequences of INAPPROPRIATE COOLING OF BUNKER LINE that cause NG LEAKS is	**STRONGER**	**MODERATE STRONGER**	than LOSS OF BUNKER VEHICLE POWER
Consequences of INAPPROPRIATE COOLING OF BUNKER LINE that cause NG LEAKS is	**VERY WEAKER**	**STRONGER**	than FAILURE OF COMMUNICATION OR ESD
Consequences of INAPPROPRIATE COOLING OF BUNKER LINE that cause NG LEAKS is	**WEAKER**	**EQUAL**	than INCORRECT SEQUENCE

Consequences of INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE that cause NG LEAKS is	**VERY STRONGER**	**MODERATE STRONGER**	than FAILURE OF AUXILIARY SYSTEMS (N2, AIR)
Consequences of INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE that cause NG LEAKS is	**EXTREMELY STRONGER**	**MODERATE STRONGER**	than LOSS OF BUNKER VEHICLE POWER
Consequences of INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE that cause NG LEAKS is	**MODERATE STRONGER**	**STRONGER**	than FAILURE OF COMMUNICATION OR ESD
Consequences of INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE that cause NG LEAKS is	**MODERATE STRONGER**	**MODERATE WEAKER**	than INCORRECT SEQUENCE
Consequences of FAILURE OF AUXILIARY SYSTEMS are that cause NG LEAKS is	**MODERATE STRONGER**	**MODERATE STRONGER**	than LOSS OF BUNKER VEHICLE POWER
Consequences of FAILURE OF AUXILIARY SYSTEMS are that cause NG LEAKS is	**WEAKER**	**VERY STRONGER**	than FAILURE OF COMMUNICATION OR ESD
Consequences of FAILURE OF AUXILIARY SYSTEMS are that cause NG LEAKS is	**WEAKER**	**MODERATE WEAKER**	than INCORRECT SEQUENCE
Consequences of LOSS OF BUNKER VEHICLE POWER that cause NG LEAKS is	**VERY WEAKER**	**MODERATE STRONGER**	than FAILURE OF COMMUNICATION OR ESD
Consequences of LOSS OF BUNKER VEHICLE POWER that cause NG LEAKS is	**WEAKER**	**WEAKER**	than INCORRECT SEQUENCE
Consequences of FAILURE OF COMMUNICATION OR ESD that cause NG LEAKS is	**EQUAL**	**VERY WEAKER**	than INCORRECT SEQUENCE
LNG TRAPPED IN PIPE CONSEQUENCES			
Consequences of EXTREME WEATHER CONDITIONS are that cause LNG TRAPPED IN PIPE is	**EQUAL**	**STRONGER**	than SHIP / TRUCK MOVEMENT
Consequences of INAPPROPRIATE COOLING OF BUNKER LINE that cause LNG TRAPPED IN PIPE is	**MODERATE STRONGER**	**STRONGER**	than LOSS OF BUNKER VEHICLE POWER
INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE CONSEQUENCES			
Consequences of LNG TRAPPED IN PIPE that cause INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE is	**EXTREMELY STRONGER**	**STRONGER**	than FAILURE OF AUXILIARY SYSTEMS
HOSE RUPTURE CONSEQUENCES			
Consequences of EXTREME WEATHER CONDITIONS are that cause HOSE RUPTURE is	**EQUAL**	**WEAKER**	than SHIP / TRUCK MOVEMENT
INCORRECT SEQUENCE CONSEQUENCES			
Consequences of FATIGUE that cause INCORRECT SEQUENCE is	**STRONGER**	**WEAKER**	than TRAINING
Consequences of FATIGUE that cause INCORRECT SEQUENCE is	**MODERATE STRONGER**	**EQUAL**	than AWARENESS
Consequences of TRAINING that cause INCORRECT SEQUENCE is	**EQUAL**	**VERY STRONGER**	than AWARENESS

BREAKAWAY COUPLING CONSEQUENCES			
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause BREAKAWAY COUPLING is	**MODERATE WEAKER**	**MODERATE WEAKER**	than FIRE ON SHIP
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause BREAKAWAY COUPLING is	**VERY WEAKER**	**VERY WEAKER**	than LNG LEAKS
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause BREAKAWAY COUPLING is	**WEAKER**	**WEAKER**	than NG LEAKS
Consequences of FIRE ON SHIP that cause BREAKAWAY COUPLING is	**VERY WEAKER**	**VERY WEAKER**	than LNG LEAKS
Consequences of FIRE ON SHIP that cause BREAKAWAY COUPLING is	**WEAKER**	**WEAKER**	than NG LEAKS
Consequences of LNG LEAKS are that cause BREAKAWAY COUPLING is	**MODERATE STRONGER**	**MODERATE STRONGER**	than NG LEAKS

DRY COUPLING DISCONNECTION CONSEQUENCES			
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause DRY COUPLING DISCONNECTION is	**EQUAL**	**MODERATE WEAKER**	than FIRE ON SHIP
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause DRY COUPLING DISCONNECTION is	**MODERATE WEAKER**	**EXTREME WEAKER**	than LNG LEAKS
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause DRY COUPLING DISCONNECTION is	**WEAKER**	**VERY WEAKER**	than NG LEAKS
Consequences of FIRE ON SHIP that cause DRY COUPLING DISCONNECTION is	**MODERATE WEAKER**	**VERY WEAKER**	than LNG LEAKS
Consequences of FIRE ON SHIP that cause DRY COUPLING DISCONNECTION is	**WEAKER**	**VERY WEAKER**	than NG LEAKS
Consequences of LNG LEAKS are that cause DRY COUPLING DISCONNECTION is	**EQUAL**	**MODERATE STRONGER**	than NG LEAKS

MISHANDLING CONSEQUENCES			
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause MISHANDLING is	**EQUAL**	**MODERATE WEAKER**	than FIRE ON SHIP
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause MISHANDLING is	**MODERATE WEAKER**	**VERY WEAKER**	than LNG LEAKS
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause MISHANDLING is	**MODERATE WEAKER**	**WEAKER**	than NG LEAKS
Consequences of FIRE ON SHIP that cause MISHANDLING is	**MODERATE WEAKER**	**VERY WEAKER**	than LNG LEAKS
Consequences of FIRE ON SHIP that cause MISHANDLING is	**MODERATE WEAKER**	**WEAKER**	than NG LEAKS
Consequences of LNG LEAKS are that cause MISHANDLING is	**EQUAL**	**MODERATE STRONGER**	than NG LEAKS

ELECTRICAL EQUIPMENT CONSEQUENCES			
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause ELECTRICAL EQUIPMENT is	**MODERATE WEAKER**	**WEAKER**	than FIRE ON SHIP
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause ELECTRICAL EQUIPMENT is	**STRONGER**	**STRONGER**	than LNG LEAKS
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause ELECTRICAL EQUIPMENT is	**STRONGER**	**STRONGER**	than NG LEAKS
Consequences of FIRE ON SHIP that cause ELECTRICAL EQUIPMENT is	**STRONGER**	**VERY STRONGER**	than LNG LEAKS
Consequences of FIRE ON SHIP that cause ELECTRICAL EQUIPMENT is	**STRONGER**	**VERY STRONGER**	than NG LEAKS
Consequences of LNG LEAKS are that cause ELECTRICAL EQUIPMENT is	**EQUAL**	**EQUAL**	than NG LEAKS

EXTREME WEATHER CONDITIONS CONSEQUENCES			
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause EXTREME WEATHER CONDITIONS is	**EQUAL**	**EQUAL**	than FIRE ON SHIP
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause EXTREME WEATHER CONDITIONS is	**VERY WEAKER**	**VERY WEAKER**	than LNG LEAKS
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause EXTREME WEATHER CONDITIONS is	**WEAKER**	**VERY WEAKER**	than NG LEAKS
Consequences of FIRE ON SHIP that cause EXTREME WEATHER CONDITIONS is	**VERY WEAKER**	**VERY WEAKER**	than LNG LEAKS
Consequences of FIRE ON SHIP that cause EXTREME WEATHER CONDITIONS is	**WEAKER**	**VERY WEAKER**	than NG LEAKS
Consequences of LNG LEAKS are that cause EXTREME WEATHER CONDITIONS is	**STRONGER**	**MODERATE STRONGER**	than NG LEAKS

FIRE ON PIER / BUNKER VESSEL CONSEQUENCES			
Consequences of LNG LEAKS are that cause FIRE ON PIER / BUNKER VESSEL is	**STRONGER**	**STRONGER**	than NG LEAKS

FIRE ON SHIP CONSEQUENCES			
Consequences of LNG LEAKS are that cause FIRE ON SHIP is	**STRONGER**	**STRONGER**	than NG LEAKS

SHIP / TRUCK MOVEMENT CONSEQUENCES			
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause SHIP / TRUCK MOVEMENT is	**EQUAL**	**EQUAL**	than FIRE ON SHIP
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause SHIP / TRUCK MOVEMENT is	**VERY WEAKER**	**VERY WEAKER**	than LNG LEAKS
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause SHIP / TRUCK MOVEMENT is	**WEAKER**	**VERY WEAKER**	than NG LEAKS
Consequences of FIRE ON SHIP that cause SHIP / TRUCK MOVEMENT is	**VERY WEAKER**	**VERY WEAKER**	than LNG LEAKS
Consequences of FIRE ON SHIP that cause SHIP / TRUCK MOVEMENT is	**WEAKER**	**VERY WEAKER**	than NG LEAKS
Consequences of LNG LEAKS are that cause SHIP / TRUCK MOVEMENT is	**STRONGER**	**MODERATE STRONGER**	than NG LEAKS

SIMULTANOUS OPERATIONS CONSEQUENCES			
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause SIMULTANOUS OPERATIONS is	**WEAKER**	**MODERATE WEAKER**	than FIRE ON SHIP
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause SIMULTANOUS OPERATIONS is	**MODERATE STRONGER**	**MODERATE STRONGER**	than LNG LEAKS
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause SIMULTANOUS OPERATIONS is	**MODERATE STRONGER**	**MODERATE STRONGER**	than NG LEAKS
Consequences of FIRE ON SHIP that cause SIMULTANOUS OPERATIONS is	**STRONGER**	**MODERATE STRONGER**	than LNG LEAKS
Consequences of FIRE ON SHIP that cause SIMULTANOUS OPERATIONS is	**STRONGER**	**MODERATE STRONGER**	than NG LEAKS
Consequences of LNG LEAKS are that cause SIMULTANOUS OPERATIONS is	**EQUAL**	**EQUAL**	than NG LEAKS

UNAUTHORIZED TRAFFIC IN SECURITY ZONE CONSEQUENCES			
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause UNAUTHORIZED TRAFFIC IN SECURITY ZONE is	**MODERATE WEAKER**	**MODERATE STRONGER**	than FIRE ON SHIP
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause UNAUTHORIZED TRAFFIC IN SECURITY ZONE is	**STRONGER**	**MODERATE STRONGER**	than LNG LEAKS
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause UNAUTHORIZED TRAFFIC IN SECURITY ZONE is	**STRONGER**	**MODERATE STRONGER**	than NG LEAKS
Consequences of FIRE ON SHIP that cause UNAUTHORIZED TRAFFIC IN SECURITY ZONE is	**STRONGER**	**MODERATE STRONGER**	than LNG LEAKS
Consequences of FIRE ON SHIP that cause UNAUTHORIZED TRAFFIC IN SECURITY ZONE is	**STRONGER**	**MODERATE STRONGER**	than NG LEAKS
Consequences of LNG LEAKS are that cause UNAUTHORIZED TRAFFIC IN SECURITY ZONE is	**EQUAL**	**EQUAL**	than NG LEAKS

AWARENESS CONSEQUENCES			
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause AWARENESS is	**EQUAL**	**EQUAL**	than FIRE ON SHIP
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause AWARENESS is	**WEAKER**	**WEAKER**	than LNG LEAKS
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause AWARENESS is	**MODERATE WEAKER**	**MODERATE WEAKER**	than NG LEAKS
Consequences of FIRE ON SHIP that cause AWARENESS is	**WEAKER**	**WEAKER**	than LNG LEAKS
Consequences of FIRE ON SHIP that cause AWARENESS is	**MODERATE WEAKER**	**MODERATE WEAKER**	than NG LEAKS
Consequences of LNG LEAKS are that cause AWARENESS is	**MODERATE STRONGER**	**MODERATE STRONGER**	than NG LEAKS

FATIGUE CONSEQUENCES			
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause FATIGUE is	**EQUAL**	**EQUAL**	than FIRE ON SHIP
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause FATIGUE is	**MODERATE WEAKER**	**WEAKER**	than LNG LEAKS
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause FATIGUE is	**MODERATE WEAKER**	**MODERATE WEAKER**	than NG LEAKS
Consequences of FIRE ON SHIP that cause FATIGUE is	**WEAKER**	**WEAKER**	than LNG LEAKS
Consequences of FIRE ON SHIP that cause FATIGUE is	**MODERATE WEAKER**	**MODERATE WEAKER**	than NG LEAKS
Consequences of LNG LEAKS are that cause FATIGUE is	**MODERATE STRONGER**	**MODERATE STRONGER**	than NG LEAKS

TRAINING CONSEQUENCES			
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause TRAINING is	**EQUAL**	**EQUAL**	than FIRE ON SHIP
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause TRAINING is	**WEAKER**	**WEAKER**	than LNG LEAKS
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause TRAINING is	**MODERATE WEAKER**	**MODERATE WEAKER**	than NG LEAKS
Consequences of FIRE ON SHIP that cause TRAINING is	**WEAKER**	**WEAKER**	than LNG LEAKS
Consequences of FIRE ON SHIP that cause TRAINING is	**MODERATE WEAKER**	**MODERATE WEAKER**	than NG LEAKS
Consequences of LNG LEAKS are that cause TRAINING is	**MODERATE STRONGER**	**MODERATE STRONGER**	than NG LEAKS

FAILURE OF AUXILIARY SYSTEMS CONSEQUENCES			
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause FAILURE OF AUXILIARY SYSTEMS is	**EQUAL**	**EQUAL**	than FIRE ON SHIP
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause FAILURE OF AUXILIARY SYSTEMS is	**VERY WEAKER**	**WEAKER**	than LNG LEAKS
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause FAILURE OF AUXILIARY SYSTEMS is	**WEAKER**	**WEAKER**	than NG LEAKS
Consequences of FIRE ON SHIP that cause FAILURE OF AUXILIARY SYSTEMS is	**WEAKER**	**WEAKER**	than LNG LEAKS
Consequences of FIRE ON SHIP that cause FAILURE OF AUXILIARY SYSTEMS is	**WEAKER**	**WEAKER**	than NG LEAKS
Consequences of LNG LEAKS are that cause FAILURE OF AUXILIARY SYSTEMS is	**MODERATE STRONGER**	**MODERATE STRONGER**	than NG LEAKS

FAILURE OF COMMUNICATION OR ESD CONSEQUENCES			
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause FAILURE OF COMMUNICATION OR ESD is	**EQUAL**	**EQUAL**	than FIRE ON SHIP
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause FAILURE OF COMMUNICATION OR ESD is	**WEAKER**	**WEAKER**	than LNG LEAKS
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause FAILURE OF COMMUNICATION OR ESD is	**WEAKER**	**WEAKER**	than NG LEAKS
Consequences of FIRE ON SHIP that cause FAILURE OF COMMUNICATION OR ESD is	**WEAKER**	**WEAKER**	than LNG LEAKS
Consequences of FIRE ON SHIP that cause FAILURE OF COMMUNICATION OR ESD is	**WEAKER**	**WEAKER**	than NG LEAKS
Consequences of LNG LEAKS are that cause FAILURE OF COMMUNICATION OR ESD is	**EQUAL**	**MODERATE STRONGER**	than NG LEAKS

HOSE RUPTURE CONSEQUENCES			
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause HOSE RUPTURE is	**EQUAL**	**MODERATE WEAKER**	than FIRE ON SHIP
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause HOSE RUPTURE is	**WEAKER**	**VERY WEAKER**	than LNG LEAKS
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause HOSE RUPTURE is	**MODERATE WEAKER**	**WEAKER**	than NG LEAKS
Consequences of FIRE ON SHIP that cause HOSE RUPTURE is	**WEAKER**	**VERY WEAKER**	than LNG LEAKS
Consequences of FIRE ON SHIP that cause HOSE RUPTURE is	**MODERATE WEAKER**	**VERY WEAKER**	than NG LEAKS
Consequences of LNG LEAKS are that cause HOSE RUPTURE is	**STRONGER**	**EQUAL**	than NG LEAKS

INAPPROPRIATE COOLING OF BUNKER LINE CONSEQUENCES			
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause INAPPROPRIATE COOLING OF BUNKER LINE is	**EQUAL**	**MODERATE WEAKER**	than FIRE ON SHIP
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause INAPPROPRIATE COOLING OF BUNKER LINE is	**EXTREME WEAKER**	**VERY WEAKER**	than LNG LEAKS
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause INAPPROPRIATE COOLING OF BUNKER LINE is	**WEAKER**	**WEAKER**	than NG LEAKS
Consequences of FIRE ON SHIP that cause INAPPROPRIATE COOLING OF BUNKER LINE is	**EXTREME WEAKER**	**VERY WEAKER**	than LNG LEAKS
Consequences of FIRE ON SHIP that cause INAPPROPRIATE COOLING OF BUNKER LINE is	**MODERATE WEAKER**	**WEAKER**	than NG LEAKS
Consequences of LNG LEAKS are that cause INAPPROPRIATE COOLING OF BUNKER LINE is	**STRONGER**	**MODERATE STRONGER**	than NG LEAKS

INAPPROPRIATE INERTING OF HOSE/BUNKER LINE CONSEQUENCES			
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause INAPPROPRIATE INERTING OF HOSE/BUNKER LINE is	**EQUAL**	**MODERATE WEAKER**	than FIRE ON SHIP
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause INAPPROPRIATE INERTING OF HOSE/BUNKER LINE is	**STRONGER**	**VERY WEAKER**	than LNG LEAKS
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause INAPPROPRIATE INERTING OF HOSE/BUNKER LINE is	**STRONGER**	**WEAKER**	than NG LEAKS
Consequences of FIRE ON SHIP that cause INAPPROPRIATE INERTING OF HOSE/BUNKER LINE is	**STRONGER**	**VERY WEAKER**	than LNG LEAKS
Consequences of FIRE ON SHIP that cause INAPPROPRIATE INERTING OF HOSE/BUNKER LINE is	**STRONGER**	**WEAKER**	than NG LEAKS
Consequences of LNG LEAKS are that cause INAPPROPRIATE INERTING OF HOSE/BUNKER LINE is	**MODERATE STRONGER**	**MODERATE STRONGER**	than NG LEAKS

INCORRECT SEQUENCE CONSEQUENCES			
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause INCORRECT SEQUENCE is	**EQUAL**	**MODERATE WEAKER**	than FIRE ON SHIP
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause INCORRECT SEQUENCE is	**MODERATE WEAKER**	**VERY WEAKER**	than LNG LEAKS
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause INCORRECT SEQUENCE is	**WEAKER**	**WEAKER**	than NG LEAKS
Consequences of FIRE ON SHIP that cause INCORRECT SEQUENCE is	**MODERATE WEAKER**	**VERY WEAKER**	than LNG LEAKS
Consequences of FIRE ON SHIP that cause INCORRECT SEQUENCE is	**WEAKER**	**WEAKER**	than NG LEAKS
Consequences of LNG LEAKS are that cause INCORRECT SEQUENCE is	**WEAKER**	**MODERATE STRONGER**	than NG LEAKS

LNG TRAPPED IN PIPE CONSEQUENCES			
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause LNG TRAPPED IN PIPE is	**VERY WEAKER**	**VERY WEAKER**	than FIRE ON SHIP
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause LNG TRAPPED IN PIPE is	**WEAKER**	**WEAKER**	than LNG LEAKS
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause LNG TRAPPED IN PIPE is	**WEAKER**	**WEAKER**	than NG LEAKS
Consequences of FIRE ON SHIP that cause LNG TRAPPED IN PIPE is	**MODERATE WEAKER**	**MODERATE WEAKER**	than LNG LEAKS
Consequences of FIRE ON SHIP that cause LNG TRAPPED IN PIPE is	**MODERATE WEAKER**	**MODERATE WEAKER**	than NG LEAKS
Consequences of LNG LEAKS are that cause LNG TRAPPED IN PIPE is	**EQUAL**	**EQUAL**	than NG LEAKS

LOSS OF BUNKER VEHICLE POWER CONSEQUENCES			
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause LOSS OF BUNKER VEHICLE POWER is	**WEAKER**	**MODERATE STRONGER**	than FIRE ON SHIP
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause LOSS OF BUNKER VEHICLE POWER is	**VERY WEAKER**	**STRONGER**	than LNG LEAKS
Consequences of FIRE ON PIER/BUNKER VESSEL is that cause LOSS OF BUNKER VEHICLE POWER is	**VERY WEAKER**	**MODERATE STRONGER**	than NG LEAKS
Consequences of FIRE ON SHIP that cause LOSS OF BUNKER VEHICLE POWER is	**WEAKER**	**MODERATE STRONGER**	than LNG LEAKS
Consequences of FIRE ON SHIP that cause LOSS OF BUNKER VEHICLE POWER is	**WEAKER**	**MODERATE WEAKER**	than NG LEAKS
Consequences of LNG LEAKS are that cause LOSS OF BUNKER VEHICLE POWER is	**EQUAL**	**VERY WEAKER**	than NG LEAKS

D.4 Questionnaire for nodes - Likelihood

	DECISION MARKER 2	DECISION MAKER 1	
MISHANDLING LIKELIHOOD			
FATIGUE is	**MODERATE STRONGLY**	**MODERATE STRONGLY**	probable than TRAINING for mishandling
FATIGUE is	**STRONGLY**	**STRONGLY**	probable than AWARENESS for mishandling
TRAINING is	**MODERATE STRONGLY**	**MODERATE STRONGLY**	probable than AWARENESS for mishandling
BREAKAWAY COUPLING DISCONNECTION LIKELIHOOD			
EXTREME WEATHER CONDITIONS are	**EXTREME WEAKLY**	**EXTREME WEAKLY**	probable than SHIP / TRUCK MOVEMENT for breakaway coupling disconnection

DRY COUPLING DISCONNECTION LIKELIHOOD			
EXTREME WEATHER CONDITIONS are	**VERY WEAKLY**	**VERY WEAKLY**	probable than SHIP / TRUCK MOVEMENT for dry coupling disconnection
FIRE ON SHIPS LIKELIHOOD			
SIMULTANOUS OPERATIONS are	**EQUALLY**	**EQUALLY**	probable than ELECTRICAL EQUIPMENTS for fire on ships
FIRE ON PIER / BUNKER VESSEL LIKELIHOOD			
SIMULTANOUS OPERATIONS are	**VERY WEAKLY**	**VERY WEAKLY**	probable than ELECTRICAL EQUIPMENTS for fire on pier / bunker vessel
SIMULTANOUS OPERATIONS are	**WEAKLY**	**WEAKLY**	probable than UNAUTHORIZED TRAFFIC IN SECURITY ZONE for fire on pier / bunker vessel
ELECTRICAL EQUIPMENTS are	**MODERATE STRONGLY**	**MODERATE STRONGLY**	probable than UNAUTHORIZED TRAFFIC IN SECURITY ZONE for fire on pier / bunker vessel
SIMULTANOUS OPERATIONS LIKELIHOOD			
TRAINING is	**VERY STRONGLY**	**VERY STRONGLY**	probable than AWARENESS for simultanous operations
ELECTRICAL EQUIPMENTS LIKELIHOOD			
TRAINING is	**VERY STRONGLY**	**VERY STRONGLY**	probable than AWARENESS for electrical equipments
UNAUTHORIZED TRAFFIC IN SECURITY ZONE LIKELIHOOD			
TRAINING is	**VERY STRONGLY**	**VERY STRONGLY**	probable than AWARENESS for unauthorized traffic in security zone
LNG LEAKS LIKELIHOOD			
MISHANDLING is	**VERY STRONGLY**	**VERY STRONGLY**	probable than DRY COUPLING DISCONNECTION for lng leaks
EXTREME WEATHER CONDITIONS are	**EXTREME WEAKLY**	**EXTREME WEAKLY**	probable than SHIP / TRUCK MOVEMENT for lng leaks
FATIGUE is	**VERY STRONGLY**	**VERY STRONGLY**	probable than TRAINING for lng leaks
FATIGUE is	**STRONGLY**	**MODERATE STRONGLY**	probable than AWARENESS for lng leaks
TRAINING is	**MODERATE WEAKLY**	**WEAKLY**	probable than AWARENESS for lng leaks
FAILURE OF AUXILIARY SYSTEMS are	**VERY STRONGLY**	**STRONGLY**	probable than HOSE RUPTURE for lng leaks
FAILURE OF AUXILIARY SYSTEMS are	**MODERATE WEAKLY**	**MODERATE WEAKLY**	probable than INCORRECT SEQUENCE for lng leaks
HOSE RUPTURE is	**EXTREME WEAKLY**	**VERY WEAKLY**	probable than INCORRECT SEQUENCE for lng leaks

NG LEAKS LIKELIHOOD			
MISHANDLING is	**VERY STRONGLY**	**VERY STRONGLY**	probable than BREAKAWAY COUPLING DISCONNECTION for ng leaks
EXTREME WEATHER CONDITIONS are	**EQUALLY**	**EQUALLY**	probable than SHIP / TRUCK MOVEMENT for ng leaks
FATIGUE is	**STRONGLY**	**STRONGLY**	probable than TRAINING for ng leaks
FATIGUE is	**MODERATE STRONGLY**	**MODERATE STRONGLY**	probable than AWARENESS for ng leaks
TRAINING is	**MODERATE WEAKLY**	**MODERATE WEAKLY**	probable than AWARENESS for ng leaks
LNG TRAPPED IN PIPE is	**STRONGLY**	**MODERATE WEAKLY**	probable than INAPPROPRIATE COOLING OF BUNKER LINE for ng leaks
LNG TRAPPED IN PIPE is	**WEAKLY**	**EQUALLY**	probable than INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE for ng leaks
LNG TRAPPED IN PIPE is	**VERY STRONGLY**	**VERY WEAKLY**	probable than FAILURE OF AUXILIARY SYSTEMS for ng leaks
LNG TRAPPED IN PIPE is	**STRONGLY**	**MODERATE WEAKLY**	probable than LOSS OF BUNKER VEHICLE POWER for ng leaks
LNG TRAPPED IN PIPE is	**WEAKLY**	**MODERATE WEAKLY**	probable than FAILURE OF COMMUNICATION OR ESD for ng leaks
LNG TRAPPED IN PIPE is	**STRONGLY**	**VERY WEAKLY**	probable than INCORRECT SEQUENCE for ng leaks
INAPPROPRIATE COOLING OF BUNKER LINE is	**EXTREME WEAKLY**	**EQUALLY**	probable than INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE for ng leaks
INAPPROPRIATE COOLING OF BUNKER LINE is	**MODERATE STRONGLY**	**VERY WEAKLY**	probable than FAILURE OF AUXILIARY SYSTEMS (N2, AIR) for ng leaks
INAPPROPRIATE COOLING OF BUNKER LINE is	**EQUALLY**	**MODERATE WEAKLY**	probable than LOSS OF BUNKER VEHICLE POWER for ng leaks
INAPPROPRIATE COOLING OF BUNKER LINE is	**VERY WEAKLY**	**MODERATE WEAKLY**	probable than FAILURE OF COMMUNICATION OR ESD for ng leaks
INAPPROPRIATE COOLING OF BUNKER LINE is	**MODERATE WEAKLY**	**VERY WEAKLY**	probable than INCORRECT SEQUENCE for ng leaks
INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE is	**EXTREMELY STRONG**	**VERY WEAKLY**	probable than FAILURE OF AUXILIARY SYSTEMS (N2, AIR) for ng leaks
INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE is	**VERY STRONGLY**	**WEAKLY**	probable than LOSS OF BUNKER VEHICLE POWER for ng leaks
INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE is	**MODERATE STRONGLY**	**MODERATE WEAKLY**	probable than FAILURE OF COMMUNICATION OR ESD for ng leaks
INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE is	**STRONGLY**	**EQUALLY**	probable than INCORRECT SEQUENCE for ng leaks
FAILURE OF AUXILIARY SYSTEMS are	**MODERATE WEAKLY**	**MODERATE STRONGLY**	probable than LOSS OF BUNKER VEHICLE POWER for ng leaks
FAILURE OF AUXILIARY SYSTEMS are	**VERY WEAKLY**	**MODERATE STRONGLY**	probable than FAILURE OF COMMUNICATION OR ESD for ng leaks
FAILURE OF AUXILIARY SYSTEMS are	**WEAKLY**	**EQUALLY**	probable than INCORRECT SEQUENCE for ng leaks
LOSS OF BUNKER VEHICLE POWER is	**VERY WEAKLY**	**EQUALLY**	probable than FAILURE OF COMMUNICATION OR ESD for ng leaks
LOSS OF BUNKER VEHICLE POWER is	**MODERATE WEAKLY**	**MODERATE WEAKLY**	probable than INCORRECT SEQUENCE for ng leaks
FAILURE OF COMMUNICATION OR ESD is	**MODERATE STRONGLY**	**MODERATE WEAKLY**	probable than INCORRECT SEQUENCE for ng leaks

LNG TRAPPED IN PIPE LIKELIHOOD			
EXTREME WEATHER CONDITIONS are	**VERY WEAKLY**	**VERY WEAKLY**	probable than SHIP / TRUCK MOVEMENT for lng trapped in pipe
INAPPROPRIATE COOLING OF BUNKER LINE is	**VERY WEAKLY**	**VERY WEAKLY**	probable than LOSS OF BUNKER VEHICLE POWER for lng trapped in pipe
INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE LIKELIHOOD			
LNG TRAPPED IN PIPE is	**WEAKLY**	**WEAKLY**	probable than FAILURE OF AUXILIARY SYSTEMS for inappropriate inerting of hose or bunker line
HOSE RUPTURE LIKELIHOOD			
EXTREME WEATHER CONDITIONS are	**EXTREME WEAKLY**	**EXTREME WEAKLY**	probable than SHIP / TRUCK MOVEMENT for hose rupture
INCORRECT SEQUENCE LIKELIHOOD			
FATIGUE is	**MODERATE STRONGLY**	**VERY WEAKLY**	probable than TRAINING for incorrect sequence
FATIGUE is	**STRONGLY**	**MODERATE STRONGLY**	probable than AWARENESS for incorrect sequence
TRAINING is	**MODERATE STRONGLY**	**EXTREMELY STRONG**	probable than AWARENESS for incorrect sequence
BREAKAWAY COUPLING LIKELIHOOD			
FIRE ON PIER/BUNKER VESSEL is	**MODERATE WEAKLY**	**MODERATE WEAKLY**	probable than FIRE ON SHIP for breakaway coupling disconnection
FIRE ON PIER/BUNKER VESSEL is	**VERY WEAKLY**	**EXTREME WEAKLY**	probable than LNG LEAKS for breakaway coupling disconnection
FIRE ON PIER/BUNKER VESSEL is	**WEAKLY**	**MODERATE WEAKLY**	probable than NG LEAKS for breakaway coupling disconnection
FIRE ON SHIP is	**VERY WEAKLY**	**VERY WEAKLY**	probable than LNG LEAKS for breakaway coupling disconnection
FIRE ON SHIP is	**WEAKLY**	**WEAKLY**	probable than NG LEAKS for breakaway coupling disconnection
LNG LEAKS are	**MODERATE STRONGLY**	**MODERATE STRONGLY**	probable than NG LEAKS for breakaway coupling disconnection

DRY COUPLING DISCONNECTION LIKELIHOOD			
FIRE ON PIER/BUNKER VESSEL is	**MODERATE WEAKLY**	**MODERATE WEAKLY**	probable than FIRE ON SHIP for dry coupling disconnection
FIRE ON PIER/BUNKER VESSEL is	**WEAKLY**	**MODERATE WEAKLY**	probable than LNG LEAKS for dry coupling disconnection
FIRE ON PIER/BUNKER VESSEL is	**VERY WEAKLY**	**EXTREME WEAKLY**	probable than NG LEAKS for dry coupling disconnection
FIRE ON SHIP is	**WEAKLY**	**WEAKLY**	probable than LNG LEAKS for dry coupling disconnection
FIRE ON SHIP is	**VERY WEAKLY**	**VERY WEAKLY**	probable than NG LEAKS for dry coupling disconnection
LNG LEAKS are	**MODERATE WEAKLY**	**MODERATE WEAKLY**	probable than NG LEAKS for dry coupling disconnection

MISHANDLING LIKELIHOOD			
FIRE ON PIER/BUNKER VESSEL is	**MODERATE WEAKLY**	**MODERATE WEAKLY**	probable than FIRE ON SHIP for mishandling
FIRE ON PIER/BUNKER VESSEL is	**VERY WEAKLY**	**VERY WEAKLY**	probable than LNG LEAKS for mishandling
FIRE ON PIER/BUNKER VESSEL is	**WEAKLY**	**WEAKLY**	probable than NG LEAKS for mishandling
FIRE ON SHIP is	**VERY WEAKLY**	**VERY WEAKLY**	probable than LNG LEAKS for mishandling
FIRE ON SHIP is	**WEAKLY**	**WEAKLY**	probable than NG LEAKS for mishandling
LNG LEAKS are	**MODERATE STRONGLY**	**EQUALLY**	probable than NG LEAKS for mishandling

ELECTRICAL EQUIPMENT LIKELIHOOD			
FIRE ON PIER/BUNKER VESSEL is	**MODERATE WEAKLY**	**MODERATE WEAKLY**	probable than FIRE ON SHIP for electrical equipment
FIRE ON PIER/BUNKER VESSEL is	**MODERATE STRONGLY**	**MODERATE STRONGLY**	probable than LNG LEAKS for electrical equipment
FIRE ON PIER/BUNKER VESSEL is	**STRONGLY**	**MODERATE STRONGLY**	probable than NG LEAKS for electrical equipment
FIRE ON SHIP is	**VERY STRONGLY**	**MODERATE STRONGLY**	probable than LNG LEAKS for electrical equipment
FIRE ON SHIP is	**STRONGLY**	**MODERATE STRONGLY**	probable than NG LEAKS for electrical equipment
LNG LEAKS are	**EQUALLY**	**EQUALLY**	probable than NG LEAKS for electrical equipment

EXTREME WEATHER CONDITIONS LIKELIHOOD			
FIRE ON PIER/BUNKER VESSEL is	**EQUALLY**	**EQUALLY**	probable than FIRE ON SHIP for extreme weather conditions
FIRE ON PIER/BUNKER VESSEL is	**VERY WEAKLY**	**VERY WEAKLY**	probable than LNG LEAKS for extreme weather conditions
FIRE ON PIER/BUNKER VESSEL is	**WEAKLY**	**VERY WEAKLY**	probable than NG LEAKS for extreme weather conditions
FIRE ON SHIP is	**VERY WEAKLY**	**VERY WEAKLY**	probable than LNG LEAKS for extreme weather conditions
FIRE ON SHIP is	**WEAKLY**	**VERY WEAKLY**	probable than NG LEAKS for extreme weather conditions
LNG LEAKS are	**MODERATE STRONGLY**	**MODERATE STRONGLY**	probable than NG LEAKS for extreme weather conditions
FIRE ON PIER / BUNKER VESSEL LIKELIHOOD			
LNG LEAKS are	**VERY WEAKLY**	**VERY WEAKLY**	probable than NG LEAKS for fire on pier / bunker vessel
FIRE ON SHIP LIKELIHOOD			
LNG LEAKS are	**VERY WEAKLY**	**VERY WEAKLY**	probable than NG LEAKS for fire on ship
SHIP / TRUCK MOVEMENT LIKELIHOOD			
FIRE ON PIER/BUNKER VESSEL is	**EQUALLY**	**EQUALLY**	probable than FIRE ON SHIP for ship / truck movement
FIRE ON PIER/BUNKER VESSEL is	**VERY WEAKLY**	**VERY WEAKLY**	probable than LNG LEAKS for ship / truck movement
FIRE ON PIER/BUNKER VESSEL is	**WEAKLY**	**VERY WEAKLY**	probable than NG LEAKS for ship / truck movement
FIRE ON SHIP is	**VERY WEAKLY**	**VERY WEAKLY**	probable than LNG LEAKS for ship / truck movement
FIRE ON SHIP is	**WEAKLY**	**VERY WEAKLY**	probable than NG LEAKS for ship / truck movement
LNG LEAKS are	**MODERATE STRONGLY**	**MODERATE STRONGLY**	probable than NG LEAKS for ship / truck movement
SIMULTANOUS OPERATIONS LIKELIHOOD			
FIRE ON PIER/BUNKER VESSEL is	**MODERATE WEAKLY**	**MODERATE WEAKLY**	probable than FIRE ON SHIP for simultanous operations
FIRE ON PIER/BUNKER VESSEL is	**MODERATE STRONGLY**	**MODERATE STRONGLY**	probable than LNG LEAKS for simultanous operations
FIRE ON PIER/BUNKER VESSEL is	**STRONGLY**	**MODERATE STRONGLY**	probable than NG LEAKS for simultanous operations
FIRE ON SHIP is	**VERY STRONGLY**	**STRONGLY**	probable than LNG LEAKS for simultanous operations
FIRE ON SHIP is	**STRONGLY**	**STRONGLY**	probable than NG LEAKS for simultanous operations
LNG LEAKS are	**EQUALLY**	**EQUALLY**	probable than NG LEAKS for simultanous operations

UNAUTHORIZED TRAFFIC IN SECURITY ZONE LIKELIHOOD			
FIRE ON PIER/BUNKER VESSEL is	**MODERATE STRONGLY**	**MODERATE STRONGLY**	probable than FIRE ON SHIP for unauthorized traffic in security zone
FIRE ON PIER/BUNKER VESSEL is	**STRONGLY**	**STRONGLY**	probable than LNG LEAKS for unauthorized traffic in security zone
FIRE ON PIER/BUNKER VESSEL is	**STRONGLY**	**STRONGLY**	probable than NG LEAKS for unauthorized traffic in security zone
FIRE ON SHIP is	**VERY STRONGLY**	**MODERATE STRONGLY**	probable than LNG LEAKS for unauthorized traffic in security zone
FIRE ON SHIP is	**STRONGLY**	**MODERATE STRONGLY**	probable than NG LEAKS for unauthorized traffic in security zone
LNG LEAKS are	**EQUALLY**	**EQUALLY**	probable than NG LEAKS for unauthorized traffic in security zone

AWARENESS LIKELIHOOD			
FIRE ON PIER/BUNKER VESSEL is	**EQUALLY**	**EQUALLY**	probable than FIRE ON SHIP for awareness
FIRE ON PIER/BUNKER VESSEL is	**VERY WEAKLY**	**VERY WEAKLY**	probable than LNG LEAKS for awareness
FIRE ON PIER/BUNKER VESSEL is	**WEAKLY**	**WEAKLY**	probable than NG LEAKS for awareness
FIRE ON SHIP is	**VERY WEAKLY**	**VERY WEAKLY**	probable than LNG LEAKS for awareness
FIRE ON SHIP is	**WEAKLY**	**WEAKLY**	probable than NG LEAKS for awareness
LNG LEAKS are	**MODERATE STRONGLY**	**MODERATE STRONGLY**	probable than NG LEAKS for awareness

FATIGUE LIKELIHOOD			
FIRE ON PIER/BUNKER VESSEL is	**EQUALLY**	**EQUALLY**	probable than FIRE ON SHIP for fatigue
FIRE ON PIER/BUNKER VESSEL is	**VERY WEAKLY**	**VERY WEAKLY**	probable than LNG LEAKS for fatigue
FIRE ON PIER/BUNKER VESSEL is	**WEAKLY**	**WEAKLY**	probable than NG LEAKS for fatigue
FIRE ON SHIP is	**VERY WEAKLY**	**VERY WEAKLY**	probable than LNG LEAKS for fatigue
FIRE ON SHIP is	**WEAKLY**	**WEAKLY**	probable than NG LEAKS for fatigue
LNG LEAKS are	**MODERATE STRONGLY**	**MODERATE STRONGLY**	probable than NG LEAKS for fatigue

TRAINING LIKELIHOOD			
FIRE ON PIER/BUNKER VESSEL is	**EQUALLY**	**EQUALLY**	probable than FIRE ON SHIP for training
FIRE ON PIER/BUNKER VESSEL is	**WEAKLY**	**VERY WEAKLY**	probable than LNG LEAKS for training
FIRE ON PIER/BUNKER VESSEL is	**WEAKLY**	**WEAKLY**	probable than NG LEAKS for training
FIRE ON SHIP is	**WEAKLY**	**VERY WEAKLY**	probable than LNG LEAKS for training
FIRE ON SHIP is	**WEAKLY**	**WEAKLY**	probable than NG LEAKS for training
LNG LEAKS are	**MODERATE STRONGLY**	**MODERATE STRONGLY**	probable than NG LEAKS for training

FAILURE OF AUXILIARY SYSTEMS LIKELIHOOD			
FIRE ON PIER/BUNKER VESSEL is	**EQUALLY**	**WEAKLY**	probable than FIRE ON SHIP for failure of auxiliary systems
FIRE ON PIER/BUNKER VESSEL is	**WEAKLY**	**WEAKLY**	probable than LNG LEAKS for failure of auxiliary systems
FIRE ON PIER/BUNKER VESSEL is	**WEAKLY**	**WEAKLY**	probable than NG LEAKS for failure of auxiliary systems
FIRE ON SHIP is	**MODERATE WEAKLY**	**MODERATE WEAKLY**	probable than LNG LEAKS for failure of auxiliary systems
FIRE ON SHIP is	**MODERATE WEAKLY**	**MODERATE WEAKLY**	probable than NG LEAKS for failure of auxiliary systems
LNG LEAKS are	**MODERATE STRONGLY**	**EQUALLY**	probable than NG LEAKS for failure of auxiliary systems

FAILURE OF COMMUNICATION OR ESD LIKELIHOOD			
FIRE ON PIER/BUNKER VESSEL is	**WEAKLY**	**WEAKLY**	probable than FIRE ON SHIP for failure of communication or esd
FIRE ON PIER/BUNKER VESSEL is	**VERY WEAKLY**	**WEAKLY**	probable than LNG LEAKS for failure of communication or esd
FIRE ON PIER/BUNKER VESSEL is	**VERY WEAKLY**	**WEAKLY**	probable than NG LEAKS for failure of communication or esd
FIRE ON SHIP is	**WEAKLY**	**MODERATE WEAKLY**	probable than LNG LEAKS for failure of communication or esd
FIRE ON SHIP is	**MODERATE WEAKLY**	**MODERATE WEAKLY**	probable than NG LEAKS for failure of communication or esd
LNG LEAKS are	**EQUALLY**	**EQUALLY**	probable than NG LEAKS for failure of communication or esd

HOSE RUPTURE LIKELIHOOD			
FIRE ON PIER/BUNKER VESSEL is	**EQUALLY**	**EQUALLY**	probable than FIRE ON SHIP for hose rupture
FIRE ON PIER/BUNKER VESSEL is	**EXTREME WEAKLY**	**VERY WEAKLY**	probable than LNG LEAKS for hose rupture
FIRE ON PIER/BUNKER VESSEL is	**VERY WEAKLY**	**VERY WEAKLY**	probable than NG LEAKS for hose rupture
FIRE ON SHIP is	**EXTREME WEAKLY**	**VERY WEAKLY**	probable than LNG LEAKS for hose rupture
FIRE ON SHIP is	**VERY WEAKLY**	**VERY WEAKLY**	probable than NG LEAKS for hose rupture
LNG LEAKS are	**MODERATE STRONGLY**	**MODERATE STRONGLY**	probable than NG LEAKS for hose rupture

INAPPROPRIATE COOLING OF BUNKER LINE LIKELIHOOD			
FIRE ON PIER/BUNKER VESSEL is	**VERY WEAKLY**	**WEAKLY**	probable than FIRE ON SHIP for inappropriate cooling of bunker line
FIRE ON PIER/BUNKER VESSEL is	**EXTREME WEAKLY**	**EXTREME WEAKLY**	probable than LNG LEAKS for inappropriate cooling of bunker line
FIRE ON PIER/BUNKER VESSEL is	**EXTREME WEAKLY**	**EXTREME WEAKLY**	probable than NG LEAKS for inappropriate cooling of bunker line
FIRE ON SHIP is	**MODERATE WEAKLY**	**WEAKLY**	probable than LNG LEAKS for inappropriate cooling of bunker line
FIRE ON SHIP is	**MODERATE WEAKLY**	**WEAKLY**	probable than NG LEAKS for inappropriate cooling of bunker line
LNG LEAKS are	**EQUALLY**	**EQUALLY**	probable than NG LEAKS for inappropriate cooling of bunker line

INAPPROPRIATE INERTING OF HOSE/BUNKER LINE LIKELIHOOD			
FIRE ON PIER/BUNKER VESSEL is	**MODERATE WEAKLY**	**WEAKLY**	probable than FIRE ON SHIP for inappropriate inerting of hose/bunker line
FIRE ON PIER/BUNKER VESSEL is	**VERY WEAKLY**	**VERY WEAKLY**	probable than LNG LEAKS for inappropriate inerting of hose/bunker line
FIRE ON PIER/BUNKER VESSEL is	**WEAKLY**	**EXTREME WEAKLY**	probable than NG LEAKS for inappropriate inerting of hose/bunker line
FIRE ON SHIP is	**VERY WEAKLY**	**MODERATE WEAKLY**	probable than LNG LEAKS for inappropriate inerting of hose/bunker line
FIRE ON SHIP is	**WEAKLY**	**WEAKLY**	probable than NG LEAKS for inappropriate inerting of hose/bunker line
LNG LEAKS are	**MODERATE STRONGLY**	**MODERATE WEAKLY**	probable than NG LEAKS for inappropriate inerting of hose/bunker line

INCORRECT SEQUENCE LIKELIHOOD			
FIRE ON PIER/BUNKER VESSEL is	**MODERATE WEAKLY**	**WEAKLY**	probable than FIRE ON SHIP for incorrect sequence
FIRE ON PIER/BUNKER VESSEL is	**VERY WEAKLY**	**EXTREME WEAKLY**	probable than LNG LEAKS for incorrect sequence
FIRE ON PIER/BUNKER VESSEL is	**WEAKLY**	**VERY WEAKLY**	probable than NG LEAKS for incorrect sequence
FIRE ON SHIP is	**VERY WEAKLY**	**WEAKLY**	probable than LNG LEAKS for incorrect sequence
FIRE ON SHIP is	**WEAKLY**	**MODERATE WEAKLY**	probable than NG LEAKS for incorrect sequence
LNG LEAKS are	**MODERATE STRONGLY**	**MODERATE STRONGLY**	probable than NG LEAKS for incorrect sequence

LNG TRAPPED IN PIPE LIKELIHOOD			
FIRE ON PIER/BUNKER VESSEL is	**MODERATE WEAKLY**	**VERY WEAKLY**	probable than FIRE ON SHIP for LNG trapped in pipe
FIRE ON PIER/BUNKER VESSEL is	**WEAKLY**	**WEAKLY**	probable than LNG LEAKS for LNG trapped in pipe
FIRE ON PIER/BUNKER VESSEL is	**VERY WEAKLY**	**EXTREME WEAKLY**	probable than NG LEAKS for LNG trapped in pipe
FIRE ON SHIP is	**MODERATE WEAKLY**	**MODERATE STRONGLY**	probable than LNG LEAKS for LNG trapped in pipe
FIRE ON SHIP is	**WEAKLY**	**MODERATE WEAKLY**	probable than NG LEAKS for LNG trapped in pipe
LNG LEAKS are	**WEAKLY**	**WEAKLY**	probable than NG LEAKS for LNG trapped in pipe

LOSS OF BUNKER VEHICLE POWER LIKELIHOOD			
FIRE ON PIER/BUNKER VESSEL is	**MODERATE WEAKLY**	**WEAKLY**	probable than FIRE ON SHIP for loss of bunker vehicle power
FIRE ON PIER/BUNKER VESSEL is	**VERY WEAKLY**	**EXTREME WEAKLY**	probable than LNG LEAKS for loss of bunker vehicle power
FIRE ON PIER/BUNKER VESSEL is	**WEAKLY**	**VERY WEAKLY**	probable than NG LEAKS for loss of bunker vehicle power
FIRE ON SHIP is	**VERY WEAKLY**	**WEAKLY**	probable than LNG LEAKS for loss of bunker vehicle power
FIRE ON SHIP is	**WEAKLY**	**MODERATE WEAKLY**	probable than NG LEAKS for loss of bunker vehicle power
LNG LEAKS are	**MODERATE STRONGLY**	**MODERATE STRONGLY**	probable than NG LEAKS for loss of bunker vehicle power

APPENDICES E CALCULATION SHEETS FOR ANP

Calculation sheets are presented on the next page.

Table E.1: Unweighted Matrix 1 (Consequences-Decision Maker 2)

		ALTERNATIVES				CONNECTION HAZARDS		
		FIRE ON PIER / BUNKER VESSEL	FIRE ON SHIP	LNG LEAKS	NG LEAKS	BREAKAWAY COUPLING DISCONNECTION	DRY COUPLING DISCONNECTION	MISHANDLING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0000	0.0000	0.0000	0.0000	0.0518	0.1019	0.1250
	FIRE ON SHIP	0.0000	0.0000	0.0000	0.0000	0.0897	0.1019	0.1250
	LNG LEAKS	0.8333	0.8333	0.0000	1.0000	0.5770	0.3475	0.3750
	NG LEAKS	0.1667	0.1667	0.0000	0.0000	0.2816	0.4486	0.3750
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.8333	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.1667	0.5000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.2000	0.8333	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.5000	0.5000	0.5000	0.5000	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.5000	0.5000	0.5000	0.5000	0.0000
	SIMULTANOUS OPERATIONS	0.6000	0.1667	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.2000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.2: Unweighted Matrix 2 (Consequences-Decision Maker 2)

		ALTERNATIVES				CONNECTION HAZARDS		
		FIRE ON PIER / BUNKER VESSEL	FIRE ON SHIP	LNG LEAKS	NG LEAKS	BREAKAWAY COUPLING DISCONNECTION	DRY COUPLING DISCONNECTION	MISHANDLING
HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.1111	0.0810	0.0000	0.0000	0.0810
	FATIGUE	0.0000	0.0000	0.7778	0.7306	0.0000	0.0000	0.7306
	TRAINING	0.0000	0.0000	0.1111	0.1884	0.0000	0.0000	0.1884
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0719	0.0407	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.2164	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.6491	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0449	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.3954	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.2790	0.1966	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0852	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0207	0.0000	0.0000	0.0000

Table E.3: Unweighted Matrix 3 (Consequences-Decision Maker 2)

		ENVIRONMENTAL HAZARDS					HUMAN HAZARDS		
		ELECTRICAL EQUIPMENTS	EXTREME WEATHER CONDITIONS	SHIP / TRUCK MOVEMENT	SIMULTANOUS OPERATIONS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	AWARENESS	FATIGUE	TRAINING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.3069	0.0655	0.0655	0.2099	0.3069	0.0963	0.1157	0.0963
	FIRE ON SHIP	0.5316	0.0655	0.0655	0.6059	0.5316	0.0963	0.1018	0.0963
	LNG LEAKS	0.0808	0.6306	0.6306	0.0921	0.0808	0.5579	0.5189	0.5579
	NG LEAKS	0.0808	0.2383	0.2383	0.0921	0.0808	0.2495	0.2637	0.2495
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.4: Unweighted Matrix 4 (Consequences-Decision Maker 2)

		ENVIRONMENTAL HAZARDS					HUMAN HAZARDS		
		ELECTRICAL EQUIPMENTS	EXTREME WEATHER CONDITIONS	SHIP / TRUCK MOVEMENT	SIMULTANOUS OPERATIONS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	AWARENESS	FATIGUE	TRAINING
HUMAN HAZARDS	AWARENESS	0.1250	0.0000	0.0000	0.5000	0.1667	0.0000	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000
	TRAINING	0.8750	0.0000	0.0000	0.5000	0.8333	0.0000	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.5: Unweighted Matrix 5 (Consequences-Decision Maker 2)

		OPERATIONAL HAZARDS							
		FAILURE OF AUXILIARY SYSTEMS	FAILURE OF COMMUNICATION OR ESD	HOSE RUPTURE	INAPPROPRIATE COOLING OF BUNKER LINE	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	INCORRECT SEQUENCE	LNG TRAPPED IN PIPE	LOSS OF BUNKER VEHICLE POWER
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0714	0.0833	0.0921	0.0583	0.4140	0.0921	0.0534	0.0437
	FIRE ON SHIP	0.0777	0.0833	0.0921	0.0662	0.4140	0.0921	0.1823	0.1156
	LNG LEAKS	0.5559	0.4167	0.6059	0.6769	0.1090	0.2099	0.3821	0.4204
	NG LEAKS	0.2951	0.4167	0.2099	0.1986	0.0629	0.6059	0.3821	0.4204
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.5000	0.0000	0.0000	0.0000	0.5000	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.5000	0.0000	0.0000	0.0000	0.5000	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.6: Unweighted Matrix 6 (Consequences-Decision Maker 2)

		OPERATIONAL HAZARDS							
		FAILURE OF AUXILIARY SYSTEMS	FAILURE OF COMMUNICATION OR ESD	HOSE RUPTURE	INAPPROPRIATE COOLING OF BUNKER LINE	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	INCORRECT SEQUENCE	LNG TRAPPED IN PIPE	LOSS OF BUNKER VEHICLE POWER
HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.0000	0.0000	0.0000	0.1852	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.6586	0.0000	0.0000
	TRAINING	0.0000	0.0000	0.0000	0.0000	0.0000	0.1562	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.1000	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.7500	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.9000	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.2500	0.0000

Table E.7: Normalized Weighted Matrix 1 (Consequences-Decision Maker 2)

		ALTERNATIVES				CONNECTION HAZARDS		
		FIRE ON PIER / BUNKER VESSEL	FIRE ON SHIP	LNG LEAKS	NG LEAKS	BREAKAWAY COUPLING DISCONNECTION	DRY COUPLING DISCONNECTION	MISHANDLING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0000	0.0000	0.0000	0.0000	0.0259	0.0510	0.0938
	FIRE ON SHIP	0.0000	0.0000	0.0000	0.0000	0.0448	0.0510	0.0938
	LNG LEAKS	0.4623	0.4623	0.0000	0.2468	0.2885	0.1737	0.2813
	NG LEAKS	0.0925	0.0925	0.0000	0.0000	0.1408	0.2243	0.2813
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0990	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.2191	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0438	0.0990	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0891	0.3711	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.1315	0.0990	0.2500	0.2500	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.1315	0.0990	0.2500	0.2500	0.0000
	SIMULTANOUS OPERATIONS	0.2672	0.0742	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0891	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.8: Normalized Weighted Matrix 2 (Consequences-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.0292	0.0160	0.0000	0.0000	0.0202
	FATIGUE	0.0000	0.0000	0.2045	0.1447	0.0000	0.0000	0.1827
	TRAINING	0.0000	0.0000	0.0292	0.0373	0.0000	0.0000	0.0471
	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0152	0.0065	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0344	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.1370	0.0000	0.0000	0.0000	0.0000
OPERATIONAL HAZARDS	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0071	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0629	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0589	0.0313	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0136	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0033	0.0000	0.0000	0.0000

Table E.9: Normalized Weighted Matrix 3 (Consequences-Decision Maker 2)

		ENVIRONMENTAL HAZARDS					HUMAN HAZARDS		
		ELECTRICAL EQUIPMENTS	EXTREME WEATHER CONDITIONS	SHIP / TRUCK MOVEMENT	SIMULTANOUS OPERATIONS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	AWARENESS	FATIGUE	TRAINING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.2302	0.0655	0.0246	0.1574	0.2302	0.0482	0.1157	0.0963
	FIRE ON SHIP	0.3987	0.0655	0.0246	0.4545	0.3987	0.0482	0.1018	0.0963
	LNG LEAKS	0.0606	0.6306	0.2365	0.0691	0.0606	0.2789	0.5189	0.5579
	NG LEAKS	0.0606	0.2383	0.0894	0.0691	0.0606	0.1247	0.2637	0.2495
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.6250	0.0000	0.0000	0.0000	0.0000	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.10: Normalized Weighted Matrix 4 (Consequences-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0313	0.0000	0.0000	0.1250	0.0417	0.0000	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000
	TRAINING	0.2188	0.0000	0.0000	0.1250	0.2083	0.0000	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.11: Normalized Weighted Matrix 5 (Consequences-Decision Maker 2)

		OPERATIONAL HAZARDS							
		FAILURE OF AUXILIARY SYSTEMS	FAILURE OF COMMUNICATION OR ESD	HOSE RUPTURE	INAPPROPRIATE COOLING OF BUNKER LINE	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	INCORRECT SEQUENCE	LNG TRAPPED IN PIPE	LOSS OF BUNKER VEHICLE POWER
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0714	0.0507	0.0511	0.0583	0.2518	0.0511	0.0082	0.0437
	FIRE ON SHIP	0.0777	0.0507	0.0511	0.0662	0.2518	0.0511	0.0281	0.1156
	LNG LEAKS	0.5559	0.2534	0.3361	0.6769	0.0663	0.1164	0.0588	0.4204
	NG LEAKS	0.2951	0.2534	0.1164	0.1986	0.0383	0.3361	0.0588	0.4204
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6235	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.2226	0.0000	0.0000	0.0000	0.0618	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.2226	0.0000	0.0000	0.0000	0.0618	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.12: Normalized Weighted Matrix 6 (Consequences-Decision Maker 2)

		OPERATIONAL HAZARDS							
		FAILURE OF AUXILIARY SYSTEMS	FAILURE OF COMMUNICATION OR ESD	HOSE RUPTURE	INAPPROPRIATE COOLING OF BUNKER LINE	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	INCORRECT SEQUENCE	LNG TRAPPED IN PIPE	LOSS OF BUNKER VEHICLE POWER
HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0825	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.2933	0.0000	0.0000
	TRAINING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0695	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.0392	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0744	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.3527	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.3919	0.0000	0.0000	0.0000	0.0000	0.0248	0.0000

Table E.13: 32th Power of Limit Matrix 1 (Consequences-Decision Maker 2)

		ALTERNATIVES				CONNECTION HAZARDS		
		FIRE ON PIER / BUNKER VESSEL	FIRE ON SHIP	LNG LEAKS	NG LEAKS	BREAKAWAY COUPLING DISCONNECTION	DRY COUPLING DISCONNECTION	MISHANDLING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416
	FIRE ON SHIP	0.0497	0.0497	0.0497	0.0497	0.0497	0.0497	0.0497
	LNG LEAKS	0.2671	0.2671	0.2671	0.2671	0.2671	0.2671	0.2671
	NG LEAKS	0.1123	0.1123	0.1123	0.1123	0.1123	0.1123	0.1123
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0136	0.0136	0.0136	0.0136	0.0136	0.0136	0.0136
	DRY COUPLING DISCONNECTION	0.0585	0.0585	0.0585	0.0585	0.0585	0.0585	0.0585
	MISHANDLING	0.0228	0.0228	0.0228	0.0228	0.0228	0.0228	0.0228
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0221	0.0221	0.0221	0.0221	0.0221	0.0221	0.0221
	EXTREME WEATHER CONDITIONS	0.1181	0.1181	0.1181	0.1181	0.1181	0.1181	0.1181
	SHIP / TRUCK MOVEMENT	0.0727	0.0727	0.0727	0.0727	0.0727	0.0727	0.0727
	SIMULTANOUS OPERATIONS	0.0148	0.0148	0.0148	0.0148	0.0148	0.0148	0.0148
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037

Table E.14: 32th Power of Limit Matrix 2 (Consequences-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0143	0.0143	0.0143	0.0143	0.0143	0.0143	0.0143
	FATIGUE	0.0879	0.0879	0.0879	0.0879	0.0879	0.0879	0.0879
	TRAINING	0.0219	0.0219	0.0219	0.0219	0.0219	0.0219	0.0219
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051
	FAILURE OF COMMUNICATION OR ESD	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039
	HOSE RUPTURE	0.0366	0.0366	0.0366	0.0366	0.0366	0.0366	0.0366
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071
	INCORRECT SEQUENCE	0.0192	0.0192	0.0192	0.0192	0.0192	0.0192	0.0192
	LNG TRAPPED IN PIPE	0.0040	0.0040	0.0040	0.0040	0.0040	0.0040	0.0040
	LOSS OF BUNKER VEHICLE POWER	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020

Table E.15: 32th Power of Limit Matrix 3 (Consequences-Decision Maker 2)

		ENVIRONMENTAL HAZARDS					HUMAN HAZARDS		
		ELECTRICAL EQUIPMENTS	EXTREME WEATHER CONDITIONS	SHIP / TRUCK MOVEMENT	SIMULTANOUS OPERATIONS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	AWARENESS	FATIGUE	TRAINING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416
	FIRE ON SHIP	0.0497	0.0497	0.0497	0.0497	0.0497	0.0497	0.0497	0.0497
	LNG LEAKS	0.2671	0.2671	0.2671	0.2671	0.2671	0.2671	0.2671	0.2671
	NG LEAKS	0.1123	0.1123	0.1123	0.1123	0.1123	0.1123	0.1123	0.1123
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0136	0.0136	0.0136	0.0136	0.0136	0.0136	0.0136	0.0136
	DRY COUPLING DISCONNECTION	0.0585	0.0585	0.0585	0.0585	0.0585	0.0585	0.0585	0.0585
	MISHANDLING	0.0228	0.0228	0.0228	0.0228	0.0228	0.0228	0.0228	0.0228
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0221	0.0221	0.0221	0.0221	0.0221	0.0221	0.0221	0.0221
	EXTREME WEATHER CONDITIONS	0.1181	0.1181	0.1181	0.1181	0.1181	0.1181	0.1181	0.1181
	SHIP / TRUCK MOVEMENT	0.0727	0.0727	0.0727	0.0727	0.0727	0.0727	0.0727	0.0727
	SIMULTANOUS OPERATIONS	0.0148	0.0148	0.0148	0.0148	0.0148	0.0148	0.0148	0.0148
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037

Table E.16: 32th Power of Limit Matrix 4 (Consequences-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0143	0.0143	0.0143	0.0143	0.0143	0.0143	0.0143	0.0143
	FATIGUE	0.0879	0.0879	0.0879	0.0879	0.0879	0.0879	0.0879	0.0879
	TRAINING	0.0219	0.0219	0.0219	0.0219	0.0219	0.0219	0.0219	0.0219
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051
	FAILURE OF COMMUNICATION OR ESD	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039
	HOSE RUPTURE	0.0366	0.0366	0.0366	0.0366	0.0366	0.0366	0.0366	0.0366
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071
	INCORRECT SEQUENCE	0.0192	0.0192	0.0192	0.0192	0.0192	0.0192	0.0192	0.0192
	LNG TRAPPED IN PIPE	0.0040	0.0040	0.0040	0.0040	0.0040	0.0040	0.0040	0.0040
	LOSS OF BUNKER VEHICLE POWER	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020

Table E.17: 32th Power of Limit Matrix 5 (Consequences-Decision Maker 2)

		OPERATIONAL HAZARDS							
		FAILURE OF AUXILIARY SYSTEMS	FAILURE OF COMMUNICATION OR ESD	HOSE RUPTURE	INAPPROPRIATE COOLING OF BUNKER LINE	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	INCORRECT SEQUENCE	LNG TRAPPED IN PIPE	LOSS OF BUNKER VEHICLE POWER
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416	0.0416
	FIRE ON SHIP	0.0497	0.0497	0.0497	0.0497	0.0497	0.0497	0.0497	0.0497
	LNG LEAKS	0.2671	0.2671	0.2671	0.2671	0.2671	0.2671	0.2671	0.2671
	NG LEAKS	0.1123	0.1123	0.1123	0.1123	0.1123	0.1123	0.1123	0.1123
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0136	0.0136	0.0136	0.0136	0.0136	0.0136	0.0136	0.0136
	DRY COUPLING DISCONNECTION	0.0585	0.0585	0.0585	0.0585	0.0585	0.0585	0.0585	0.0585
	MISHANDLING	0.0228	0.0228	0.0228	0.0228	0.0228	0.0228	0.0228	0.0228
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0221	0.0221	0.0221	0.0221	0.0221	0.0221	0.0221	0.0221
	EXTREME WEATHER CONDITIONS	0.1181	0.1181	0.1181	0.1181	0.1181	0.1181	0.1181	0.1181
	SHIP / TRUCK MOVEMENT	0.0727	0.0727	0.0727	0.0727	0.0727	0.0727	0.0727	0.0727
	SIMULTANOUS OPERATIONS	0.0148	0.0148	0.0148	0.0148	0.0148	0.0148	0.0148	0.0148
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037

Table E.18: 32th Power of Limit Matrix 6 (Consequences-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0143	0.0143	0.0143	0.0143	0.0143	0.0143	0.0143	0.0143
	FATIGUE	0.0879	0.0879	0.0879	0.0879	0.0879	0.0879	0.0879	0.0879
	TRAINING	0.0219	0.0219	0.0219	0.0219	0.0219	0.0219	0.0219	0.0219
	FAILURE OF AUXILIARY SYSTEMS	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051
	FAILURE OF COMMUNICATION OR ESD	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039
	HOSE RUPTURE	0.0366	0.0366	0.0366	0.0366	0.0366	0.0366	0.0366	0.0366
OPERATIONAL HAZARDS	INAPPROPRIATE COOLING OF BUNKER LINE	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071
	INCORRECT SEQUENCE	0.0192	0.0192	0.0192	0.0192	0.0192	0.0192	0.0192	0.0192
	LNG TRAPPED IN PIPE	0.0040	0.0040	0.0040	0.0040	0.0040	0.0040	0.0040	0.0040
	LOSS OF BUNKER VEHICLE POWER	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020

Table E.19: Unweighted Matrix 1 (Likelihood-Decision Maker 2)

		ALTERNATIVES				CONNECTION HAZARDS		
		FIRE ON PIER / BUNKER VESSEL	FIRE ON SHIP	LNG LEAKS	NG LEAKS	BREAKAWAY COUPLING DISCONNECTION	DRY COUPLING DISCONNECTION	MISHANDLING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0000	0.0000	0.0000	0.0000	0.0518	0.0518	0.0518
	FIRE ON SHIP	0.0000	0.0000	0.0000	0.0000	0.0897	0.0897	0.0897
	LNG LEAKS	0.1250	0.1250	0.0000	1.0000	0.5770	0.2816	0.5770
	NG LEAKS	0.8750	0.8750	0.0000	0.0000	0.2816	0.5770	0.2816
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.1250	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.1250	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.8750	0.8750	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.6491	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.1000	0.5000	0.1000	0.1250	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.9000	0.5000	0.9000	0.8750	0.0000
	SIMULTANOUS OPERATIONS	0.0719	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.2790	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.20: Unweighted Matrix 2 (Likelihood-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.1884	0.2583	0.0000	0.0000	0.1047
	FATIGUE	0.0000	0.0000	0.7306	0.6370	0.0000	0.0000	0.6370
	TRAINING	0.0000	0.0000	0.0810	0.1047	0.0000	0.0000	0.2583
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.2897	0.0217	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.2584	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0549	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0392	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.4089	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.6554	0.0829	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.1482	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0406	0.0000	0.0000	0.0000

Table E.21: Unweighted Matrix 3 (Likelihood-Decision Maker 2)

		ENVIRONMENTAL HAZARDS					HUMAN HAZARDS		
		ELECTRICAL EQUIPMENTS	EXTREME WEATHER CONDITIONS	SHIP / TRUCK MOVEMENT	SIMULTANOUS OPERATIONS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	AWARENESS	FATIGUE	TRAINING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.2665	0.0685	0.0685	0.2665	0.5209	0.0685	0.0685	0.0808
	FIRE ON SHIP	0.5705	0.0685	0.0685	0.5705	0.3271	0.0685	0.0685	0.0808
	LNG LEAKS	0.0833	0.5800	0.5800	0.0833	0.0728	0.5800	0.5800	0.5316
	NG LEAKS	0.0797	0.2830	0.2830	0.0797	0.0792	0.2830	0.2830	0.3069
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.22: Unweighted Matrix 4 (Likelihood-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.1250	0.0000	0.0000	0.1250	0.1250	0.0000	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000
	TRAINING	0.8750	0.0000	0.0000	0.8750	0.8750	0.0000	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.23: Unweighted Matrix 5 (Likelihood-Decision Maker 2)

		OPERATIONAL HAZARDS							
		FAILURE OF AUXILIARY SYSTEMS	FAILURE OF COMMUNICATION OR ESD	HOSE RUPTURE	INAPPROPRIATE COOLING OF BUNKER LINE	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	INCORRECT SEQUENCE	LNG TRAPPED IN PIPE	LOSS OF BUNKER VEHICLE POWER
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0875	0.0453	0.0532	0.0359	0.0518	0.0518	0.0526	0.0518
	FIRE ON SHIP	0.1130	0.1360	0.0532	0.1647	0.0897	0.0897	0.1127	0.0897
	LNG LEAKS	0.5069	0.4355	0.5921	0.3997	0.5770	0.5770	0.2218	0.5770
	NG LEAKS	0.2926	0.3833	0.3015	0.3997	0.2816	0.2816	0.6129	0.2816
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.1000	0.0000	0.0000	0.0000	0.1250	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.9000	0.0000	0.0000	0.0000	0.8750	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.24: Unweighted Matrix 6 (Likelihood-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.0000	0.0000	0.0000	0.1047	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.6370	0.0000	0.0000
	TRAINING	0.0000	0.0000	0.0000	0.0000	0.0000	0.2583	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.8333	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1250	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.1667	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.8750	0.0000

Table E.25: Normalized Weighted Matrix 1 (Likelihood-Decision Maker 2)

		ALTERNATIVES				CONNECTION HAZARDS		
		FIRE ON PIER / BUNKER VESSEL	FIRE ON SHIP	LNG LEAKS	NG LEAKS	BREAKAWAY COUPLING DISCONNECTION	DRY COUPLING DISCONNECTION	MISHANDLING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0000	0.0000	0.0000	0.0000	0.0156	0.0156	0.0412
	FIRE ON SHIP	0.0000	0.0000	0.0000	0.0000	0.0270	0.0270	0.0713
	LNG LEAKS	0.0510	0.0510	0.0000	0.0852	0.1734	0.0846	0.4587
	NG LEAKS	0.3570	0.3570	0.0000	0.0000	0.0846	0.1734	0.2238
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0497	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0543	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.3801	0.3477	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.3843	0.2960	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.0135	0.0618	0.0699	0.0874	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.1216	0.0618	0.6295	0.6120	0.0000
	SIMULTANOUS OPERATIONS	0.0426	0.2960	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.1651	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.26: Normalized Weighted Matrix 2 (Likelihood-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.0095	0.0120	0.0000	0.0000	0.0215
	FATIGUE	0.0000	0.0000	0.0370	0.0295	0.0000	0.0000	0.1306
	TRAINING	0.0000	0.0000	0.0041	0.0049	0.0000	0.0000	0.0529
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.1100	0.0075	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0898	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0208	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0136	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.1420	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.2489	0.0288	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0515	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0141	0.0000	0.0000	0.0000

Table E.27: Normalized Weighted Matrix 3 (Likelihood-Decision Maker 2)

		ENVIRONMENTAL HAZARDS					HUMAN HAZARDS		
		ELECTRICAL EQUIPMENTS	EXTREME WEATHER CONDITIONS	SHIP / TRUCK MOVEMENT	SIMULTANOUS OPERATIONS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	AWARENESS	FATIGUE	TRAINING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.1333	0.0685	0.0068	0.1333	0.2605	0.0342	0.0685	0.0808
	FIRE ON SHIP	0.2853	0.0685	0.0068	0.2853	0.1636	0.0342	0.0685	0.0808
	LNG LEAKS	0.0416	0.5800	0.0580	0.0416	0.0364	0.2900	0.5800	0.5316
	NG LEAKS	0.0399	0.2830	0.0283	0.0399	0.0396	0.1415	0.2830	0.3069
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.9000	0.0000	0.0000	0.0000	0.0000	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.28: Normalized Weighted Matrix 4 (Likelihood-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0625	0.0000	0.0000	0.0625	0.0625	0.0000	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000
	TRAINING	0.4375	0.0000	0.0000	0.4375	0.4375	0.0000	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.29: Normalized Weighted Matrix 5 (Likelihood-Decision Maker 2)

		OPERATIONAL HAZARDS							
		FAILURE OF AUXILIARY SYSTEMS	FAILURE OF COMMUNICATION OR ESD	HOSE RUPTURE	INAPPROPRIATE COOLING OF BUNKER LINE	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	INCORRECT SEQUENCE	LNG TRAPPED IN PIPE	LOSS OF BUNKER VEHICLE POWER
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0875	0.0068	0.0158	0.0359	0.0078	0.0272	0.0021	0.0518
	FIRE ON SHIP	0.1130	0.0205	0.0158	0.1647	0.0135	0.0471	0.0045	0.0897
	LNG LEAKS	0.5069	0.0657	0.1756	0.3997	0.0871	0.3032	0.0088	0.5770
	NG LEAKS	0.2926	0.0579	0.0894	0.3997	0.0425	0.1480	0.0244	0.2816
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6419	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.0703	0.0000	0.0000	0.0000	0.0118	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.6331	0.0000	0.0000	0.0000	0.0826	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.30: Normalized Weighted Matrix 6 (Likelihood-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0497	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.3022	0.0000	0.0000
	TRAINING	0.0000	0.0000	0.0000	0.0000	0.0000	0.1226	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.7075	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0280	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.1415	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.8490	0.0000	0.0000	0.0000	0.0000	0.1959	0.0000

Table E.31: 32th Power of Limit Matrix 1 (Likelihood-Decision Maker 2)

		ALTERNATIVES				CONNECTION HAZARDS		
		FIRE ON PIER / BUNKER VESSEL	FIRE ON SHIP	LNG LEAKS	NG LEAKS	BREAKAWAY COUPLING DISCONNECTION	DRY COUPLING DISCONNECTION	MISHANDLING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297
	FIRE ON SHIP	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424
	LNG LEAKS	0.2216	0.2216	0.2216	0.2216	0.2216	0.2216	0.2216
	NG LEAKS	0.1333	0.1333	0.1333	0.1333	0.1333	0.1333	0.1333
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0127	0.0127	0.0127	0.0127	0.0127	0.0127	0.0127
	DRY COUPLING DISCONNECTION	0.0120	0.0120	0.0120	0.0120	0.0120	0.0120	0.0120
	MISHANDLING	0.1306	0.1306	0.1306	0.1306	0.1306	0.1306	0.1306
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0239	0.0239	0.0239	0.0239	0.0239	0.0239	0.0239
	EXTREME WEATHER CONDITIONS	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625
	SHIP / TRUCK MOVEMENT	0.0543	0.0543	0.0543	0.0543	0.0543	0.0543	0.0543
	SIMULTANOUS OPERATIONS	0.0138	0.0138	0.0138	0.0138	0.0138	0.0138	0.0138
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049

Table E.32: 32th Power of Limit Matrix 2 (Likelihood-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0121	0.0121	0.0121	0.0121	0.0121	0.0121	0.0121
	FATIGUE	0.0531	0.0531	0.0531	0.0531	0.0531	0.0531	0.0531
	TRAINING	0.0344	0.0344	0.0344	0.0344	0.0344	0.0344	0.0344
	FAILURE OF AUXILIARY SYSTEMS	0.0388	0.0388	0.0388	0.0388	0.0388	0.0388	0.0388
	FAILURE OF COMMUNICATION OR ESD	0.0120	0.0120	0.0120	0.0120	0.0120	0.0120	0.0120
	HOSE RUPTURE	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046
OPERATIONAL HAZARDS	INAPPROPRIATE COOLING OF BUNKER LINE	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0189	0.0189	0.0189	0.0189	0.0189	0.0189	0.0189
	INCORRECT SEQUENCE	0.0590	0.0590	0.0590	0.0590	0.0590	0.0590	0.0590
	LNG TRAPPED IN PIPE	0.0095	0.0095	0.0095	0.0095	0.0095	0.0095	0.0095
	LOSS OF BUNKER VEHICLE POWER	0.0139	0.0139	0.0139	0.0139	0.0139	0.0139	0.0139

Table E.33: 32th Power of Limit Matrix 3 (Likelihood-Decision Maker 2)

		ENVIRONMENTAL HAZARDS					HUMAN HAZARDS		
		ELECTRICAL EQUIPMENTS	EXTREME WEATHER CONDITIONS	SHIP / TRUCK MOVEMENT	SIMULTANOUS OPERATIONS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	AWARENESS	FATIGUE	TRAINING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297
	FIRE ON SHIP	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424
	LNG LEAKS	0.2216	0.2216	0.2216	0.2216	0.2216	0.2216	0.2216	0.2216
	NG LEAKS	0.1333	0.1333	0.1333	0.1333	0.1333	0.1333	0.1333	0.1333
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0127	0.0127	0.0127	0.0127	0.0127	0.0127	0.0127	0.0127
	DRY COUPLING DISCONNECTION	0.0120	0.0120	0.0120	0.0120	0.0120	0.0120	0.0120	0.0120
	MISHANDLING	0.1306	0.1306	0.1306	0.1306	0.1306	0.1306	0.1306	0.1306
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0239	0.0239	0.0239	0.0239	0.0239	0.0239	0.0239	0.0239
	EXTREME WEATHER CONDITIONS	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625
	SHIP / TRUCK MOVEMENT	0.0543	0.0543	0.0543	0.0543	0.0543	0.0543	0.0543	0.0543
	SIMULTANOUS OPERATIONS	0.0138	0.0138	0.0138	0.0138	0.0138	0.0138	0.0138	0.0138
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049

Table E.34: 32th Power of Limit Matrix 4 (Likelihood-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0121	0.0121	0.0121	0.0121	0.0121	0.0121	0.0121	0.0121
	FATIGUE	0.0531	0.0531	0.0531	0.0531	0.0531	0.0531	0.0531	0.0531
	TRAINING	0.0344	0.0344	0.0344	0.0344	0.0344	0.0344	0.0344	0.0344
	FAILURE OF AUXILIARY SYSTEMS	0.0388	0.0388	0.0388	0.0388	0.0388	0.0388	0.0388	0.0388
	FAILURE OF COMMUNICATION OR ESD	0.0120	0.0120	0.0120	0.0120	0.0120	0.0120	0.0120	0.0120
	HOSE RUPTURE	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046
OPERATIONAL HAZARDS	INAPPROPRIATE COOLING OF BUNKER LINE	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0189	0.0189	0.0189	0.0189	0.0189	0.0189	0.0189	0.0189
	INCORRECT SEQUENCE	0.0590	0.0590	0.0590	0.0590	0.0590	0.0590	0.0590	0.0590
	LNG TRAPPED IN PIPE	0.0095	0.0095	0.0095	0.0095	0.0095	0.0095	0.0095	0.0095
	LOSS OF BUNKER VEHICLE POWER	0.0139	0.0139	0.0139	0.0139	0.0139	0.0139	0.0139	0.0139

Table E.35: 32th Power of Limit Matrix 5 (Likelihood-Decision Maker 2)

		OPERATIONAL HAZARDS							
		FAILURE OF AUXILIARY SYSTEMS	FAILURE OF COMMUNICATION OR ESD	HOSE RUPTURE	INAPPROPRIATE COOLING OF BUNKER LINE	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	INCORRECT SEQUENCE	LNG TRAPPED IN PIPE	LOSS OF BUNKER VEHICLE POWER
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297
	FIRE ON SHIP	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424	0.0424
	LNG LEAKS	0.2216	0.2216	0.2216	0.2216	0.2216	0.2216	0.2216	0.2216
	NG LEAKS	0.1333	0.1333	0.1333	0.1333	0.1333	0.1333	0.1333	0.1333
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0127	0.0127	0.0127	0.0127	0.0127	0.0127	0.0127	0.0127
	DRY COUPLING DISCONNECTION	0.0120	0.0120	0.0120	0.0120	0.0120	0.0120	0.0120	0.0120
	MISHANDLING	0.1306	0.1306	0.1306	0.1306	0.1306	0.1306	0.1306	0.1306
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0239	0.0239	0.0239	0.0239	0.0239	0.0239	0.0239	0.0239
	EXTREME WEATHER CONDITIONS	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625
	SHIP / TRUCK MOVEMENT	0.0543	0.0543	0.0543	0.0543	0.0543	0.0543	0.0543	0.0543
	SIMULTANOUS OPERATIONS	0.0138	0.0138	0.0138	0.0138	0.0138	0.0138	0.0138	0.0138
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049

Table E.36: 32th Power of Limit Matrix 6 (Likelihood-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0121	0.0121	0.0121	0.0121	0.0121	0.0121	0.0121	0.0121
	FATIGUE	0.0531	0.0531	0.0531	0.0531	0.0531	0.0531	0.0531	0.0531
	TRAINING	0.0344	0.0344	0.0344	0.0344	0.0344	0.0344	0.0344	0.0344
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0388	0.0388	0.0388	0.0388	0.0388	0.0388	0.0388	0.0388
	FAILURE OF COMMUNICATION OR ESD	0.0120	0.0120	0.0120	0.0120	0.0120	0.0120	0.0120	0.0120
	HOSE RUPTURE	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0189	0.0189	0.0189	0.0189	0.0189	0.0189	0.0189	0.0189
	INCORRECT SEQUENCE	0.0590	0.0590	0.0590	0.0590	0.0590	0.0590	0.0590	0.0590
	LNG TRAPPED IN PIPE	0.0095	0.0095	0.0095	0.0095	0.0095	0.0095	0.0095	0.0095
	LOSS OF BUNKER VEHICLE POWER	0.0139	0.0139	0.0139	0.0139	0.0139	0.0139	0.0139	0.0139

Table E.37: Unweighted Matrix 1 (Consequences-Decision Maker 1)

		ALTERNATIVES				CONNECTION HAZARDS		
		FIRE ON PIER / BUNKER VESSEL	FIRE ON SHIP	LNG LEAKS	NG LEAKS	BREAKAWAY COUPLING DISCONNECTION	DRY COUPLING DISCONNECTION	MISHANDLING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0000	0.0000	0.0000	0.0000	0.0518	0.0416	0.0518
	FIRE ON SHIP	0.0000	0.0000	0.0000	0.0000	0.0897	0.0767	0.0897
	LNG LEAKS	0.8333	0.8333	0.0000	1.0000	0.5770	0.5717	0.5770
	NG LEAKS	0.1667	0.1667	0.0000	0.0000	0.2816	0.3100	0.2816
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.8750	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.2500	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.7500	0.1250	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.7306	0.8333	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.1250	0.1250	0.1667	0.1667	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.8750	0.8750	0.8333	0.8333	0.0000
	SIMULTANOUS OPERATIONS	0.1884	0.1667	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0810	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.38: Unweighted Matrix 2 (Consequences-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.1047	0.1047	0.0000	0.0000	0.1884
	FATIGUE	0.0000	0.0000	0.2583	0.2583	0.0000	0.0000	0.0810
	TRAINING	0.0000	0.0000	0.6370	0.6370	0.0000	0.0000	0.7306
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0704	0.0912	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0272	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.7514	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.2399	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.1629	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.1782	0.2944	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.1294	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0549	0.0000	0.0000	0.0000

Table E.39: Unweighted Matrix 3 (Consequences-Decision Maker 1)

		ENVIRONMENTAL HAZARDS					HUMAN HAZARDS		
		ELECTRICAL EQUIPMENTS	EXTREME WEATHER CONDITIONS	SHIP / TRUCK MOVEMENT	SIMULTANOUS OPERATIONS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	AWARENESS	FATIGUE	TRAINING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.2383	0.0605	0.0605	0.2771	0.4799	0.0963	0.0963	0.0963
	FIRE ON SHIP	0.6306	0.0605	0.0605	0.4799	0.2771	0.0963	0.0963	0.0963
	LNG LEAKS	0.0655	0.5573	0.5573	0.1215	0.1215	0.5579	0.5579	0.5579
	NG LEAKS	0.0655	0.3217	0.3217	0.1215	0.1215	0.2495	0.2495	0.2495
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.40: Unweighted Matrix 4 (Consequences-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.1667	0.0000	0.0000	0.1667	0.1667	0.0000	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000
	TRAINING	0.8333	0.0000	0.0000	0.8333	0.8333	0.0000	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.41: Unweighted Matrix 5 (Consequences-Decision Maker 1)

		OPERATIONAL HAZARDS							
		FAILURE OF AUXILIARY SYSTEMS	FAILURE OF COMMUNICATION OR ESD	HOSE RUPTURE	INAPPROPRIATE COOLING OF BUNKER LINE	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	INCORRECT SEQUENCE	LNG TRAPPED IN PIPE	LOSS OF BUNKER VEHICLE POWER
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0808	0.0808	0.0531	0.0518	0.0518	0.0518	0.0534	0.4897
	FIRE ON SHIP	0.0808	0.0808	0.0845	0.0897	0.0897	0.0897	0.1823	0.1437
	LNG LEAKS	0.5316	0.5316	0.4494	0.5770	0.5770	0.5770	0.3821	0.0591
	NG LEAKS	0.3069	0.3069	0.4131	0.2816	0.2816	0.2816	0.3821	0.3075
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.1667	0.0000	0.0000	0.0000	0.8333	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.8333	0.0000	0.0000	0.0000	0.1667	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.42: Unweighted Matrix 6 (Consequences-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.0000	0.0000	0.0000	0.1194	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.1336	0.0000	0.0000
	TRAINING	0.0000	0.0000	0.0000	0.0000	0.0000	0.7471	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.1667	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.8333	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.8333	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.1667	0.0000

Table E.43: Normalized Weighted Matrix 1 (Consequences-Decision Maker 1)

		ALTERNATIVES				CONNECTION HAZARDS		
		FIRE ON PIER / BUNKER VESSEL	FIRE ON SHIP	LNG LEAKS	NG LEAKS	BREAKAWAY COUPLING DISCONNECTION	DRY COUPLING DISCONNECTION	MISHANDLING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0000	0.0000	0.0000	0.0000	0.0114	0.0091	0.0281
	FIRE ON SHIP	0.0000	0.0000	0.0000	0.0000	0.0197	0.0168	0.0486
	LNG LEAKS	0.4623	0.4623	0.0000	0.2468	0.1266	0.1255	0.3130
	NG LEAKS	0.0925	0.0925	0.0000	0.0000	0.0618	0.0680	0.1527
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.1733	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0657	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.1972	0.0248	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.3253	0.3711	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.0329	0.0248	0.1301	0.1301	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.2301	0.1733	0.6505	0.6505	0.0000
	SIMULTANOUS OPERATIONS	0.0839	0.0742	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0361	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.44: Normalized Weighted Matrix 2 (Consequences-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.0275	0.0207	0.0000	0.0000	0.0862
	FATIGUE	0.0000	0.0000	0.0679	0.0512	0.0000	0.0000	0.0370
	TRAINING	0.0000	0.0000	0.1675	0.1262	0.0000	0.0000	0.3343
	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0149	0.0145	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0043	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.1586	0.0000	0.0000	0.0000	0.0000
OPERATIONAL HAZARDS	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0381	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0259	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0376	0.0468	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0206	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0087	0.0000	0.0000	0.0000

Table E.45: Normalized Weighted Matrix 3 (Consequences-Decision Maker 1)

		ENVIRONMENTAL HAZARDS					HUMAN HAZARDS		
		ELECTRICAL EQUIPMENTS	EXTREME WEATHER CONDITIONS	SHIP / TRUCK MOVEMENT	SIMULTANOUS OPERATIONS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	AWARENESS	FATIGUE	TRAINING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0337	0.0605	0.0057	0.0391	0.0678	0.0482	0.0963	0.0963
	FIRE ON SHIP	0.0890	0.0605	0.0057	0.0678	0.0391	0.0482	0.0963	0.0963
	LNG LEAKS	0.0093	0.5573	0.0528	0.0172	0.0172	0.2789	0.5579	0.5579
	NG LEAKS	0.0093	0.3217	0.0305	0.0172	0.0172	0.1247	0.2495	0.2495
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.9052	0.0000	0.0000	0.0000	0.0000	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.46: Normalized Weighted Matrix 4 (Consequences-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.1431	0.0000	0.0000	0.1431	0.1431	0.0000	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000
	TRAINING	0.7157	0.0000	0.0000	0.7157	0.7157	0.0000	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.47: Normalized Weighted Matrix 5 (Consequences-Decision Maker 1)

		OPERATIONAL HAZARDS							
		FAILURE OF AUXILIARY SYSTEMS	FAILURE OF COMMUNICATION OR ESD	HOSE RUPTURE	INAPPROPRIATE COOLING OF BUNKER LINE	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	INCORRECT SEQUENCE	LNG TRAPPED IN PIPE	LOSS OF BUNKER VEHICLE POWER
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0808	0.0491	0.0294	0.0518	0.0315	0.0287	0.0082	0.4897
	FIRE ON SHIP	0.0808	0.0491	0.0469	0.0897	0.0545	0.0497	0.0281	0.1437
	LNG LEAKS	0.5316	0.3233	0.2493	0.5770	0.3509	0.3201	0.0588	0.0591
	NG LEAKS	0.3069	0.1866	0.2292	0.2816	0.1712	0.1562	0.0588	0.3075
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6235	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.0742	0.0000	0.0000	0.0000	0.1029	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.3711	0.0000	0.0000	0.0000	0.0206	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.48: Normalized Weighted Matrix 6 (Consequences-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0532	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0595	0.0000	0.0000
	TRAINING	0.0000	0.0000	0.0000	0.0000	0.0000	0.3327	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.0653	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0826	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.3266	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.3919	0.0000	0.0000	0.0000	0.0000	0.0165	0.0000

Table E.49: 32th Power of Limit Matrix 1 (Consequences-Decision Maker 1)

		ALTERNATIVES				CONNECTION HAZARDS		
		FIRE ON PIER / BUNKER VESSEL	FIRE ON SHIP	LNG LEAKS	NG LEAKS	BREAKAWAY COUPLING DISCONNECTION	DRY COUPLING DISCONNECTION	MISHANDLING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0276	0.0276	0.0276	0.0276	0.0276	0.0276	0.0276
	FIRE ON SHIP	0.0311	0.0311	0.0311	0.0311	0.0311	0.0311	0.0311
	LNG LEAKS	0.2515	0.2515	0.2515	0.2515	0.2515	0.2515	0.2515
	NG LEAKS	0.1104	0.1104	0.1104	0.1104	0.1104	0.1104	0.1104
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0211	0.0211	0.0211	0.0211	0.0211	0.0211	0.0211
	DRY COUPLING DISCONNECTION	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165
	MISHANDLING	0.0523	0.0523	0.0523	0.0523	0.0523	0.0523	0.0523
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0205	0.0205	0.0205	0.0205	0.0205	0.0205	0.0205
	EXTREME WEATHER CONDITIONS	0.1246	0.1246	0.1246	0.1246	0.1246	0.1246	0.1246
	SHIP / TRUCK MOVEMENT	0.1164	0.1164	0.1164	0.1164	0.1164	0.1164	0.1164
	SIMULTANOUS OPERATIONS	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010

Table E.50: 32th Power of Limit Matrix 2 (Consequences-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0182	0.0182	0.0182	0.0182	0.0182	0.0182	0.0182
	FATIGUE	0.0347	0.0347	0.0347	0.0347	0.0347	0.0347	0.0347
	TRAINING	0.0971	0.0971	0.0971	0.0971	0.0971	0.0971	0.0971
	FAILURE OF AUXILIARY SYSTEMS	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055
	FAILURE OF COMMUNICATION OR ESD	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
	HOSE RUPTURE	0.0399	0.0399	0.0399	0.0399	0.0399	0.0399	0.0399
OPERATIONAL HAZARDS	INAPPROPRIATE COOLING OF BUNKER LINE	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029
	INCORRECT SEQUENCE	0.0146	0.0146	0.0146	0.0146	0.0146	0.0146	0.0146
	LNG TRAPPED IN PIPE	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032
	LOSS OF BUNKER VEHICLE POWER	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012

Table E.51: 32th Power of Limit Matrix 3 (Consequences-Decision Maker 1)

		ENVIRONMENTAL HAZARDS					HUMAN HAZARDS		
		ELECTRICAL EQUIPMENTS	EXTREME WEATHER CONDITIONS	SHIP / TRUCK MOVEMENT	SIMULTANOUS OPERATIONS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	AWARENESS	FATIGUE	TRAINING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0276	0.0276	0.0276	0.0276	0.0276	0.0276	0.0276	0.0276
	FIRE ON SHIP	0.0311	0.0311	0.0311	0.0311	0.0311	0.0311	0.0311	0.0311
	LNG LEAKS	0.2515	0.2515	0.2515	0.2515	0.2515	0.2515	0.2515	0.2515
	NG LEAKS	0.1104	0.1104	0.1104	0.1104	0.1104	0.1104	0.1104	0.1104
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0211	0.0211	0.0211	0.0211	0.0211	0.0211	0.0211	0.0211
	DRY COUPLING DISCONNECTION	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165
	MISHANDLING	0.0523	0.0523	0.0523	0.0523	0.0523	0.0523	0.0523	0.0523
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0205	0.0205	0.0205	0.0205	0.0205	0.0205	0.0205	0.0205
	EXTREME WEATHER CONDITIONS	0.1246	0.1246	0.1246	0.1246	0.1246	0.1246	0.1246	0.1246
	SHIP / TRUCK MOVEMENT	0.1164	0.1164	0.1164	0.1164	0.1164	0.1164	0.1164	0.1164
	SIMULTANOUS OPERATIONS	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010

Table E.52: 32th Power of Limit Matrix 4 (Consequences-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0182	0.0182	0.0182	0.0182	0.0182	0.0182	0.0182	0.0182
	FATIGUE	0.0347	0.0347	0.0347	0.0347	0.0347	0.0347	0.0347	0.0347
	TRAINING	0.0971	0.0971	0.0971	0.0971	0.0971	0.0971	0.0971	0.0971
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055
	FAILURE OF COMMUNICATION OR ESD	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
	HOSE RUPTURE	0.0399	0.0399	0.0399	0.0399	0.0399	0.0399	0.0399	0.0399
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029
	INCORRECT SEQUENCE	0.0146	0.0146	0.0146	0.0146	0.0146	0.0146	0.0146	0.0146
	LNG TRAPPED IN PIPE	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032
	LOSS OF BUNKER VEHICLE POWER	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012

Table E.53: 32th Power of Limit Matrix 5 (Consequences-Decision Maker 1)

		OPERATIONAL HAZARDS							
		FAILURE OF AUXILIARY SYSTEMS	FAILURE OF COMMUNICATION OR ESD	HOSE RUPTURE	INAPPROPRIATE COOLING OF BUNKER LINE	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	INCORRECT SEQUENCE	LNG TRAPPED IN PIPE	LOSS OF BUNKER VEHICLE POWER
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0276	0.0276	0.0276	0.0276	0.0276	0.0276	0.0276	0.0276
	FIRE ON SHIP	0.0311	0.0311	0.0311	0.0311	0.0311	0.0311	0.0311	0.0311
	LNG LEAKS	0.2515	0.2515	0.2515	0.2515	0.2515	0.2515	0.2515	0.2515
	NG LEAKS	0.1104	0.1104	0.1104	0.1104	0.1104	0.1104	0.1104	0.1104
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0211	0.0211	0.0211	0.0211	0.0211	0.0211	0.0211	0.0211
	DRY COUPLING DISCONNECTION	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165
	MISHANDLING	0.0523	0.0523	0.0523	0.0523	0.0523	0.0523	0.0523	0.0523
	ELECTRICAL EQUIPMENTS	0.0205	0.0205	0.0205	0.0205	0.0205	0.0205	0.0205	0.0205
ENVIRONMENTAL HAZARDS	EXTREME WEATHER CONDITIONS	0.1246	0.1246	0.1246	0.1246	0.1246	0.1246	0.1246	0.1246
	SHIP / TRUCK MOVEMENT	0.1164	0.1164	0.1164	0.1164	0.1164	0.1164	0.1164	0.1164
	SIMULTANOUS OPERATIONS	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010

Table E.54: 32th Power of Limit Matrix 6 (Consequences-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0182	0.0182	0.0182	0.0182	0.0182	0.0182	0.0182	0.0182
	FATIGUE	0.0347	0.0347	0.0347	0.0347	0.0347	0.0347	0.0347	0.0347
	TRAINING	0.0971	0.0971	0.0971	0.0971	0.0971	0.0971	0.0971	0.0971
	FAILURE OF AUXILIARY SYSTEMS	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055
	FAILURE OF COMMUNICATION OR ESD	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
	HOSE RUPTURE	0.0399	0.0399	0.0399	0.0399	0.0399	0.0399	0.0399	0.0399
OPERATIONAL HAZARDS	INAPPROPRIATE COOLING OF BUNKER LINE	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029
	INCORRECT SEQUENCE	0.0146	0.0146	0.0146	0.0146	0.0146	0.0146	0.0146	0.0146
	LNG TRAPPED IN PIPE	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032
	LOSS OF BUNKER VEHICLE POWER	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012

Table E.55: Unweighted Matrix 1 (Likelihood-Decision Maker 1)

		ALTERNATIVES				CONNECTION HAZARDS		
		FIRE ON PIER / BUNKER VESSEL	FIRE ON SHIP	LNG LEAKS	NG LEAKS	BREAKAWAY COUPLING DISCONNECTION	DRY COUPLING DISCONNECTION	MISHANDLING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0000	0.0000	0.0000	0.0000	0.0548	0.0548	0.0545
	FIRE ON SHIP	0.0000	0.0000	0.0000	0.0000	0.0890	0.0890	0.0943
	LNG LEAKS	0.1250	0.1250	0.0000	1.0000	0.6101	0.2460	0.4613
	NG LEAKS	0.8750	0.8750	0.0000	0.0000	0.2460	0.6101	0.3899
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.1250	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.1250	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.8750	0.8750	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.6491	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.1000	0.5000	0.1000	0.1250	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.9000	0.5000	0.9000	0.8750	0.0000
	SIMULTANOUS OPERATIONS	0.0719	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.2790	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.56: Unweighted Matrix 2 (Likelihood-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.2790	0.2583	0.0000	0.0000	0.1047
	FATIGUE	0.0000	0.0000	0.6491	0.6370	0.0000	0.0000	0.6370
	TRAINING	0.0000	0.0000	0.0719	0.1047	0.0000	0.0000	0.2583
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.2790	0.3378	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.1254	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0719	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0525	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0551	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.6491	0.2558	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0384	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.1349	0.0000	0.0000	0.0000

Table E.57: Unweighted Matrix 3 (Likelihood-Decision Maker 1)

		ENVIRONMENTAL HAZARDS					HUMAN HAZARDS		
		ELECTRICAL EQUIPMENTS	EXTREME WEATHER CONDITIONS	SHIP / TRUCK MOVEMENT	SIMULTANOUS OPERATIONS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	AWARENESS	FATIGUE	TRAINING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.2771	0.0605	0.0605	0.2495	0.5579	0.0685	0.0685	0.0685
	FIRE ON SHIP	0.4799	0.0605	0.0605	0.5579	0.2495	0.0685	0.0685	0.0685
	LNG LEAKS	0.1215	0.5573	0.5573	0.0963	0.0963	0.5800	0.5800	0.5800
	NG LEAKS	0.1215	0.3217	0.3217	0.0963	0.0963	0.2830	0.2830	0.2830
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.58: Unweighted Matrix 4 (Likelihood-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.1250	0.0000	0.0000	0.1250	0.1250	0.0000	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000
	TRAINING	0.8750	0.0000	0.0000	0.8750	0.8750	0.0000	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.59: Unweighted Matrix 5 (Likelihood-Decision Maker 1)

		OPERATIONAL HAZARDS							
		FAILURE OF AUXILIARY SYSTEMS	FAILURE OF COMMUNICATION OR ESD	HOSE RUPTURE	INAPPROPRIATE COOLING OF BUNKER LINE	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	INCORRECT SEQUENCE	LNG TRAPPED IN PIPE	LOSS OF BUNKER VEHICLE POWER
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0587	0.0587	0.0605	0.0367	0.0393	0.0393	0.0393	0.0393
	FIRE ON SHIP	0.1693	0.1693	0.0605	0.1101	0.1260	0.1260	0.2696	0.1260
	LNG LEAKS	0.3860	0.3860	0.5573	0.4266	0.2696	0.5651	0.1260	0.5651
	NG LEAKS	0.3860	0.3860	0.3217	0.4266	0.5651	0.2696	0.5651	0.2696
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.1000	0.0000	0.0000	0.0000	0.1250	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.9000	0.0000	0.0000	0.0000	0.8750	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.60: Unweighted Matrix 6 (Likelihood-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0658	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.1488	0.0000	0.0000
	TRAINING	0.0000	0.0000	0.0000	0.0000	0.0000	0.7854	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.8333	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1250	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.1667	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.8750	0.0000

Table E.61: Normalized Weighted Matrix 1 (Likelihood-Decision Maker 1)

		ALTERNATIVES				CONNECTION HAZARDS		
		FIRE ON PIER / BUNKER VESSEL	FIRE ON SHIP	LNG LEAKS	NG LEAKS	BREAKAWAY COUPLING DISCONNECTION	DRY COUPLING DISCONNECTION	MISHANDLING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0000	0.0000	0.0000	0.0000	0.0158	0.0158	0.0388
	FIRE ON SHIP	0.0000	0.0000	0.0000	0.0000	0.0257	0.0257	0.0671
	LNG LEAKS	0.0824	0.0824	0.0000	0.1882	0.1760	0.0710	0.3282
	NG LEAKS	0.5767	0.5767	0.0000	0.0000	0.0710	0.1760	0.2774
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0365	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0450	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.3147	0.2555	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.2213	0.1705	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.0120	0.0487	0.0712	0.0889	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.1079	0.0487	0.6404	0.6226	0.0000
	SIMULTANOUS OPERATIONS	0.0245	0.1705	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0951	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.62: Normalized Weighted Matrix 2 (Likelihood-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.0646	0.0486	0.0000	0.0000	0.0302
	FATIGUE	0.0000	0.0000	0.1504	0.1198	0.0000	0.0000	0.1838
	TRAINING	0.0000	0.0000	0.0167	0.0197	0.0000	0.0000	0.0745
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0805	0.0792	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0294	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0208	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0123	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0129	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.1874	0.0600	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0090	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0316	0.0000	0.0000	0.0000

Table E.63: Normalized Weighted Matrix 3 (Likelihood-Decision Maker 1)

		ENVIRONMENTAL HAZARDS					HUMAN HAZARDS		
		ELECTRICAL EQUIPMENTS	EXTREME WEATHER CONDITIONS	SHIP / TRUCK MOVEMENT	SIMULTANOUS OPERATIONS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	AWARENESS	FATIGUE	TRAINING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.1268	0.0605	0.0174	0.1141	0.2552	0.0342	0.0685	0.0685
	FIRE ON SHIP	0.2196	0.0605	0.0174	0.2552	0.1141	0.0342	0.0685	0.0685
	LNG LEAKS	0.0556	0.5573	0.1607	0.0441	0.0441	0.2900	0.5800	0.5800
	NG LEAKS	0.0556	0.3217	0.0928	0.0441	0.0441	0.1415	0.2830	0.2830
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.7115	0.0000	0.0000	0.0000	0.0000	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.64: Normalized Weighted Matrix 4 (Likelihood-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0678	0.0000	0.0000	0.0678	0.0678	0.0000	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000
	TRAINING	0.4747	0.0000	0.0000	0.4747	0.4747	0.0000	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.65: Normalized Weighted Matrix 5 (Likelihood-Decision Maker 1)

		OPERATIONAL HAZARDS							
		FAILURE OF AUXILIARY SYSTEMS	FAILURE OF COMMUNICATION OR ESD	HOSE RUPTURE	INAPPROPRIATE COOLING OF BUNKER LINE	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	INCORRECT SEQUENCE	LNG TRAPPED IN PIPE	LOSS OF BUNKER VEHICLE POWER
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0587	0.0200	0.0368	0.0367	0.0134	0.0239	0.0044	0.0393
	FIRE ON SHIP	0.1693	0.0577	0.0368	0.1101	0.0429	0.0766	0.0298	0.1260
	LNG LEAKS	0.3860	0.1316	0.3389	0.4266	0.0919	0.3436	0.0139	0.5651
	NG LEAKS	0.3860	0.1316	0.1957	0.4266	0.1926	0.1640	0.0625	0.2696
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6045	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.0392	0.0000	0.0000	0.0000	0.0089	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.3527	0.0000	0.0000	0.0000	0.0623	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table E.66: Normalized Weighted Matrix 6 (Likelihood-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0258	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0583	0.0000	0.0000
	TRAINING	0.0000	0.0000	0.0000	0.0000	0.0000	0.3078	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.5492	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0267	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.1098	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.6591	0.0000	0.0000	0.0000	0.0000	0.1870	0.0000

Table E.67: 32th Power of Limit Matrix 1 (Likelihood-Decision Maker 1)

		ALTERNATIVES				CONNECTION HAZARDS		
		FIRE ON PIER / BUNKER VESSEL	FIRE ON SHIP	LNG LEAKS	NG LEAKS	BREAKAWAY COUPLING DISCONNECTION	DRY COUPLING DISCONNECTION	MISHANDLING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0260	0.0260	0.0260	0.0260	0.0260	0.0260	0.0260
	FIRE ON SHIP	0.0391	0.0391	0.0391	0.0391	0.0391	0.0391	0.0391
	LNG LEAKS	0.2401	0.2401	0.2401	0.2401	0.2401	0.2401	0.2401
	NG LEAKS	0.1635	0.1635	0.1635	0.1635	0.1635	0.1635	0.1635
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070
	DRY COUPLING DISCONNECTION	0.0108	0.0108	0.0108	0.0108	0.0108	0.0108	0.0108
	MISHANDLING	0.1173	0.1173	0.1173	0.1173	0.1173	0.1173	0.1173
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0124	0.0124	0.0124	0.0124	0.0124	0.0124	0.0124
	EXTREME WEATHER CONDITIONS	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459
	SHIP / TRUCK MOVEMENT	0.0469	0.0469	0.0469	0.0469	0.0469	0.0469	0.0469
	SIMULTANOUS OPERATIONS	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025

Table E.68: 32th Power of Limit Matrix 2 (Likelihood-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0299	0.0299	0.0299	0.0299	0.0299	0.0299	0.0299
	FATIGUE	0.0954	0.0954	0.0954	0.0954	0.0954	0.0954	0.0954
	TRAINING	0.0434	0.0434	0.0434	0.0434	0.0434	0.0434	0.0434
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0334	0.0334	0.0334	0.0334	0.0334	0.0334	0.0334
	FAILURE OF COMMUNICATION OR ESD	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048
	HOSE RUPTURE	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021
	INCORRECT SEQUENCE	0.0548	0.0548	0.0548	0.0548	0.0548	0.0548	0.0548
	LNG TRAPPED IN PIPE	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017
	LOSS OF BUNKER VEHICLE POWER	0.0087	0.0087	0.0087	0.0087	0.0087	0.0087	0.0087

Table E.69: 32th Power of Limit Matrix 3 (Likelihood-Decision Maker 1)

		ENVIRONMENTAL HAZARDS					HUMAN HAZARDS		
		ELECTRICAL EQUIPMENTS	EXTREME WEATHER CONDITIONS	SHIP / TRUCK MOVEMENT	SIMULTANOUS OPERATIONS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	AWARENESS	FATIGUE	TRAINING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0260	0.0260	0.0260	0.0260	0.0260	0.0260	0.0260	0.0260
	FIRE ON SHIP	0.0391	0.0391	0.0391	0.0391	0.0391	0.0391	0.0391	0.0391
	LNG LEAKS	0.2401	0.2401	0.2401	0.2401	0.2401	0.2401	0.2401	0.2401
	NG LEAKS	0.1635	0.1635	0.1635	0.1635	0.1635	0.1635	0.1635	0.1635
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070
	DRY COUPLING DISCONNECTION	0.0108	0.0108	0.0108	0.0108	0.0108	0.0108	0.0108	0.0108
	MISHANDLING	0.1173	0.1173	0.1173	0.1173	0.1173	0.1173	0.1173	0.1173
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0124	0.0124	0.0124	0.0124	0.0124	0.0124	0.0124	0.0124
	EXTREME WEATHER CONDITIONS	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459
	SHIP / TRUCK MOVEMENT	0.0469	0.0469	0.0469	0.0469	0.0469	0.0469	0.0469	0.0469
	SIMULTANOUS OPERATIONS	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025

Table E.70: 32th Power of Limit Matrix 4 (Likelihood-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0299	0.0299	0.0299	0.0299	0.0299	0.0299	0.0299	0.0299
	FATIGUE	0.0954	0.0954	0.0954	0.0954	0.0954	0.0954	0.0954	0.0954
	TRAINING	0.0434	0.0434	0.0434	0.0434	0.0434	0.0434	0.0434	0.0434
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0334	0.0334	0.0334	0.0334	0.0334	0.0334	0.0334	0.0334
	FAILURE OF COMMUNICATION OR ESD	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048
	HOSE RUPTURE	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021
	INCORRECT SEQUENCE	0.0548	0.0548	0.0548	0.0548	0.0548	0.0548	0.0548	0.0548
	LNG TRAPPED IN PIPE	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017
	LOSS OF BUNKER VEHICLE POWER	0.0087	0.0087	0.0087	0.0087	0.0087	0.0087	0.0087	0.0087

Table E.71: 32th Power of Limit Matrix 5 (Likelihood-Decision Maker 1)

		OPERATIONAL HAZARDS							
		FAILURE OF AUXILIARY SYSTEMS	FAILURE OF COMMUNICATION OR ESD	HOSE RUPTURE	INAPPROPRIATE COOLING OF BUNKER LINE	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	INCORRECT SEQUENCE	LNG TRAPPED IN PIPE	LOSS OF BUNKER VEHICLE POWER
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0260	0.0260	0.0260	0.0260	0.0260	0.0260	0.0260	0.0260
	FIRE ON SHIP	0.0391	0.0391	0.0391	0.0391	0.0391	0.0391	0.0391	0.0391
	LNG LEAKS	0.2401	0.2401	0.2401	0.2401	0.2401	0.2401	0.2401	0.2401
	NG LEAKS	0.1635	0.1635	0.1635	0.1635	0.1635	0.1635	0.1635	0.1635
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070
	DRY COUPLING DISCONNECTION	0.0108	0.0108	0.0108	0.0108	0.0108	0.0108	0.0108	0.0108
	MISHANDLING	0.1173	0.1173	0.1173	0.1173	0.1173	0.1173	0.1173	0.1173
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0124	0.0124	0.0124	0.0124	0.0124	0.0124	0.0124	0.0124
	EXTREME WEATHER CONDITIONS	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459
	SHIP / TRUCK MOVEMENT	0.0469	0.0469	0.0469	0.0469	0.0469	0.0469	0.0469	0.0469
	SIMULTANOUS OPERATIONS	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025

Table E.72: 32th Power of Limit Matrix 6 (Likelihood-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0299	0.0299	0.0299	0.0299	0.0299	0.0299	0.0299	0.0299
	FATIGUE	0.0954	0.0954	0.0954	0.0954	0.0954	0.0954	0.0954	0.0954
	TRAINING	0.0434	0.0434	0.0434	0.0434	0.0434	0.0434	0.0434	0.0434
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0334	0.0334	0.0334	0.0334	0.0334	0.0334	0.0334	0.0334
	FAILURE OF COMMUNICATION OR ESD	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048
	HOSE RUPTURE	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021
	INCORRECT SEQUENCE	0.0548	0.0548	0.0548	0.0548	0.0548	0.0548	0.0548	0.0548
	LNG TRAPPED IN PIPE	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017
	LOSS OF BUNKER VEHICLE POWER	0.0087	0.0087	0.0087	0.0087	0.0087	0.0087	0.0087	0.0087

APPENDICES F CALCULATION SHEETS FOR FUZZY-ANP

Calculation sheets are presented on next page

Table F.1: Unweighted Matrix 1 (Consequences-Decision Maker 2)

		ALTERNATIVES				CONNECTION HAZARDS		
		FIRE ON PIER / BUNKER VESSEL	FIRE ON SHIP	LNG LEAKS	NG LEAKS	BREAKAWAY COUPLING DISCONNECTION	DRY COUPLING DISCONNECTION	MISHANDLING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0000	0.0000	0.0000	0.0000	0.0000	0.1733	0.2141
	FIRE ON SHIP	0.0000	0.0000	0.0000	0.0000	0.1523	0.1733	0.2141
	LNG LEAKS	0.7142	0.7142	0.0000	1.0000	0.4782	0.3037	0.2859
	NG LEAKS	0.2858	0.2858	0.0000	0.0000	0.3695	0.3496	0.2859
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.7142	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.2858	0.5000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.3064	0.7142	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.5000	0.5000	0.5000	0.5000	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.5000	0.5000	0.5000	0.5000	0.0000
	SIMULTANOUS OPERATIONS	0.3872	0.2858	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.3064	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.2: Unweighted Matrix 2 (Consequences-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.1080	0.0564	0.0000	0.0000	0.0564
	FATIGUE	0.0000	0.0000	0.7841	0.6350	0.0000	0.0000	0.6350
	TRAINING	0.0000	0.0000	0.1080	0.3086	0.0000	0.0000	0.3086
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0649	0.0194	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.2483	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.5330	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0547	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.2955	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.4021	0.2232	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.1589	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.3: Unweighted Matrix 3 (Consequences-Decision Maker 2)

		ENVIRONMENTAL HAZARDS					HUMAN HAZARDS		
		ELECTRICAL EQUIPMENTS	EXTREME WEATHER CONDITIONS	SHIP / TRUCK MOVEMENT	SIMULTANOUS OPERATIONS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	AWARENESS	FATIGUE	TRAINING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.3388	0.0208	0.0208	0.2808	0.3388	0.1764	0.2032	0.1764
	FIRE ON SHIP	0.3717	0.0208	0.0208	0.4106	0.3717	0.1764	0.1933	0.1764
	LNG LEAKS	0.1448	0.5723	0.5723	0.1543	0.1448	0.3639	0.3258	0.3639
	NG LEAKS	0.1448	0.3862	0.3862	0.1543	0.1448	0.2833	0.2777	0.2833
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.4: Unweighted Matrix 4 (Consequences-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0761	0.0000	0.0000	0.5000	0.2858	0.0000	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000
	TRAINING	0.9239	0.0000	0.0000	0.5000	0.7142	0.0000	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.5: Unweighted Matrix 5 (Consequences-Decision Maker 2)

		OPERATIONAL HAZARDS							
		FAILURE OF AUXILIARY SYSTEMS	FAILURE OF COMMUNICATION OR ESD	HOSE RUPTURE	INAPPROPRIATE COOLING OF BUNKER LINE	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	INCORRECT SEQUENCE	LNG TRAPPED IN PIPE	LOSS OF BUNKER VEHICLE POWER
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.1110	0.1429	0.1543	0.0000	0.3618	0.1543	0.0773	0.0000
	FIRE ON SHIP	0.1155	0.1429	0.1543	0.0000	0.3618	0.1543	0.2869	0.2137
	LNG LEAKS	0.4202	0.3571	0.4106	0.6955	0.1982	0.2808	0.3179	0.3931
	NG LEAKS	0.3533	0.3571	0.2808	0.3045	0.0782	0.4106	0.3179	0.3931
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.5000	0.0000	0.0000	0.0000	0.5000	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.5000	0.0000	0.0000	0.0000	0.5000	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.6: Unweighted Matrix 6 (Consequences-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.0000	0.0000	0.0000	0.2875	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.4410	0.0000	0.0000
	TRAINING	0.0000	0.0000	0.0000	0.0000	0.0000	0.2715	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5719	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.4281	0.0000

Table F.7: Normalized Weighted Matrix 1 (Consequences-Decision Maker 2)

		ALTERNATIVES				CONNECTION HAZARDS		
		FIRE ON PIER / BUNKER VESSEL	FIRE ON SHIP	LNG LEAKS	NG LEAKS	BREAKAWAY COUPLING DISCONNECTION	DRY COUPLING DISCONNECTION	MISHANDLING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0867	0.1271
	FIRE ON SHIP	0.0000	0.0000	0.0000	0.0000	0.0762	0.0867	0.1271
	LNG LEAKS	0.3635	0.3635	0.0000	0.2087	0.2391	0.1519	0.1697
	NG LEAKS	0.1455	0.1455	0.0000	0.0000	0.1847	0.1748	0.1697
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.1007	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.1817	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0727	0.1007	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.1505	0.3507	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.1272	0.1007	0.2500	0.2500	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.1272	0.1007	0.2500	0.2500	0.0000
	SIMULTANOUS OPERATIONS	0.1901	0.1403	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.1505	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.8: Normalized Weighted Matrix 2 (Consequences-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.0275	0.0114	0.0000	0.0000	0.0229
	FATIGUE	0.0000	0.0000	0.1995	0.1279	0.0000	0.0000	0.2581
	TRAINING	0.0000	0.0000	0.0275	0.0621	0.0000	0.0000	0.1254
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0153	0.0036	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0465	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.1261	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0102	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0553	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0951	0.0418	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0298	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.9: Normalized Weighted Matrix 3 (Consequences-Decision Maker 2)

		ENVIRONMENTAL HAZARDS					HUMAN HAZARDS		
		ELECTRICAL EQUIPMENTS	EXTREME WEATHER CONDITIONS	SHIP / TRUCK MOVEMENT	SIMULTANOUS OPERATIONS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	AWARENESS	FATIGUE	TRAINING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.1891	0.0208	0.0058	0.1567	0.1891	0.0882	0.2032	0.1764
	FIRE ON SHIP	0.2075	0.0208	0.0058	0.2292	0.2075	0.0882	0.1933	0.1764
	LNG LEAKS	0.0808	0.5723	0.1597	0.0861	0.0808	0.1820	0.3258	0.3639
	NG LEAKS	0.0808	0.3862	0.1078	0.0861	0.0808	0.1417	0.2777	0.2833
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.7209	0.0000	0.0000	0.0000	0.0000	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.10: Normalized Weighted Matrix 4 (Consequences-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0336	0.0000	0.0000	0.2209	0.1263	0.0000	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000
	TRAINING	0.4082	0.0000	0.0000	0.2209	0.3155	0.0000	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.11: Normalized Weighted Matrix 5 (Consequences-Decision Maker 2)

		OPERATIONAL HAZARDS						
		FAILURE OF COMMUNICATION OR ESD	HOSE RUPTURE	INAPPROPRIATE COOLING OF BUNKER LINE	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	INCORRECT SEQUENCE	LNG TRAPPED IN PIPE	LOSS OF BUNKER VEHICLE POWER
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0753	0.0785	0.0000	0.1907	0.0785	0.0101	0.0000
	FIRE ON SHIP	0.0753	0.0785	0.0000	0.1907	0.0785	0.0375	0.2137
	LNG LEAKS	0.1882	0.2090	0.6955	0.1045	0.1429	0.0415	0.3931
	NG LEAKS	0.1882	0.1429	0.3045	0.0412	0.2090	0.0415	0.3931
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.6261	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.2455	0.0000	0.0000	0.0000	0.0630	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.2455	0.0000	0.0000	0.0000	0.0630	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.12: Normalized Weighted Matrix 6 (Consequences-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.0000	0.0000	0.1412	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.2165	0.0000	0.0000
	TRAINING	0.0000	0.0000	0.0000	0.0000	0.1333	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0670	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.4728	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.4728	0.0000	0.0000	0.0000	0.0000	0.0502	0.0000

Table F.13: 32th Power of Limit Matrix 1 (Consequences-Decision Maker 2)

		ALTERNATIVES				CONNECTION HAZARDS		
		FIRE ON PIER / BUNKER VESSEL	FIRE ON SHIP	LNG LEAKS	NG LEAKS	BREAKAWAY COUPLING DISCONNECTION	DRY COUPLING DISCONNECTION	MISHANDLING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0513	0.0513	0.0513	0.0513	0.0513	0.0513	0.0513
	FIRE ON SHIP	0.0547	0.0547	0.0547	0.0547	0.0547	0.0547	0.0547
	LNG LEAKS	0.2202	0.2202	0.2202	0.2202	0.2202	0.2202	0.2202
	NG LEAKS	0.1356	0.1356	0.1356	0.1356	0.1356	0.1356	0.1356
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0184	0.0184	0.0184	0.0184	0.0184	0.0184	0.0184
	DRY COUPLING DISCONNECTION	0.0400	0.0400	0.0400	0.0400	0.0400	0.0400	0.0400
	MISHANDLING	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0269	0.0269	0.0269	0.0269	0.0269	0.0269	0.0269
	EXTREME WEATHER CONDITIONS	0.1094	0.1094	0.1094	0.1094	0.1094	0.1094	0.1094
	SHIP / TRUCK MOVEMENT	0.0636	0.0636	0.0636	0.0636	0.0636	0.0636	0.0636
	SIMULTANOUS OPERATIONS	0.0174	0.0174	0.0174	0.0174	0.0174	0.0174	0.0174
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0077	0.0077	0.0077	0.0077	0.0077	0.0077	0.0077

Table F.14: 32th Power of Limit Matrix 2 (Consequences-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0178	0.0178	0.0178	0.0178	0.0178	0.0178	0.0178
	FATIGUE	0.0836	0.0836	0.0836	0.0836	0.0836	0.0836	0.0836
	TRAINING	0.0390	0.0390	0.0390	0.0390	0.0390	0.0390	0.0390
	FAILURE OF AUXILIARY SYSTEMS	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039
	FAILURE OF COMMUNICATION OR ESD	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063
OPERATIONAL HAZARDS	HOSE RUPTURE	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075
	INCORRECT SEQUENCE	0.0266	0.0266	0.0266	0.0266	0.0266	0.0266	0.0266
	LNG TRAPPED IN PIPE	0.0076	0.0076	0.0076	0.0076	0.0076	0.0076	0.0076
	LOSS OF BUNKER VEHICLE POWER	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034

Table F.15: 32th Power of Limit Matrix 3 (Consequences-Decision Maker 2)

		ENVIRONMENTAL HAZARDS					HUMAN HAZARDS		
		ELECTRICAL EQUIPMENTS	EXTREME WEATHER CONDITIONS	SHIP / TRUCK MOVEMENT	SIMULTANOUS OPERATIONS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	AWARENESS	FATIGUE	TRAINING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0513	0.0513	0.0513	0.0513	0.0513	0.0513	0.0513	0.0513
	FIRE ON SHIP	0.0547	0.0547	0.0547	0.0547	0.0547	0.0547	0.0547	0.0547
	LNG LEAKS	0.2202	0.2202	0.2202	0.2202	0.2202	0.2202	0.2202	0.2202
	NG LEAKS	0.1356	0.1356	0.1356	0.1356	0.1356	0.1356	0.1356	0.1356
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0184	0.0184	0.0184	0.0184	0.0184	0.0184	0.0184	0.0184
	DRY COUPLING DISCONNECTION	0.0400	0.0400	0.0400	0.0400	0.0400	0.0400	0.0400	0.0400
	MISHANDLING	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0269	0.0269	0.0269	0.0269	0.0269	0.0269	0.0269	0.0269
	EXTREME WEATHER CONDITIONS	0.1094	0.1094	0.1094	0.1094	0.1094	0.1094	0.1094	0.1094
	SHIP / TRUCK MOVEMENT	0.0636	0.0636	0.0636	0.0636	0.0636	0.0636	0.0636	0.0636
	SIMULTANOUS OPERATIONS	0.0174	0.0174	0.0174	0.0174	0.0174	0.0174	0.0174	0.0174
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0077	0.0077	0.0077	0.0077	0.0077	0.0077	0.0077	0.0077

Table F.16: 32th Power of Limit Matrix 4 (Consequences-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0178	0.0178	0.0178	0.0178	0.0178	0.0178	0.0178	0.0178
	FATIGUE	0.0836	0.0836	0.0836	0.0836	0.0836	0.0836	0.0836	0.0836
	TRAINING	0.0390	0.0390	0.0390	0.0390	0.0390	0.0390	0.0390	0.0390
	FAILURE OF AUXILIARY SYSTEMS	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039
	FAILURE OF COMMUNICATION OR ESD	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063
	HOSE RUPTURE	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278
OPERATIONAL HAZARDS	INAPPROPRIATE COOLING OF BUNKER LINE	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075
	INCORRECT SEQUENCE	0.0266	0.0266	0.0266	0.0266	0.0266	0.0266	0.0266	0.0266
	LNG TRAPPED IN PIPE	0.0076	0.0076	0.0076	0.0076	0.0076	0.0076	0.0076	0.0076
	LOSS OF BUNKER VEHICLE POWER	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034

Table F.17: 32th Power of Limit Matrix 5 (Consequences-Decision Maker 2)

		OPERATIONAL HAZARDS							
		FAILURE OF AUXILIARY SYSTEMS	FAILURE OF COMMUNICATION OR ESD	HOSE RUPTURE	INAPPROPRIATE COOLING OF BUNKER LINE	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	INCORRECT SEQUENCE	LNG TRAPPED IN PIPE	LOSS OF BUNKER VEHICLE POWER
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0513	0.0513	0.0513	0.0513	0.0513	0.0513	0.0513	0.0513
	FIRE ON SHIP	0.0547	0.0547	0.0547	0.0547	0.0547	0.0547	0.0547	0.0547
	LNG LEAKS	0.2202	0.2202	0.2202	0.2202	0.2202	0.2202	0.2202	0.2202
	NG LEAKS	0.1356	0.1356	0.1356	0.1356	0.1356	0.1356	0.1356	0.1356
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0184	0.0184	0.0184	0.0184	0.0184	0.0184	0.0184	0.0184
	DRY COUPLING DISCONNECTION	0.0400	0.0400	0.0400	0.0400	0.0400	0.0400	0.0400	0.0400
	MISHANDLING	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0269	0.0269	0.0269	0.0269	0.0269	0.0269	0.0269	0.0269
	EXTREME WEATHER CONDITIONS	0.1094	0.1094	0.1094	0.1094	0.1094	0.1094	0.1094	0.1094
	SHIP / TRUCK MOVEMENT	0.0636	0.0636	0.0636	0.0636	0.0636	0.0636	0.0636	0.0636
	SIMULTANOUS OPERATIONS	0.0174	0.0174	0.0174	0.0174	0.0174	0.0174	0.0174	0.0174
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0077	0.0077	0.0077	0.0077	0.0077	0.0077	0.0077	0.0077

Table F.18: 32th Power of Limit Matrix 6 (Consequences-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0178	0.0178	0.0178	0.0178	0.0178	0.0178	0.0178	0.0178
	FATIGUE	0.0836	0.0836	0.0836	0.0836	0.0836	0.0836	0.0836	0.0836
	TRAINING	0.0390	0.0390	0.0390	0.0390	0.0390	0.0390	0.0390	0.0390
	FAILURE OF AUXILIARY SYSTEMS	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039
	FAILURE OF COMMUNICATION OR ESD	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063
	HOSE RUPTURE	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278	0.0278
OPERATIONAL HAZARDS	INAPPROPRIATE COOLING OF BUNKER LINE	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075
	INCORRECT SEQUENCE	0.0266	0.0266	0.0266	0.0266	0.0266	0.0266	0.0266	0.0266
	LNG TRAPPED IN PIPE	0.0076	0.0076	0.0076	0.0076	0.0076	0.0076	0.0076	0.0076
	LOSS OF BUNKER VEHICLE POWER	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034

Table F.19: Unweighted Matrix 1 (Likelihood-Decision Maker 2)

		ALTERNATIVES				CONNECTION HAZARDS		
		FIRE ON PIER / BUNKER VESSEL	FIRE ON SHIP	LNG LEAKS	NG LEAKS	BREAKAWAY COUPLING DISCONNECTION	DRY COUPLING DISCONNECTION	MISHANDLING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FIRE ON SHIP	0.0000	0.0000	0.0000	0.0000	0.1523	0.1523	0.1523
	LNG LEAKS	0.0761	0.0761	0.0000	1.0000	0.4782	0.3695	0.4782
	NG LEAKS	0.9239	0.9239	0.0000	0.0000	0.3695	0.4782	0.3695
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0761	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0761	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.9239	0.9239	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.5330	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.0000	0.5000	0.0000	0.0761	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	1.0000	0.5000	1.0000	0.9239	0.0000
	SIMULTANOUS OPERATIONS	0.0649	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.4021	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.20: Unweighted Matrix 2 (Likelihood-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.3086	0.3483	0.0000	0.0000	0.1997
	FATIGUE	0.0000	0.0000	0.6350	0.4520	0.0000	0.0000	0.4520
	TRAINING	0.0000	0.0000	0.0564	0.1997	0.0000	0.0000	0.3483
	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.4375	0.0000	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.2852	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
OPERATIONAL HAZARDS	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0147	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.3228	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.5625	0.1283	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.2333	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0156	0.0000	0.0000	0.0000

Table F.21: Unweighted Matrix 3 (Likelihood-Decision Maker 2)

		ENVIRONMENTAL HAZARDS					HUMAN HAZARDS		
		ELECTRICAL EQUIPMENTS	EXTREME WEATHER CONDITIONS	SHIP / TRUCK MOVEMENT	SIMULTANOUS OPERATIONS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	AWARENESS	FATIGUE	TRAINING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.3197	0.0731	0.0731	0.3197	0.3752	0.0731	0.0731	0.1448
	FIRE ON SHIP	0.4142	0.0731	0.0731	0.4142	0.3670	0.0731	0.0731	0.1448
	LNG LEAKS	0.1408	0.4831	0.4831	0.1408	0.1268	0.4831	0.4831	0.3717
	NG LEAKS	0.1254	0.3707	0.3707	0.1254	0.1310	0.3707	0.3707	0.3388
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.22: Unweighted Matrix 4 (Likelihood-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0761	0.0000	0.0000	0.0761	0.0761	0.0000	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000
	TRAINING	0.9239	0.0000	0.0000	0.9239	0.9239	0.0000	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.23: Unweighted Matrix 5 (Likelihood-Decision Maker 2)

		OPERATIONAL HAZARDS							
		FAILURE OF AUXILIARY SYSTEMS	FAILURE OF COMMUNICATION OR ESD	HOSE RUPTURE	INAPPROPRIATE COOLING OF BUNKER LINE	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	INCORRECT SEQUENCE	LNG TRAPPED IN PIPE	LOSS OF BUNKER VEHICLE POWER
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.1745	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FIRE ON SHIP	0.1968	0.2337	0.0000	0.2655	0.1523	0.1523	0.1871	0.1523
	LNG LEAKS	0.3283	0.3970	0.5527	0.3673	0.4782	0.4782	0.3309	0.4782
	NG LEAKS	0.3004	0.3693	0.4473	0.3673	0.3695	0.3695	0.4820	0.3695
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0761	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.9239	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.24: Unweighted Matrix 6 (Likelihood-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.0000	0.0000	0.0000	0.1997	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.4520	0.0000	0.0000
	TRAINING	0.0000	0.0000	0.0000	0.0000	0.0000	0.3483	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.7142	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0761	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.2858	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.9239	0.0000

Table F.25: Normalized Weighted Matrix 1 (Likelihood-Decision Maker 2)

		ALTERNATIVES				CONNECTION HAZARDS		
		FIRE ON PIER / BUNKER VESSEL	FIRE ON SHIP	LNG LEAKS	NG LEAKS	BREAKAWAY COUPLING DISCONNECTION	DRY COUPLING DISCONNECTION	MISHANDLING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FIRE ON SHIP	0.0000	0.0000	0.0000	0.0000	0.0655	0.0655	0.1312
	LNG LEAKS	0.0315	0.0315	0.0000	0.1388	0.2056	0.1589	0.4118
	NG LEAKS	0.3823	0.3823	0.0000	0.0000	0.1589	0.2056	0.3181
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0253	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0294	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.3570	0.3074	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.3125	0.2931	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.0000	0.0983	0.0000	0.0434	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.2283	0.0983	0.5700	0.5266	0.0000
	SIMULTANOUS OPERATIONS	0.0380	0.2931	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.2357	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.26: Normalized Weighted Matrix 2 (Likelihood-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.0110	0.0106	0.0000	0.0000	0.0277
	FATIGUE	0.0000	0.0000	0.0225	0.0138	0.0000	0.0000	0.0628
	TRAINING	0.0000	0.0000	0.0020	0.0061	0.0000	0.0000	0.0484
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.1531	0.0000	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0859	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0044	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0973	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.1968	0.0387	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0703	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0047	0.0000	0.0000	0.0000

Table F.27: Normalized Weighted Matrix 3 (Likelihood-Decision Maker 2)

		ENVIRONMENTAL HAZARDS					HUMAN HAZARDS		
		ELECTRICAL EQUIPMENTS	EXTREME WEATHER CONDITIONS	SHIP / TRUCK MOVEMENT	SIMULTANOUS OPERATIONS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	AWARENESS	FATIGUE	TRAINING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.1598	0.0731	0.0071	0.1598	0.1876	0.0365	0.0731	0.1448
	FIRE ON SHIP	0.2071	0.0731	0.0071	0.2071	0.1835	0.0365	0.0731	0.1448
	LNG LEAKS	0.0704	0.4831	0.0471	0.0704	0.0634	0.2416	0.4831	0.3717
	NG LEAKS	0.0627	0.3707	0.0361	0.0627	0.0655	0.1853	0.3707	0.3388
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.9026	0.0000	0.0000	0.0000	0.0000	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.28: Normalized Weighted Matrix 4 (Likelihood-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0381	0.0000	0.0000	0.0381	0.0381	0.0000	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000
	TRAINING	0.4619	0.0000	0.0000	0.4619	0.4619	0.0000	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.29: Normalized Weighted Matrix 5 (Likelihood-Decision Maker 2)

		OPERATIONAL HAZARDS							
		FAILURE OF AUXILIARY SYSTEMS	FAILURE OF COMMUNICATION OR ESD	HOSE RUPTURE	INAPPROPRIATE COOLING OF BUNKER LINE	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	INCORRECT SEQUENCE	LNG TRAPPED IN PIPE	LOSS OF BUNKER VEHICLE POWER
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.1745	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FIRE ON SHIP	0.1968	0.0590	0.0000	0.2655	0.0385	0.0818	0.0114	0.1523
	LNG LEAKS	0.3283	0.1002	0.1691	0.3673	0.1208	0.2567	0.0201	0.4782
	NG LEAKS	0.3004	0.0933	0.1368	0.3673	0.0933	0.1983	0.0293	0.3695
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6210	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0105	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.6941	0.0000	0.0000	0.0000	0.1275	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.30: Normalized Weighted Matrix 6 (Likelihood-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0925	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.2094	0.0000	0.0000
	TRAINING	0.0000	0.0000	0.0000	0.0000	0.0000	0.1613	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.5338	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0137	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.2137	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.7475	0.0000	0.0000	0.0000	0.0000	0.1664	0.0000

Table F.31: 32th Power of Limit Matrix 1 (Likelihood-Decision Maker 2)

		ALTERNATIVES				CONNECTION HAZARDS		
		FIRE ON PIER / BUNKER VESSEL	FIRE ON SHIP	LNG LEAKS	NG LEAKS	BREAKAWAY COUPLING DISCONNECTION	DRY COUPLING DISCONNECTION	MISHANDLING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293
	FIRE ON SHIP	0.0564	0.0564	0.0564	0.0564	0.0564	0.0564	0.0564
	LNG LEAKS	0.1892	0.1892	0.1892	0.1892	0.1892	0.1892	0.1892
	NG LEAKS	0.1641	0.1641	0.1641	0.1641	0.1641	0.1641	0.1641
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0134	0.0134	0.0134	0.0134	0.0134	0.0134	0.0134
	DRY COUPLING DISCONNECTION	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056
	MISHANDLING	0.1180	0.1180	0.1180	0.1180	0.1180	0.1180	0.1180
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0257	0.0257	0.0257	0.0257	0.0257	0.0257	0.0257
	EXTREME WEATHER CONDITIONS	0.0813	0.0813	0.0813	0.0813	0.0813	0.0813	0.0813
	SHIP / TRUCK MOVEMENT	0.0718	0.0718	0.0718	0.0718	0.0718	0.0718	0.0718
	SIMULTANOUS OPERATIONS	0.0176	0.0176	0.0176	0.0176	0.0176	0.0176	0.0176
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069

Table F.32: 32th Power of Limit Matrix 2 (Likelihood-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0130	0.0130	0.0130	0.0130	0.0130	0.0130	0.0130
	FATIGUE	0.0296	0.0296	0.0296	0.0296	0.0296	0.0296	0.0296
	TRAINING	0.0373	0.0373	0.0373	0.0373	0.0373	0.0373	0.0373
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0375	0.0375	0.0375	0.0375	0.0375	0.0375	0.0375
	FAILURE OF COMMUNICATION OR ESD	0.0141	0.0141	0.0141	0.0141	0.0141	0.0141	0.0141
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0160	0.0160	0.0160	0.0160	0.0160	0.0160	0.0160
	INCORRECT SEQUENCE	0.0436	0.0436	0.0436	0.0436	0.0436	0.0436	0.0436
	LNG TRAPPED IN PIPE	0.0149	0.0149	0.0149	0.0149	0.0149	0.0149	0.0149
	LOSS OF BUNKER VEHICLE POWER	0.0138	0.0138	0.0138	0.0138	0.0138	0.0138	0.0138

Table F.33: 32th Power of Limit Matrix 3 (Likelihood-Decision Maker 2)

		ENVIRONMENTAL HAZARDS					HUMAN HAZARDS		
		ELECTRICAL EQUIPMENTS	EXTREME WEATHER CONDITIONS	SHIP / TRUCK MOVEMENT	SIMULTANOUS OPERATIONS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	AWARENESS	FATIGUE	TRAINING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293
	FIRE ON SHIP	0.0564	0.0564	0.0564	0.0564	0.0564	0.0564	0.0564	0.0564
	LNG LEAKS	0.1892	0.1892	0.1892	0.1892	0.1892	0.1892	0.1892	0.1892
	NG LEAKS	0.1641	0.1641	0.1641	0.1641	0.1641	0.1641	0.1641	0.1641
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0134	0.0134	0.0134	0.0134	0.0134	0.0134	0.0134	0.0134
	DRY COUPLING DISCONNECTION	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056
	MISHANDLING	0.1180	0.1180	0.1180	0.1180	0.1180	0.1180	0.1180	0.1180
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0257	0.0257	0.0257	0.0257	0.0257	0.0257	0.0257	0.0257
	EXTREME WEATHER CONDITIONS	0.0813	0.0813	0.0813	0.0813	0.0813	0.0813	0.0813	0.0813
	SHIP / TRUCK MOVEMENT	0.0718	0.0718	0.0718	0.0718	0.0718	0.0718	0.0718	0.0718
	SIMULTANOUS OPERATIONS	0.0176	0.0176	0.0176	0.0176	0.0176	0.0176	0.0176	0.0176
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069

Table F.34: 32th Power of Limit Matrix 4 (Likelihood-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0130	0.0130	0.0130	0.0130	0.0130	0.0130	0.0130	0.0130
	FATIGUE	0.0296	0.0296	0.0296	0.0296	0.0296	0.0296	0.0296	0.0296
	TRAINING	0.0373	0.0373	0.0373	0.0373	0.0373	0.0373	0.0373	0.0373
	FAILURE OF AUXILIARY SYSTEMS	0.0375	0.0375	0.0375	0.0375	0.0375	0.0375	0.0375	0.0375
	FAILURE OF COMMUNICATION OR ESD	0.0141	0.0141	0.0141	0.0141	0.0141	0.0141	0.0141	0.0141
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
OPERATIONAL HAZARDS	INAPPROPRIATE COOLING OF BUNKER LINE	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0160	0.0160	0.0160	0.0160	0.0160	0.0160	0.0160	0.0160
	INCORRECT SEQUENCE	0.0436	0.0436	0.0436	0.0436	0.0436	0.0436	0.0436	0.0436
	LNG TRAPPED IN PIPE	0.0149	0.0149	0.0149	0.0149	0.0149	0.0149	0.0149	0.0149
	LOSS OF BUNKER VEHICLE POWER	0.0138	0.0138	0.0138	0.0138	0.0138	0.0138	0.0138	0.0138

Table F.35: 32th Power of Limit Matrix 5 (Likelihood-Decision Maker 2)

		OPERATIONAL HAZARDS							
		FAILURE OF AUXILIARY SYSTEMS	FAILURE OF COMMUNICATION OR ESD	HOSE RUPTURE	INAPPROPRIATE COOLING OF BUNKER LINE	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	INCORRECT SEQUENCE	LNG TRAPPED IN PIPE	LOSS OF BUNKER VEHICLE POWER
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293
	FIRE ON SHIP	0.0564	0.0564	0.0564	0.0564	0.0564	0.0564	0.0564	0.0564
	LNG LEAKS	0.1892	0.1892	0.1892	0.1892	0.1892	0.1892	0.1892	0.1892
	NG LEAKS	0.1641	0.1641	0.1641	0.1641	0.1641	0.1641	0.1641	0.1641
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0134	0.0134	0.0134	0.0134	0.0134	0.0134	0.0134	0.0134
	DRY COUPLING DISCONNECTION	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056
	MISHANDLING	0.1180	0.1180	0.1180	0.1180	0.1180	0.1180	0.1180	0.1180
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0257	0.0257	0.0257	0.0257	0.0257	0.0257	0.0257	0.0257
	EXTREME WEATHER CONDITIONS	0.0813	0.0813	0.0813	0.0813	0.0813	0.0813	0.0813	0.0813
	SHIP / TRUCK MOVEMENT	0.0718	0.0718	0.0718	0.0718	0.0718	0.0718	0.0718	0.0718
	SIMULTANOUS OPERATIONS	0.0176	0.0176	0.0176	0.0176	0.0176	0.0176	0.0176	0.0176
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069

Table F.36: 32th Power of Limit Matrix 6 (Likelihood-Decision Maker 2)

HUMAN HAZARDS	AWARENESS	0.0130	0.0130	0.0130	0.0130	0.0130	0.0130	0.0130	0.0130
	FATIGUE	0.0296	0.0296	0.0296	0.0296	0.0296	0.0296	0.0296	0.0296
	TRAINING	0.0373	0.0373	0.0373	0.0373	0.0373	0.0373	0.0373	0.0373
	FAILURE OF AUXILIARY SYSTEMS	0.0375	0.0375	0.0375	0.0375	0.0375	0.0375	0.0375	0.0375
	FAILURE OF COMMUNICATION OR ESD	0.0141	0.0141	0.0141	0.0141	0.0141	0.0141	0.0141	0.0141
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
OPERATIONAL HAZARDS	INAPPROPRIATE COOLING OF BUNKER LINE	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0160	0.0160	0.0160	0.0160	0.0160	0.0160	0.0160	0.0160
	INCORRECT SEQUENCE	0.0436	0.0436	0.0436	0.0436	0.0436	0.0436	0.0436	0.0436
	LNG TRAPPED IN PIPE	0.0149	0.0149	0.0149	0.0149	0.0149	0.0149	0.0149	0.0149
	LOSS OF BUNKER VEHICLE POWER	0.0138	0.0138	0.0138	0.0138	0.0138	0.0138	0.0138	0.0138

Table F.37: Unweighted Matrix 1 (Consequence-Decision Maker 1)

		ALTERNATIVES				CONNECTION HAZARDS		
		FIRE ON PIER / BUNKER VESSEL	FIRE ON SHIP	LNG LEAKS	NG LEAKS	BREAKAWAY COUPLING DISCONNECTION	DRY COUPLING DISCONNECTION	MISHANDLING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FIRE ON SHIP	0.0000	0.0000	0.0000	0.0000	0.1523	0.0764	0.1523
	LNG LEAKS	0.7142	0.7142	0.0000	1.0000	0.4782	0.4952	0.4782
	NG LEAKS	0.2858	0.2858	0.0000	0.0000	0.3695	0.4284	0.3695
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.9239	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.4281	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.5719	0.0761	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.6350	0.7142	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.0761	0.0761	0.2858	0.2858	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.9239	0.9239	0.7142	0.7142	0.0000
	SIMULTANOUS OPERATIONS	0.3086	0.2858	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0564	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.38: Unweighted Matrix 2 (Consequence-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.1997	0.1997	0.0000	0.0000	0.3086
	FATIGUE	0.0000	0.0000	0.3483	0.3483	0.0000	0.0000	0.0564
	TRAINING	0.0000	0.0000	0.4520	0.4520	0.0000	0.0000	0.6350
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.1506	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0195	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.7439	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.1934	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.1740	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.2561	0.2036	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.1644	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0945	0.0000	0.0000	0.0000

Table F.39: Unweighted Matrix 3 (Consequence-Decision Maker 1)

		ENVIRONMENTAL HAZARDS					HUMAN HAZARDS		
		ELECTRICAL EQUIPMENTS	EXTREME WEATHER CONDITIONS	SHIP / TRUCK MOVEMENT	SIMULTANOUS OPERATIONS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	AWARENESS	FATIGUE	TRAINING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.3862	0.0442	0.0442	0.2731	0.2966	0.1764	0.1764	0.1764
	FIRE ON SHIP	0.5723	0.0442	0.0442	0.2966	0.2731	0.1764	0.1764	0.1764
	LNG LEAKS	0.0208	0.4778	0.4778	0.2151	0.2151	0.3639	0.3639	0.3639
	NG LEAKS	0.0208	0.4338	0.4338	0.2151	0.2151	0.2833	0.2833	0.2833
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.40: Unweighted Matrix 4 (Consequence-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.2858	0.0000	0.0000	0.2858	0.2858	0.0000	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000
	TRAINING	0.7142	0.0000	0.0000	0.7142	0.7142	0.0000	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.41: Unweighted Matrix 5 (Consequence-Decision Maker 1)

		OPERATIONAL HAZARDS							
		FAILURE OF AUXILIARY SYSTEMS	FAILURE OF COMMUNICATION OR ESD	HOSE RUPTURE	INAPPROPRIATE COOLING OF BUNKER LINE	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	INCORRECT SEQUENCE	LNG TRAPPED IN PIPE	LOSS OF BUNKER VEHICLE POWER
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.1448	0.1448	0.0000	0.0000	0.0000	0.0000	0.0773	0.3363
	FIRE ON SHIP	0.1448	0.1448	0.1304	0.1523	0.1523	0.1523	0.2869	0.2301
	LNG LEAKS	0.3717	0.3717	0.4501	0.4782	0.4782	0.4782	0.3179	0.1042
	NG LEAKS	0.3388	0.3388	0.4195	0.3695	0.3695	0.3695	0.3179	0.3294
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.2858	0.0000	0.0000	0.0000	0.7142	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.7142	0.0000	0.0000	0.0000	0.2858	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.42: Unweighted Matrix 6 (Consequence-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.0000	0.0000	0.0000	0.1831	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.1909	0.0000	0.0000
	TRAINING	0.0000	0.0000	0.0000	0.0000	0.0000	0.6260	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.2858	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.7142	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.7142	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.2858	0.0000

Table F.43: Normalized Weighted Matrix 1 (Consequence-Decision Maker 1)

		ALTERNATIVES				CONNECTION HAZARDS		
		FIRE ON PIER / BUNKER VESSEL	FIRE ON SHIP	LNG LEAKS	NG LEAKS	BREAKAWAY COUPLING DISCONNECTION	DRY COUPLING DISCONNECTION	MISHANDLING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FIRE ON SHIP	0.0000	0.0000	0.0000	0.0000	0.0601	0.0302	0.0783
	LNG LEAKS	0.3635	0.3635	0.0000	0.2087	0.1887	0.1954	0.2459
	NG LEAKS	0.1455	0.1455	0.0000	0.0000	0.1458	0.1691	0.1900
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.1860	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.1089	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.1455	0.0153	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.3118	0.3507	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.0194	0.0153	0.1730	0.1730	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.2351	0.1860	0.4323	0.4323	0.0000
	SIMULTANOUS OPERATIONS	0.1515	0.1403	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0277	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.44: Normalized Weighted Matrix 2 (Consequence-Decision Maker 1)

	AWARENESS	0.0000	0.0000	0.0508	0.0402	0.0000	0.0000	0.1499
HUMAN HAZARDS	FATIGUE	0.0000	0.0000	0.0886	0.0701	0.0000	0.0000	0.0274
	TRAINING	0.0000	0.0000	0.1150	0.0910	0.0000	0.0000	0.3084
	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0282	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0036	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.1760	0.0000	0.0000	0.0000	0.0000
OPERATIONAL HAZARDS	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0362	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0326	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0606	0.0381	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0308	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0177	0.0000	0.0000	0.0000

Table F.45: Normalized Weighted Matrix 3 (Consequence-Decision Maker 1)

		ENVIRONMENTAL HAZARDS					HUMAN HAZARDS		
		ELECTRICAL EQUIPMENTS	EXTREME WEATHER CONDITIONS	SHIP / TRUCK MOVEMENT	SIMULTANOUS OPERATIONS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	AWARENESS	FATIGUE	TRAINING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.1183	0.0442	0.0074	0.0837	0.0909	0.0882	0.1764	0.1764
	FIRE ON SHIP	0.1754	0.0442	0.0074	0.0909	0.0837	0.0882	0.1764	0.1764
	LNG LEAKS	0.0064	0.4778	0.0795	0.0659	0.0659	0.1820	0.3639	0.3639
	NG LEAKS	0.0064	0.4338	0.0722	0.0659	0.0659	0.1417	0.2833	0.2833
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.8335	0.0000	0.0000	0.0000	0.0000	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.46: Normalized Weighted Matrix 4 (Consequence-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.1982	0.0000	0.0000	0.1982	0.1982	0.0000	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000
	TRAINING	0.4953	0.0000	0.0000	0.4953	0.4953	0.0000	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.47: Normalized Weighted Matrix 5 (Consequence-Decision Maker 1)

		OPERATIONAL HAZARDS							
		FAILURE OF AUXILIARY SYSTEMS	FAILURE OF COMMUNICATION OR ESD	HOSE RUPTURE	INAPPROPRIATE COOLING OF BUNKER LINE	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	INCORRECT SEQUENCE	LNG TRAPPED IN PIPE	LOSS OF BUNKER VEHICLE POWER
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.1448	0.0763	0.0000	0.0000	0.0000	0.0000	0.0101	0.3363
	FIRE ON SHIP	0.1448	0.0763	0.0664	0.1523	0.0803	0.0775	0.0375	0.2301
	LNG LEAKS	0.3717	0.1959	0.2291	0.4782	0.2521	0.2434	0.0415	0.1042
	NG LEAKS	0.3388	0.1786	0.2135	0.3695	0.1948	0.1881	0.0415	0.3294
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6261	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.1403	0.0000	0.0000	0.0000	0.0900	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.3507	0.0000	0.0000	0.0000	0.0360	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.48: Normalized Weighted Matrix 6 (Consequence-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0899	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0937	0.0000	0.0000
	TRAINING	0.0000	0.0000	0.0000	0.0000	0.0000	0.3074	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.1351	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0837	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.3377	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.4728	0.0000	0.0000	0.0000	0.0000	0.0335	0.0000

Table F.49: 32th Power of Limit Matrix 1 (Consequence-Decision Maker 1)

		ALTERNATIVES				CONNECTION HAZARDS		
		FIRE ON PIER / BUNKER VESSEL	FIRE ON SHIP	LNG LEAKS	NG LEAKS	BREAKAWAY COUPLING DISCONNECTION	DRY COUPLING DISCONNECTION	MISHANDLING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0352	0.0352	0.0352	0.0352	0.0352	0.0352	0.0352
	FIRE ON SHIP	0.0467	0.0467	0.0467	0.0467	0.0467	0.0467	0.0467
	LNG LEAKS	0.2071	0.2071	0.2071	0.2071	0.2071	0.2071	0.2071
	NG LEAKS	0.1383	0.1383	0.1383	0.1383	0.1383	0.1383	0.1383
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293
	DRY COUPLING DISCONNECTION	0.0226	0.0226	0.0226	0.0226	0.0226	0.0226	0.0226
	MISHANDLING	0.0323	0.0323	0.0323	0.0323	0.0323	0.0323	0.0323
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274
	EXTREME WEATHER CONDITIONS	0.1123	0.1123	0.1123	0.1123	0.1123	0.1123	0.1123
	SHIP / TRUCK MOVEMENT	0.1098	0.1098	0.1098	0.1098	0.1098	0.1098	0.1098
	SIMULTANOUS OPERATIONS	0.0119	0.0119	0.0119	0.0119	0.0119	0.0119	0.0119
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010

Table F.50: 32th Power of Limit Matrix 2 (Consequence-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0305	0.0305	0.0305	0.0305	0.0305	0.0305	0.0305
	FATIGUE	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459
	TRAINING	0.0718	0.0718	0.0718	0.0718	0.0718	0.0718	0.0718
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045
	FAILURE OF COMMUNICATION OR ESD	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
	HOSE RUPTURE	0.0365	0.0365	0.0365	0.0365	0.0365	0.0365	0.0365
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045
	INCORRECT SEQUENCE	0.0178	0.0178	0.0178	0.0178	0.0178	0.0178	0.0178
	LNG TRAPPED IN PIPE	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058
	LOSS OF BUNKER VEHICLE POWER	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029

Table F.51: 32th Power of Limit Matrix 3 (Consequence-Decision Maker 1)

		ENVIRONMENTAL HAZARDS					HUMAN HAZARDS		
		ELECTRICAL EQUIPMENTS	EXTREME WEATHER CONDITIONS	SHIP / TRUCK MOVEMENT	SIMULTANOUS OPERATIONS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	AWARENESS	FATIGUE	TRAINING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0352	0.0352	0.0352	0.0352	0.0352	0.0352	0.0352	0.0352
	FIRE ON SHIP	0.0467	0.0467	0.0467	0.0467	0.0467	0.0467	0.0467	0.0467
	LNG LEAKS	0.2071	0.2071	0.2071	0.2071	0.2071	0.2071	0.2071	0.2071
	NG LEAKS	0.1383	0.1383	0.1383	0.1383	0.1383	0.1383	0.1383	0.1383
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293
	DRY COUPLING DISCONNECTION	0.0226	0.0226	0.0226	0.0226	0.0226	0.0226	0.0226	0.0226
	MISHANDLING	0.0323	0.0323	0.0323	0.0323	0.0323	0.0323	0.0323	0.0323
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274
	EXTREME WEATHER CONDITIONS	0.1123	0.1123	0.1123	0.1123	0.1123	0.1123	0.1123	0.1123
	SHIP / TRUCK MOVEMENT	0.1098	0.1098	0.1098	0.1098	0.1098	0.1098	0.1098	0.1098
	SIMULTANOUS OPERATIONS	0.0119	0.0119	0.0119	0.0119	0.0119	0.0119	0.0119	0.0119
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010

Table F.52: 32th Power of Limit Matrix 4 (Consequence-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0305	0.0305	0.0305	0.0305	0.0305	0.0305	0.0305	0.0305
	FATIGUE	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459
	TRAINING	0.0718	0.0718	0.0718	0.0718	0.0718	0.0718	0.0718	0.0718
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045
	FAILURE OF COMMUNICATION OR ESD	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
	HOSE RUPTURE	0.0365	0.0365	0.0365	0.0365	0.0365	0.0365	0.0365	0.0365
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045
	INCORRECT SEQUENCE	0.0178	0.0178	0.0178	0.0178	0.0178	0.0178	0.0178	0.0178
	LNG TRAPPED IN PIPE	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058
	LOSS OF BUNKER VEHICLE POWER	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029

Table F.53: 32th Power of Limit Matrix 5 (Consequence-Decision Maker 1)

		OPERATIONAL HAZARDS							
		FAILURE OF AUXILIARY SYSTEMS	FAILURE OF COMMUNICATION OR ESD	HOSE RUPTURE	INAPPROPRIATE COOLING OF BUNKER LINE	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	INCORRECT SEQUENCE	LNG TRAPPED IN PIPE	LOSS OF BUNKER VEHICLE POWER
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0352	0.0352	0.0352	0.0352	0.0352	0.0352	0.0352	0.0352
	FIRE ON SHIP	0.0467	0.0467	0.0467	0.0467	0.0467	0.0467	0.0467	0.0467
	LNG LEAKS	0.2071	0.2071	0.2071	0.2071	0.2071	0.2071	0.2071	0.2071
	NG LEAKS	0.1383	0.1383	0.1383	0.1383	0.1383	0.1383	0.1383	0.1383
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293	0.0293
	DRY COUPLING DISCONNECTION	0.0226	0.0226	0.0226	0.0226	0.0226	0.0226	0.0226	0.0226
	MISHANDLING	0.0323	0.0323	0.0323	0.0323	0.0323	0.0323	0.0323	0.0323
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274	0.0274
	EXTREME WEATHER CONDITIONS	0.1123	0.1123	0.1123	0.1123	0.1123	0.1123	0.1123	0.1123
	SHIP / TRUCK MOVEMENT	0.1098	0.1098	0.1098	0.1098	0.1098	0.1098	0.1098	0.1098
	SIMULTANOUS OPERATIONS	0.0119	0.0119	0.0119	0.0119	0.0119	0.0119	0.0119	0.0119
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010

Table F.54: 32th Power of Limit Matrix 6 (Consequence-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0305	0.0305	0.0305	0.0305	0.0305	0.0305	0.0305	0.0305
	FATIGUE	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459	0.0459
	TRAINING	0.0718	0.0718	0.0718	0.0718	0.0718	0.0718	0.0718	0.0718
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045
	FAILURE OF COMMUNICATION OR ESD	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
	HOSE RUPTURE	0.0365	0.0365	0.0365	0.0365	0.0365	0.0365	0.0365	0.0365
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045
	INCORRECT SEQUENCE	0.0178	0.0178	0.0178	0.0178	0.0178	0.0178	0.0178	0.0178
	LNG TRAPPED IN PIPE	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058
	LOSS OF BUNKER VEHICLE POWER	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029

Table F.55: Unweighted Matrix 1 (Likelihood-Decision Maker 1)

		ALTERNATIVES				CONNECTION HAZARDS		
		FIRE ON PIER / BUNKER VESSEL	FIRE ON SHIP	LNG LEAKS	NG LEAKS	BREAKAWAY COUPLING DISCONNECTION	DRY COUPLING DISCONNECTION	MISHANDLING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FIRE ON SHIP	0.0000	0.0000	0.0000	0.0000	0.1276	0.1276	0.1470
	LNG LEAKS	0.0761	0.0761	0.0000	1.0000	0.5322	0.3402	0.4577
	NG LEAKS	0.9239	0.9239	0.0000	0.0000	0.3402	0.5322	0.3953
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0761	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0761	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.9239	0.9239	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.5330	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.0000	0.5000	0.0000	0.0761	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	1.0000	0.5000	1.0000	0.9239	0.0000
	SIMULTANOUS OPERATIONS	0.0649	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.4021	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.56: Unweighted Matrix 2 (Likelihood-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.4021	0.3483	0.0000	0.0000	0.1997
	FATIGUE	0.0000	0.0000	0.5330	0.4520	0.0000	0.0000	0.4520
	TRAINING	0.0000	0.0000	0.0649	0.1997	0.0000	0.0000	0.3483
	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.4021	0.2418	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.1544	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0649	0.0000	0.0000	0.0000	0.0000
OPERATIONAL HAZARDS	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0856	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0885	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.5330	0.2223	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0402	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.1672	0.0000	0.0000	0.0000

Table F.57: Unweighted Matrix 3 (Likelihood-Decision Maker 1)

		ENVIRONMENTAL HAZARDS					HUMAN HAZARDS		
		ELECTRICAL EQUIPMENTS	EXTREME WEATHER CONDITIONS	SHIP / TRUCK MOVEMENT	SIMULTANOUS OPERATIONS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	AWARENESS	FATIGUE	TRAINING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.2731	0.0442	0.0442	0.2833	0.3639	0.0731	0.0731	0.0731
	FIRE ON SHIP	0.2966	0.0442	0.0442	0.3639	0.2833	0.0731	0.0731	0.0731
	LNG LEAKS	0.2151	0.4778	0.4778	0.1764	0.1764	0.4831	0.4831	0.4831
	NG LEAKS	0.2151	0.4338	0.4338	0.1764	0.1764	0.3707	0.3707	0.3707
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.58: Unweighted Matrix 4 (Likelihood-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0761	0.0000	0.0000	0.0761	0.0761	0.0000	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000
	TRAINING	0.9239	0.0000	0.0000	0.9239	0.9239	0.0000	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.59: Unweighted Matrix 5 (Likelihood-Decision Maker 1)

		OPERATIONAL HAZARDS							
		FAILURE OF AUXILIARY SYSTEMS	FAILURE OF COMMUNICATION OR ESD	HOSE RUPTURE	INAPPROPRIATE COOLING OF BUNKER LINE	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	INCORRECT SEQUENCE	LNG TRAPPED IN PIPE	LOSS OF BUNKER VEHICLE POWER
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0917	0.0917	0.0442	0.0000	0.0000	0.0000	0.0000	0.0000
	FIRE ON SHIP	0.2630	0.2630	0.0442	0.1711	0.2137	0.2137	0.3457	0.2137
	LNG LEAKS	0.3226	0.3226	0.4778	0.4145	0.3457	0.4406	0.2137	0.4406
	NG LEAKS	0.3226	0.3226	0.4338	0.4145	0.4406	0.3457	0.4406	0.3457
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0761	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.9239	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.60: Unweighted Matrix 6 (Likelihood-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.1561	0.0000	0.0000
	TRAINING	0.0000	0.0000	0.0000	0.0000	0.0000	0.8439	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.7142	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0761	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.2858	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.9239	0.0000

Table F.61: Normalized Weighted Matrix 1 (Likelihood-Decision Maker 1)

		ALTERNATIVES				CONNECTION HAZARDS		
		FIRE ON PIER / BUNKER VESSEL	FIRE ON SHIP	LNG LEAKS	NG LEAKS	BREAKAWAY COUPLING DISCONNECTION	DRY COUPLING DISCONNECTION	MISHANDLING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FIRE ON SHIP	0.0000	0.0000	0.0000	0.0000	0.0555	0.0555	0.0934
	LNG LEAKS	0.0435	0.0435	0.0000	0.2069	0.2316	0.1481	0.2909
	NG LEAKS	0.5284	0.5284	0.0000	0.0000	0.1481	0.2316	0.2512
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0168	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0212	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.2574	0.2042	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.2281	0.2140	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.0000	0.0774	0.0000	0.0430	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.1952	0.0774	0.5648	0.5218	0.0000
	SIMULTANOUS OPERATIONS	0.0278	0.2140	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.1721	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.62: Normalized Weighted Matrix 2 (Likelihood-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.1027	0.0706	0.0000	0.0000	0.0728
	FATIGUE	0.0000	0.0000	0.1362	0.0916	0.0000	0.0000	0.1647
	TRAINING	0.0000	0.0000	0.0166	0.0405	0.0000	0.0000	0.1269
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.1088	0.0519	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0331	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0176	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0184	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0190	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.1443	0.0477	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0086	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0359	0.0000	0.0000	0.0000

Table F.63: Normalized Weighted Matrix 3 (Likelihood-Decision Maker 1)

		ENVIRONMENTAL HAZARDS					HUMAN HAZARDS		
		ELECTRICAL EQUIPMENTS	EXTREME WEATHER CONDITIONS	SHIP / TRUCK MOVEMENT	SIMULTANOUS OPERATIONS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	AWARENESS	FATIGUE	TRAINING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.1296	0.0442	0.0122	0.1344	0.1727	0.0365	0.0731	0.0731
	FIRE ON SHIP	0.1407	0.0442	0.0122	0.1727	0.1344	0.0365	0.0731	0.0731
	LNG LEAKS	0.1021	0.4778	0.1324	0.0837	0.0837	0.2416	0.4831	0.4831
	NG LEAKS	0.1021	0.4338	0.1202	0.0837	0.0837	0.1853	0.3707	0.3707
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.7228	0.0000	0.0000	0.0000	0.0000	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.64: Normalized Weighted Matrix 4 (Likelihood-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0400	0.0000	0.0000	0.0400	0.0400	0.0000	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000
	TRAINING	0.4856	0.0000	0.0000	0.4856	0.4856	0.0000	0.0000	0.0000
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.65: Normalized Weighted Matrix 5 (Likelihood-Decision Maker 1)

		OPERATIONAL HAZARDS							
		FAILURE OF AUXILIARY SYSTEMS	FAILURE OF COMMUNICATION OR ESD	HOSE RUPTURE	INAPPROPRIATE COOLING OF BUNKER LINE	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	INCORRECT SEQUENCE	LNG TRAPPED IN PIPE	LOSS OF BUNKER VEHICLE POWER
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0917	0.0437	0.0239	0.0000	0.0000	0.0000	0.0000	0.0000
	FIRE ON SHIP	0.2630	0.1253	0.0239	0.1711	0.1018	0.1157	0.0445	0.2137
	LNG LEAKS	0.3226	0.1537	0.2586	0.4145	0.1647	0.2384	0.0275	0.4406
	NG LEAKS	0.3226	0.1537	0.2348	0.4145	0.2099	0.1871	0.0568	0.3457
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6204	0.0000
	DRY COUPLING DISCONNECTION	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	MISHANDLING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EXTREME WEATHER CONDITIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0083	0.0000
	SHIP / TRUCK MOVEMENT	0.0000	0.0000	0.4588	0.0000	0.0000	0.0000	0.1009	0.0000
	SIMULTANOUS OPERATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table F.66: Normalized Weighted Matrix 6 (Likelihood-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	FATIGUE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0716	0.0000	0.0000
	TRAINING	0.0000	0.0000	0.0000	0.0000	0.0000	0.3871	0.0000	0.0000
	FAILURE OF AUXILIARY SYSTEMS	0.0000	0.0000	0.0000	0.0000	0.3740	0.0000	0.0000	0.0000
	FAILURE OF COMMUNICATION OR ESD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	HOSE RUPTURE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
OPERATIONAL HAZARDS	INAPPROPRIATE COOLING OF BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0108	0.0000
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	INCORRECT SEQUENCE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	LNG TRAPPED IN PIPE	0.0000	0.0000	0.0000	0.0000	0.1497	0.0000	0.0000	0.0000
	LOSS OF BUNKER VEHICLE POWER	0.0000	0.5236	0.0000	0.0000	0.0000	0.0000	0.1308	0.0000

Table F.67: 32th Power of Limit Matrix 1 (Likelihood-Decision Maker 1)

		ALTERNATIVES				CONNECTION HAZARDS		
		FIRE ON PIER / BUNKER VESSEL	FIRE ON SHIP	LNG LEAKS	NG LEAKS	BREAKAWAY COUPLING DISCONNECTION	DRY COUPLING DISCONNECTION	MISHANDLING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0225	0.0225	0.0225	0.0225	0.0225	0.0225	0.0225
	FIRE ON SHIP	0.0461	0.0461	0.0461	0.0461	0.0461	0.0461	0.0461
	LNG LEAKS	0.2141	0.2141	0.2141	0.2141	0.2141	0.2141	0.2141
	NG LEAKS	0.1820	0.1820	0.1820	0.1820	0.1820	0.1820	0.1820
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0044	0.0044	0.0044	0.0044	0.0044	0.0044	0.0044
	DRY COUPLING DISCONNECTION	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045
	MISHANDLING	0.0923	0.0923	0.0923	0.0923	0.0923	0.0923	0.0923
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0150	0.0150	0.0150	0.0150	0.0150	0.0150	0.0150
	EXTREME WEATHER CONDITIONS	0.0596	0.0596	0.0596	0.0596	0.0596	0.0596	0.0596
	SHIP / TRUCK MOVEMENT	0.0627	0.0627	0.0627	0.0627	0.0627	0.0627	0.0627
	SIMULTANOUS OPERATIONS	0.0105	0.0105	0.0105	0.0105	0.0105	0.0105	0.0105
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039

Table F.68: 32th Power of Limit Matrix 2 (Likelihood-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0427	0.0427	0.0427	0.0427	0.0427	0.0427	0.0427
	FATIGUE	0.0852	0.0852	0.0852	0.0852	0.0852	0.0852	0.0852
	TRAINING	0.0522	0.0522	0.0522	0.0522	0.0522	0.0522	0.0522
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0340	0.0340	0.0340	0.0340	0.0340	0.0340	0.0340
	FAILURE OF COMMUNICATION OR ESD	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060
	HOSE RUPTURE	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035
	INCORRECT SEQUENCE	0.0396	0.0396	0.0396	0.0396	0.0396	0.0396	0.0396
	LNG TRAPPED IN PIPE	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021
	LOSS OF BUNKER VEHICLE POWER	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100

Table F.69: 32th Power of Limit Matrix 3 (Likelihood-Decision Maker 1)

		ENVIRONMENTAL HAZARDS					HUMAN HAZARDS		
		ELECTRICAL EQUIPMENTS	EXTREME WEATHER CONDITIONS	SHIP / TRUCK MOVEMENT	SIMULTANOUS OPERATIONS	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	AWARENESS	FATIGUE	TRAINING
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0225	0.0225	0.0225	0.0225	0.0225	0.0225	0.0225	0.0225
	FIRE ON SHIP	0.0461	0.0461	0.0461	0.0461	0.0461	0.0461	0.0461	0.0461
	LNG LEAKS	0.2141	0.2141	0.2141	0.2141	0.2141	0.2141	0.2141	0.2141
	NG LEAKS	0.1820	0.1820	0.1820	0.1820	0.1820	0.1820	0.1820	0.1820
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0044	0.0044	0.0044	0.0044	0.0044	0.0044	0.0044	0.0044
	DRY COUPLING DISCONNECTION	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045
	MISHANDLING	0.0923	0.0923	0.0923	0.0923	0.0923	0.0923	0.0923	0.0923
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0150	0.0150	0.0150	0.0150	0.0150	0.0150	0.0150	0.0150
	EXTREME WEATHER CONDITIONS	0.0596	0.0596	0.0596	0.0596	0.0596	0.0596	0.0596	0.0596
	SHIP / TRUCK MOVEMENT	0.0627	0.0627	0.0627	0.0627	0.0627	0.0627	0.0627	0.0627
	SIMULTANOUS OPERATIONS	0.0105	0.0105	0.0105	0.0105	0.0105	0.0105	0.0105	0.0105
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039

Table F.70: 32th Power of Limit Matrix 4 (Likelihood-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0427	0.0427	0.0427	0.0427	0.0427	0.0427	0.0427	0.0427
	FATIGUE	0.0852	0.0852	0.0852	0.0852	0.0852	0.0852	0.0852	0.0852
	TRAINING	0.0522	0.0522	0.0522	0.0522	0.0522	0.0522	0.0522	0.0522
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0340	0.0340	0.0340	0.0340	0.0340	0.0340	0.0340	0.0340
	FAILURE OF COMMUNICATION OR ESD	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060
	HOSE RUPTURE	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035
	INCORRECT SEQUENCE	0.0396	0.0396	0.0396	0.0396	0.0396	0.0396	0.0396	0.0396
	LNG TRAPPED IN PIPE	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021
	LOSS OF BUNKER VEHICLE POWER	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100

Table F.71: 32th Power of Limit Matrix 5 (Likelihood-Decision Maker 1)

		OPERATIONAL HAZARDS							
		FAILURE OF AUXILIARY SYSTEMS	FAILURE OF COMMUNICATION OR ESD	HOSE RUPTURE	INAPPROPRIATE COOLING OF BUNKER LINE	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	INCORRECT SEQUENCE	LNG TRAPPED IN PIPE	LOSS OF BUNKER VEHICLE POWER
ALTERNATIVES	FIRE ON PIER / BUNKER VESSEL	0.0225	0.0225	0.0225	0.0225	0.0225	0.0225	0.0225	0.0225
	FIRE ON SHIP	0.0461	0.0461	0.0461	0.0461	0.0461	0.0461	0.0461	0.0461
	LNG LEAKS	0.2141	0.2141	0.2141	0.2141	0.2141	0.2141	0.2141	0.2141
	NG LEAKS	0.1820	0.1820	0.1820	0.1820	0.1820	0.1820	0.1820	0.1820
CONNECTION HAZARDS	BREAKAWAY COUPLING DISCONNECTION	0.0044	0.0044	0.0044	0.0044	0.0044	0.0044	0.0044	0.0044
	DRY COUPLING DISCONNECTION	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045
	MISHANDLING	0.0923	0.0923	0.0923	0.0923	0.0923	0.0923	0.0923	0.0923
ENVIRONMENTAL HAZARDS	ELECTRICAL EQUIPMENTS	0.0150	0.0150	0.0150	0.0150	0.0150	0.0150	0.0150	0.0150
	EXTREME WEATHER CONDITIONS	0.0596	0.0596	0.0596	0.0596	0.0596	0.0596	0.0596	0.0596
	SHIP / TRUCK MOVEMENT	0.0627	0.0627	0.0627	0.0627	0.0627	0.0627	0.0627	0.0627
	SIMULTANOUS OPERATIONS	0.0105	0.0105	0.0105	0.0105	0.0105	0.0105	0.0105	0.0105
	UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039

Table F.72: 32th Power of Limit Matrix 6 (Likelihood-Decision Maker 1)

HUMAN HAZARDS	AWARENESS	0.0427	0.0427	0.0427	0.0427	0.0427	0.0427	0.0427	0.0427
	FATIGUE	0.0852	0.0852	0.0852	0.0852	0.0852	0.0852	0.0852	0.0852
	TRAINING	0.0522	0.0522	0.0522	0.0522	0.0522	0.0522	0.0522	0.0522
OPERATIONAL HAZARDS	FAILURE OF AUXILIARY SYSTEMS	0.0340	0.0340	0.0340	0.0340	0.0340	0.0340	0.0340	0.0340
	FAILURE OF COMMUNICATION OR ESD	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060
	HOSE RUPTURE	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038
	INAPPROPRIATE COOLING OF BUNKER LINE	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034
	INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035
	INCORRECT SEQUENCE	0.0396	0.0396	0.0396	0.0396	0.0396	0.0396	0.0396	0.0396
	LNG TRAPPED IN PIPE	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021
	LOSS OF BUNKER VEHICLE POWER	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100

APPENDICES G SUPERDECISIONS ANP MODEL

In order to verify results, Superdecisions Software version 2.6.0-RC1 used. Model of the structure is presented in below figures; A to C.

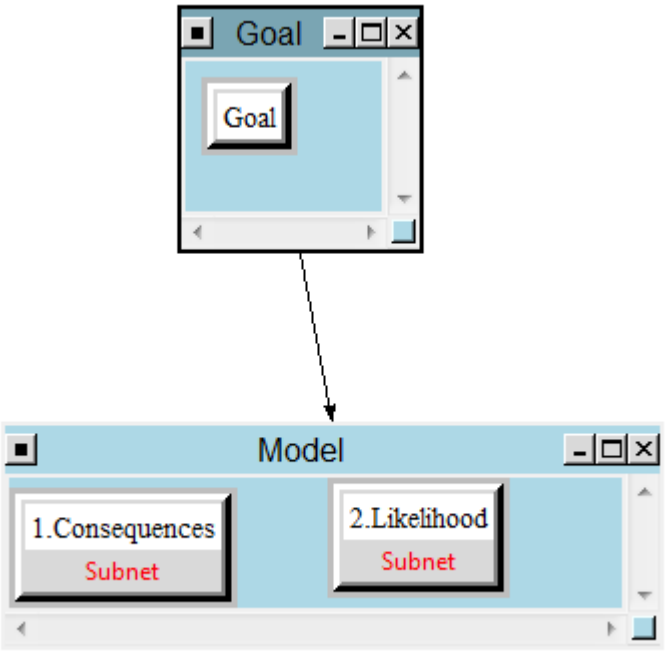

Figure G.A Main model structure

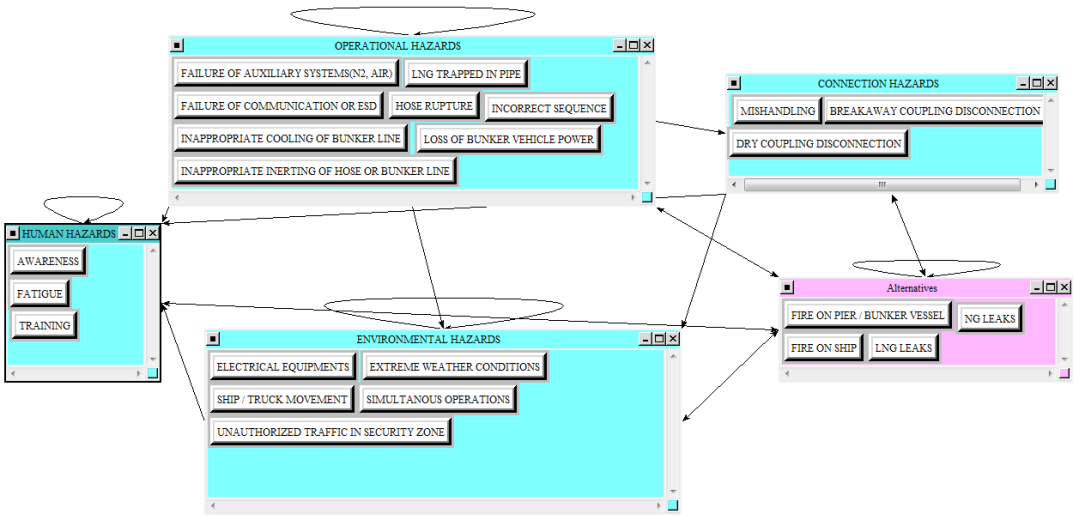

Figure G.B Consequences sub-model

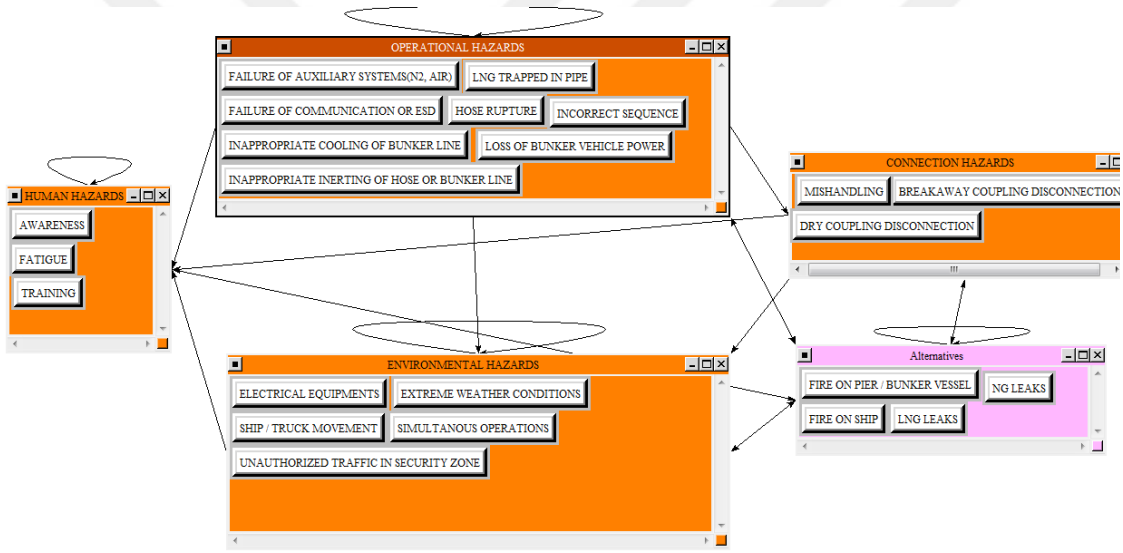

Figure G.C Likelihood sub-model

Comparison results for ANP with Eigen vectors for Decision maker 2 Consequences sub-model is presented below.

Alternatives	
FIRE ON PIER / BUNKER VESSEL	0.041862
FIRE ON SHIP	0.049726
LNG LEAKS	0.278322
NG LEAKS	0.115504
CONNECTION HAZARDS	
BREAKAWAY COUPLING DISCONNECTION	0.012232
DRY COUPLING DISCONNECTION	0.060575
MISHANDLING	0.023327
ENVIRONMENTAL HAZARDS	
ELECTRICAL EQUIPMENTS	0.021453
EXTREME WEATHER CONDITIONS	0.093364
SHIP / TRUCK MOVEMENT	
SIMULTANOUS OPERATIONS	0.014387
UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.003606
HUMAN HAZARDS	
AWARENESS	0.014615
FATIGUE	0.090293
TRAINING	0.022019
OPERATIONAL HAZARDS	
FAILURE OF AUXILIARY SYSTEMS(N2, AIR)	0.005346
FAILURE OF COMMUNICATION OR ESD	0.003972
HOSE RUPTURE	0.039111
INAPPROPRIATE COOLING OF BUNKER LINE	0.001470
INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.007284
INCORRECT SEQUENCE	0.020461
LNG TRAPPED IN PIPE	0.004232
LOSS OF BUNKER VEHICLE POWER	0.002149

Similarly results for Decision maker 2 Likelihood sub-model are;

Alternatives	
FIRE ON PIER / BUNKER VESSEL	0.029575
FIRE ON SHIP	0.042549
LNG LEAKS	0.222763
NG LEAKS	0.133315
CONNECTION HAZARDS	
BREAKAWAY COUPLING DISCONNECTION	0.010737
DRY COUPLING DISCONNECTION	0.012501
MISHANDLING	0.135351
ENVIRONMENTAL HAZARDS	
ELECTRICAL EQUIPMENTS	0.024162
EXTREME WEATHER CONDITIONS	0.062371
SHIP / TRUCK MOVEMENT	0.055261
SIMULTANOUS OPERATIONS	0.013971
UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.004925
HUMAN HAZARDS	
AWARENESS	0.012038
FATIGUE	0.052773
TRAINING	0.034533
OPERATIONAL HAZARDS	
FAILURE OF AUXILIARY SYSTEMS(N2, AIR)	0.036957
FAILURE OF COMMUNICATION OR ESD	0.011767
HOSE RUPTURE	0.004425
INAPPROPRIATE COOLING OF BUNKER LINE	0.001995
INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.017875
INCORRECT SEQUENCE	0.056267
LNG TRAPPED IN PIPE	0.009329
LOSS OF BUNKER VEHICLE POWER	0.014561

Results for Decision maker 1 Consequences and Likelihood respectively are presented below.

Alternatives	
FIRE ON PIER / BUNKER VESSEL	0.027939
FIRE ON SHIP	0.031861
LNG LEAKS	0.260105
NG LEAKS	0.113062
CONNECTION HAZARDS	
BREAKAWAY COUPLING DISCONNECTION	0.020012
DRY COUPLING DISCONNECTION	0.016983
MISHANDLING	0.053693
ENVIRONMENTAL HAZARDS	
ELECTRICAL EQUIPMENTS	0.020227
EXTREME WEATHER CONDITIONS	0.103735
SHIP / TRUCK MOVEMENT	0.118031
SIMULTANOUS OPERATIONS	0.004554
UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.000974
HUMAN HAZARDS	
AWARENESS	0.018507
FATIGUE	0.035329
TRAINING	0.098509
OPERATIONAL HAZARDS	
FAILURE OF AUXILIARY SYSTEMS(N2, AIR)	0.005862
FAILURE OF COMMUNICATION OR ESD	0.000494
HOSE RUPTURE	0.042311
INAPPROPRIATE COOLING OF BUNKER LINE	0.005162
INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.002895
INCORRECT SEQUENCE	0.015147
LNG TRAPPED IN PIPE	0.003343
LOSS OF BUNKER VEHICLE POWER	0.001263

Alternatives	
FIRE ON PIER / BUNKER VESSEL	0.026256
FIRE ON SHIP	0.039686
LNG LEAKS	0.255156
NG LEAKS	0.157136
CONNECTION HAZARDS	
BREAKAWAY COUPLING DISCONNECTION	0.006255
DRY COUPLING DISCONNECTION	0.011690
MISHANDLING	0.122710
ENVIRONMENTAL HAZARDS	
ELECTRICAL EQUIPMENTS	0.012702
EXTREME WEATHER CONDITIONS	0.023373
SHIP / TRUCK MOVEMENT	0.049051
SIMULTANOUS OPERATIONS	0.007483
UNAUTHORIZED TRAFFIC IN SECURITY ZONE	0.002522
HUMAN HAZARDS	
AWARENESS	0.032979
FATIGUE	0.088956
TRAINING	0.052335
OPERATIONAL HAZARDS	
FAILURE OF AUXILIARY SYSTEMS(N2, AIR)	0.032499
FAILURE OF COMMUNICATION OR ESD	0.004258
HOSE RUPTURE	0.005115
INAPPROPRIATE COOLING OF BUNKER LINE	0.001932
INAPPROPRIATE INERTING OF HOSE OR BUNKER LINE	0.002460
INCORRECT SEQUENCE	0.055575
LNG TRAPPED IN PIPE	0.001614
LOSS OF BUNKER VEHICLE POWER	0.008257

APPENDICES H EXCEL VBA CODES

Three methods used to solve this network model;

- ANP solved using Logarithmic Least Square Method in Excel
- Fuzzy – ANP solved using Chang's Method in Excel
- ANP solved using Superdecision Software which uses Eigen Values for calculation

Study of Saaty and Vargas (1984) named "Comparison of Eigen Values, Logarithmic Least Squares and Least Squares methods in estimating ratios" proved that Eigen Values is the best method to deal with inconsistency. In this study it has been tried to identify the difference between these methods in case of low inconsistency values.

Two modules and VBA codes on worksheets created to perform calculations. Code included worksheets are marked in below figure.

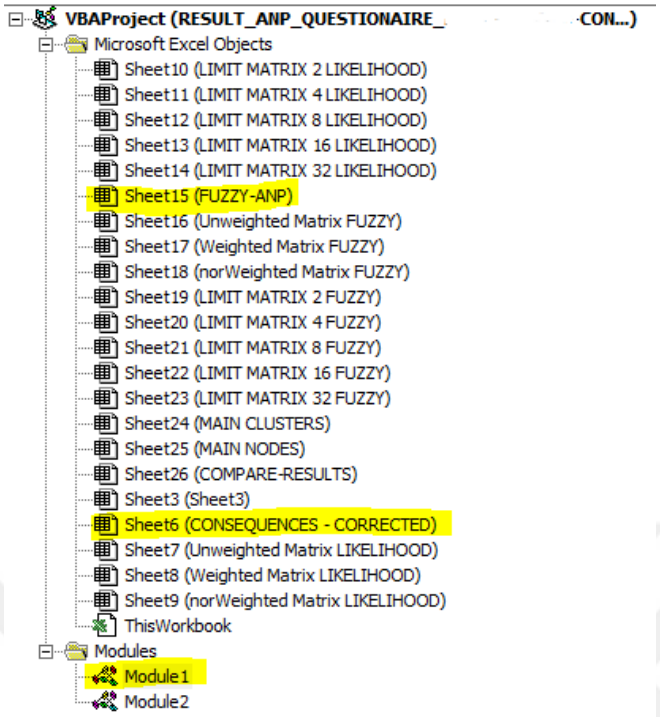

Figure H.A: Worksheet and Modules include code

Module 1 includes below three functions; LLSM – Logarithmic Least Square Method, FUZZY and CHANG.

```
Function LLSM(a)
Dim matrix(2)
myrow = ActiveCell.Row
mycol = ActiveCell.Column

ncol = a.Columns.Count
nrow = a.Rows.Count
b = 1
matrix(1) = 0

For i = 1 To ncol
b = b * (a.Cells(1, i).Value)
Next i
matrix(1) = (b ^ (1 / ncol))

LLSM = matrix(1)

'Range(Cells(myrow, mycol)).Formula = LLSM

'Range(Cells(myrow + 1, mycol), Cells(myrow + 1, mycol + ncol)).FillDown


End Function
```

```
Function FUZZY(a)

Dim ilk, son, uzunluk As Integer

myrow = ActiveCell.Row
mycol = ActiveCell.Column

ncol = a.Columns.Count
nrow = a.Rows.Count
Dim vector(150)
Dim matrix_f(3, 150)
Dim S(3, 150)
Dim V(150, 150)
Dim Minimum(150)
Dim W(150)                '       W=W'/sigma(d'(Ai))
                          '       d'(Ai)=minV(Si>=Sk)

For j = 1 To nrow

    ilk_deger = 0
    orta_deger = 0
    son_deger = 0

    toplam_ilk_deger = 0
    toplam_orta_deger = 0
    toplam_son_deger = 0

For i = 1 To ncol
ilk = InStr(1, a.Cells(j, i).Value, ",")              'position of first comma
son = InStr(ilk + 1, a.Cells(j, i).Value, ",")        'position of second comma
uzunluk = Len(a.Cells(j, i))

ilk_deger = Left(a.Cells(j, i).Value, ilk - 1)        'value of first fuzzy number


'value of last fuzzy number
son_deger = Right(a.Cells(j, i).Value, uzunluk - son)
'value of second fuzzy number
orta_deger = Mid(a.Cells(j, i).Value, ilk + 1, (uzunluk - (ilk + (uzunluk - son + 1))))

toplam_ilk_deger = ilk_deger + toplam_ilk_deger
toplam_son_deger = son_deger + toplam_son_deger
toplam_orta_deger = orta_deger + toplam_orta_deger
Next i

matrix_f(1, j) = toplam_ilk_deger
matrix_f(2, j) = toplam_orta_deger
matrix_f(3, j) = toplam_son_deger

    sutun_toplam_ilk = toplam_ilk_deger + sutun_toplam_ilk
    sutun_toplam_son = toplam_son_deger + sutun_toplam_son
    sutun_toplam_orta = toplam_orta_deger + sutun_toplam_orta

Next j

vector(1) = 1 / sutun_toplam_son
vector(2) = 1 / sutun_toplam_orta
vector(3) = 1 / sutun_toplam_ilk

For j = 1 To nrow                          'For each row calculates (l,m,u)
   'S(a,b): a fuzzy triangle (3 conditions lower, mid, upper), b number of rows
    S(1, j) = matrix_f(1, j) * vector(1)
    S(2, j) = matrix_f(2, j) * vector(2)
    S(3, j) = matrix_f(3, j) * vector(3)
Next j

toplam_minimum = 0
For j = 1 To nrow
```

```
Minimum(j) = 100              'First value for finding minimum
    For i = 1 To nrow
        If i = j Then
        GoTo son
        Else: V(j, i) = Chang(S(1, j), S(2, j), S(3, j), S(1, i), S(2, i), S(3, i))
        End If


        If Minimum(j) > V(j, i) Then
        Minimum(j) = V(j, i)
        End If

son:
Next i

toplam_minimum = Minimum(j) + toplam_minimum

Next j

FUZZY_STR = Null
For j = 1 To nrow

    W(j) = Minimum(j) / toplam_minimum

    FUZZY_STR = FUZZY_STR & "," & W(j)

Next j

uzunluk = Len(FUZZY_STR)

FUZZY = Right(FUZZY_STR, uzunluk - 1)
'getting rid of the comma at the beginning

End Function

Function Chang(l2, m2, u2, l1, m1, u1)

If m2 >= m1 Then
condition = 1
ElseIf l1 >= u2 Then
condition = 2
Else: condition = 3
End If


Select Case condition 'Chang's method

    Case 1
    Chang = 1                'if m2>m1

    Case 2
    Chang = 0                'if l1>u2

    Case 3                   'otherwise
    Chang = (l1 - u2) / ((m2 - u2) - (m1 - l1))

End Select



End Function
```

In worksheet named “Fuzzy-Anp” below listed code activates when user double clicks on the screen. This code separates the single fuzzy values into l, m and u values.

```
Private Sub Worksheet_BeforeDoubleClick(ByVal Target As Range, Cancel As Boolean)

kolon = ActiveSheet.Range("K" & Rows.Count).End(xlUp).Row    'find the last row used in K colum

For col = 1 To kolon

    A1 = Cells(col, 11).Value

If A1 <> "" Then

    n = Len(A1) - Len(Replace(A1, ",", ""))

    ilk = 0
    sayac = 0
    uzunluk = Len(A1)

    For i = 1 To n + 1
    ilk = InStr(1 + ilk, A1, ",")                          'position of first comma
    'son = InStr(ilk + 1, a.Cells(J, i).Value, ",")        'position of second comma

    If i = n + 1 Then
    ilk_deger = Mid(A1, sayac + 1, uzunluk)                'value of first fuzzy numberuzunluk
    Else
    ilk_deger = Mid(A1, sayac + 1, ilk - sayac - 1)        'value of first fuzzy number
    End If

    sayac = ilk
    Cells(col + i - 1, 12) = ilk_deger

    Next i
End If
Next col
End Sub
```

Similarly worksheet named “Consequences-corrected” also includes a code that again actives when user double clicks on the page. This code gets data calculated by LLSM command, calculates consistency index and weight vector.

```
Private Sub Worksheet_BeforeDoubleClick(ByVal Target As Range, Cancel As Boolean)
kolon = ActiveSheet.Range("L" & Rows.Count).End(xlUp).Row   'find the last row used in K colum

For col = 1 To kolon
sayac = 0

    A1 = Cells(col, 12).Value

If A1 <> "" Then

        A2 = A1
        While A2 <> ""
        A2 = Cells(col + sayac, 12).Value
        sayac = sayac + 1                 'number of non empty cells in group
        Wend

    sayac = sayac - 1
    sayac1 = sayac
    r2 = Range(Cells(col, 12), Cells(col + sayac - 1, 12))  'llsm result
    r2 = Application.WorksheetFunction.Transpose(r2)

        toplam = 0
        For i = 0 To sayac - 1
        r1 = Range(Cells(col + i, 3), Cells(col + i, 2 + sayac))
        carpim = Application.WorksheetFunction.SumProduct(r1, r2)
        A3 = Cells(col + i, 12)
        bolum = carpim / A3
        Cells(col + i, 13) = bolum
        toplam = toplam + bolum
        Next i

        lamda_mean = toplam / sayac

        Select Case sayac
        Case 1
        ri = 1


         Case 2
         ri = 1
         Case 3
         ri = 0.58
         Case 4
         ri = 0.9
         Case 5
         ri = 1.12
         Case 6
         ri = 1.24
         Case 7
         ri = 1.32
         Case 8
         ri = 1.41
         Case 9
         ri = 1.45
         Case 10
         ri = 1.49
         Case 11
         ri = 1.51
         Case 12
         ri = 1.48
         Case 13
         ri = 1.56
         Case 14
         ri = 1.57

         End Select
         Cells(col + i + 1, 13).Interior.ColorIndex = 0
         ci = (lamda_mean - sayac) / (sayac - 1)
         consistency_ratio = ci / ri
         If consistency_ratio > 0.1 Then
         Cells(col + i + 1, 13).Interior.ColorIndex = 3
         End If
         Cells(col + i + 1, 13) = consistency_ratio
```

```
    col = col + sayac

End If

Next col

End Sub
```

APPENDICES I CALCULATION OF DECISION MAKERS' RANKS

Network structure created for decision maker ranks is shown in Figure 3.L. Based on this network model below pairwise comparisons performed.

Table I.1: Pairwise comparisons for decision makers' ranks

AIM	Experience	Theoretical Knowledge	Logarithmic Least Squares	Weight
Experience	1	3	1.7320508	0.75
Theoretical Knowledge	0.333333333	1	0.5773503	0.25
			2.3094011	

EXPERIENCE	Decision maker 1	Decision maker 2	Logarithmic Least Squares	Weight
Decision maker 1	1	0.2	0.4472136	0.166667
Decision maker 2	5	1	2.236068	0.833333
			2.6832816	

THEORETICAL KNOWLEDGE	Decision maker 1	Decision maker 2	Logarithmic Least Squares	Weight
Decision maker 1	1	3	1.7320508	0.75
Decision maker 2	0.333333333	1	0.5773503	0.25
			2.3094011	

DECISION MAKER 1	Experience	Theoretical Knowledge	Logarithmic Least Squares	Weight
Experience	1	0.2	0.4472136	0.166667
Theoretical Knowledge	5	1	2.236068	0.833333
			2.6832816	

DECISION MAKER 2	Experience	Theoretical Knowledge	Logarithmic Least Squares	Weight
Experience	1	3	1.7320508	0.75
Theoretical Knowledge	0.333333333	1	0.5773503	0.25
			2.3094011	

From above comparison weights below presented super matrix is generated.

Table I.2: Super Matrix

	AIM	EXPERIENCE	THEORETICAL KNOWLEDGE	DECISION MAKER 1	DECISION MAKER 2
AIM	0	0	0	0	0
EXPERIENCE	0.75	0	0	0.166666667	0.75
THEORETICAL KNOWLEDGE	0.25	0	0	0.833333333	0.25
DECISION MAKER 1	0	0.16666667	0.75	0	0
DECISION MAKER 2	0	0.83333333	0.25	0	0

32th power of the super matrix is the limit matrix where weights are constant.

Table I.3: Limit Matrix

32th power	AIM	EXPERIENCE	THEORETICAL KNOWLEDGE	DECISION MAKER 1	DECISION MAKER 2
AIM	0	0	0	0	0
EXPERIENCE	0	0.47377882	0.473599066	0	0
THEORETICAL KNOWLEDGE	0	0.52622118	0.526400934	0	0
DECISION MAKER 1	0.473599	0	0	0.473778816	0.473599066
DECISION MAKER 2	0.526401	0	0	0.526221184	0.526400934

According to the limit matrix ranks of decision makers are shown below. Results show that based on the model the ranks of decision makers are very close to the each other.

Table I.4: Decision Maker Ranks

DECISION MAKER 1	0.473599
DECISION MAKER 2	0.526401

APPENDICES J CIRRICULUM VITAE

Name Surname :	Emre Koray Gençsoy
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E-Mail :	emre.gencsoy@gmail.com
Bachelor's degree :	Istanbul Technical University

PUBLICATIONS/PRESENTATIONS ON THE THESIS

-none-

Professional Experience

- **Chief Surveyor**

  2004 - Present

  Bureau Veritas (BV) Marine / Turkiye & China

  Project leader responsible for both shipyard and owner side relationships, supervision and follow-up of the projects as per international regulations and BV rules. Performs on side control for all disciplines including hull (steel and aluminium), machinery, electricity, safety and statutory items for new building ships. Authorized to sign all class and statutory certificates. Specialized especially for bulk carriers, general cargo ships, container ships, asphalt tankers, oil and chemical tankers, fast crew boats, pilot boats, tug boats, floating docks, stand-by rescue vessels and pleasure yachts with conventional, lpg and

electrical propulsion systems.

In 2010 worked for BV China at Zhoushan area on temporary duty as project leader for three 57000 dwt bulk carriers.

Besides surveyor activities, designed the web based surveyor invitation database system and local shipyards welding procedures database projects for BV Turkiye. Systems are used since 2007 without an interrupt.

- **Team Leader Design Chief**

  Admarin Designers, Consultants, Contractors / Turkiye **1998 - 2004**

  Design chief dedicated to customer and class relationships for concept and detailed design of oil/chemical tankers, bulk carriers, general cargo ships and search and rescue ships. Planing and leading the design team to work as per time, scope and quality management plans. Represent the company against third parties. Planning of the workforce of the company and recruitment. Responsible for setting up ISO 9001 and AQAP 110 systems, company's internal quality auditor. Designed an intranet system for project management.

- **Assistant Engineer**

  Istanbul Technical University, Naval Architecture and Marine Engineering Faculty, Research and Application Group / Turkiye **1997 - 1998**

  Worked for “Manufacturing Management Division” under the supervision of Prof.Dr.Yücel Odabaşı. Participated in projects such as shipyard organizations, quality management systems, preparing alternative shipyard organization systems and MILGEM.