İSTANBUL TECHNICAL UNIVERSITY ★ GRADUATE SCHOOL OF SCIENCE ENGINEERING AND TECHNOLOGY

A FUZZY SET APPROACH FOR ACCEPTABILITY OF EIA THROUGH INTEGRATION MANAGEMENT SYSTEM

M.Sc. THESIS

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Environmental Sciences and Engineering Programme

JUNE 2016

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ENTEGRE YÖNETİM SİSTEMLERİYLE KABUL EDİLEBİLİR BİR ÇEVRESEL ETKİ DEĞERLENDİRME İÇİN BULANIK MANTIK YAKLAŞIMI

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To my wife and children,

FOREWORD

I let my gratitude in this study, showing the way to help and support me and who contributed greatly in the completion of my thesis, Prof.Dr.İlhan Talınlı.
I would like to state that all who have supported me at every stage of my life and I also state my gratitude to my wife Meltem, my daughter İdil and my son Mehmet Emir sincere feeling standing behind me..

June 2016 Mustafa KAVUKCU

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ABBREVIATIONS

A	: Agriculture
Ad HOC	: Ad hoc is a Latin phrase meaning "for this"
AHP	: Analytic Hierarchy Process
AQ	: Air Quality
AVtR	: Add Value to Region
BoP	: Benefit of the Project
C	: Climate
C&LC	: Cultural and Local Compatibility
CIP	: Clean in Place
CP	: Cleaner Production
DIS	: The draft international Standard
DoI	: Distribution of Income
DS	: Demographic Stability
EEI	: Estimated Environmental Impact
EFP	: Eco Friendly Production
EHS	: Environmental, Health and Safety
EIA	: Environmental Impact Assessment
EIS	: Environmental Impact Statement
EMS	: Environmental Management System
Emp	: Employment
EPA	: Environmental Protection Agency
ETV	: Environmental Technology Verification
F	: Forest
FAHP	: Fuzzy Analytic Hierarchy Process
FDIS	: The final draft international Standard
FF	: Flora, Fauna
GS	: Geomorphologic Structure
H&TA	: Historical & Touristic Area
IM	: Impact Magnitude
IMS	: Integrated Management System
ISO	: The International Organization for Standardization
L-BoP	: Large (Benefit means) - BoP
L-EEI	: L (great damage means) –EEI
MCDA	: Multi Criteria Decision Analysis
MMR	: Materials Management and Remediation
NEPA	: National Environmental Policy Act
NT	: New Technology
OHSAMS	: Occupational Health Safety Management System
OHSAS	: Occupation Health and Safety Assessment Series
P	: Productivity
PB	: Public Benefit
PDCA	: Plan-Do-Check-Act

QMS : Quality Management System
RA : Recreational area
RC : Resource Conservation
RCRA : The Resource Conservation and Recovery Act
S-BoP : Less (benefit means) – BoP
SC : Subcommittees
SEA : Strategic Environmental Assessment
S-EEI : S (less or negligible damage means) –EEI
S&GW : Surface & Groundwater
SI : Source Independency
STFN : Standard Trapezoid Fuzzy Number
TC : Technical Committees
U : Urbanization
UNEP : United Nation Environment Program
W : Welfare
W-WS : Water & Watershed

SYMBOLS

C	: Capacitance
C.I	: Consistency Index
R.I	: Random Index
C.R	: Consistency Ratio
F.I	: Factor Index
IM	: Impact Magnitude
$\mathbf{IM_{BoP}}$	: Total Impact Magnitude of BoP
$\mathbf{IM_{EEI}}$	: Total Impact Magnitude of EEI
$\mathbf{IM_{C}}$	: The calculated IM
$\mathbf{IM_{A}}$	: Acceptable IM
$\mathbf{IM_{R}}$	: Residual IM
$\mathbf{IM_{EMS}}$	: Total IM of EMS
a_{ij}	: a_{ij} is the value in the ith row, j column of a; also called i, j entry of “a”
$w_{i,}$	: own weight for i th criterion
w_i'	: inhierarchy weight for i th criterion
$\lambda_{max.}$	: λis calculated by averaging the value of the consistency Vector
μ	: Membership function
Z	: Crisp output
Cij	: Consistency vector

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FUZZY SET APPROACH FOR ACCEPTABILITY OF EIA THROUGH INTEGRATED MANAGEMENT SYSTEM

SUMMARY

Nowadays people need is increasing with each passing day. To meet those needs require industrialization, urbanization and economic development. While performing these changes, the consumption of environmental resources and the ecological damage cycle has been increased.

In parallel, this ecological destruction and consumption of environmental sources increased pollutions and it decreased environmental quality.

The contradiction between increasing environmental pollution and economic development, could not be a solution yet. Studies are underway in this regards.

A model was created in order to contribute to these efforts.

To reveal the size of the environmental impact, the main parameters that cause the dilemma of industrial development and environmental pollution has been taken into account. The magnitude of the environmental impact obtained has been reduced through the use of environmental management systems (EIA).

In this study, Analytic Hierarchy Process (AHP) and Fuzzy Logic is thought as the most appropriate method to be used.

The reason for choosing the Analytical Hierarchy Model is to provide a systematic approach to hierarchy of sub-factors which will reveal the environmental Impact Magnitude.

With pair-wise comparison method which is the basic feature of AHP, all sub-factors were compared in pair wise comparison with each other.

In assessments that are vague and uncertain, fuzzy logic-based modeling has been used. With Fuzzy Logic model, linguistic variables of expert opinion are used as an input instead of uncertainty and missing data. Thus, Factor index (FI) and membership grade used in the calculation of the environmental impact magnitude (IM) is found.

The implementation steps of the proposed approach, a environmental impact of facility and the environmental value affected by facility was assessed "big" and "small" qualifying. The impact magnitude which is obtained by possible combinations are assessed.

To reduce the calculated impact magnitude, a method have been developed with ISO 9001 ISO 14001 and OHSAS 18001 which is the combination of Environmental Management System.

In the model, in order to contribute to the reduction of environmental impacts, according to the production type of facility, remediation is recommended for using as a support elements of the Environmental Management System. For reduction of Environmental Impact, a rating scale has been obtained by utilizing the constituent of Environmental Management System.

Thus, for environmental impact assessment, decision-makers is offered flexible alternatives. Model is proposed to be used as quantitative support at EIA studies in the planning stage of the project.

ENTEGRE YÖNETİM SİSTEMLERİYLE KABUL EDİLEBİLİR BİR ÇEVRESEL ETKİ DEĞERLENDİRME İÇİN BULANIK MANTIK YAKLAŞIMI

ÖZET

Bilindiği gibi çevre koruma felsefesinde iki görüş hakimdir. Bu görüşlerden biri konservasyonist(conservationist) diğeri ise preservasyonist(preservationist) görüştür.
Türkçede her iki görüş de korumacı olarak tercüme edilsede, konservasyonist görüş doğal kaynakların "akılcı kullanımı"nı, preservasyonist görüş ise hiçbir şekilde doğal kaynaklara dokunulmamasını ifade etmektedir.
Günümüzde konservasyonist görüşün ağır bastığı söylenebilir.
Dünya nüfusunun kontrolsüz artışına bağlı olarak insanların ihtiyaçları her geçen gün artmaktadır. Bu ihtiyaçları karşılamak endüstrileşmeyi, şehirleşmeyi ve ekonomik gelişmeyi gerektirmektedir. Bu değişimler gerçekleşirken çevresel kaynakların tüketimi ve ekolojik çevrenin tahribatı artmaktadır.
Buna paralel olarak bu tüketim ve tahribatlar çevre kirliğini artırmakta ve çevresel kaliteyi düşürmektedir.
Ekonomik gelişme ile çevresel kirliliğin artması çelişkisine henüz çözüm getirilememiştir. Bu konuda sağlıklı ve güvenli bir çalışma ortamı oluşturmak için Mühendislik, Tıp ve benzer çevreler uzun zamandır bu konu üzerinde çalışmaktadırlar. Özellikle son yüzyılda gelişmiş ülkeler çevresel kirliliğe en fazla neden olmaları yanında, önlemeler alma konusundada başı çekmektedirler. Öte taraftan Avrupa Birliğinin uyum yasaları ve gelişen şartlara göre güncellenen kanun ve yönetmelikler çevrenin korunmasına destek vermektedir.
Bu iyileştirici çabaların başında işyerlerinin uygun çalışma ortamlarının yanında, çalışma düzenlerinin ve çalışma sistemlerinin olması büyük önem taşır.
İşyerlerine katkı sağlayabilecek yönetim sistemleri, firmaların politikalarının dışında tüm dünyada geçerli olan ISO 9001, ISO 14001 ve OHSAS 18001 yönetim sistemleridir.
Bu kalite, çevre ve iş sağlığı güvenliği sistemleri her geçen gün birbirine yaklaşmakta ve bu üç yönetim sistemi entegre olarak kullanılabilmektedir.
İş yerleri kendi yaptıkları işin özelliklerine göre yönetim sistemlerinin kombinasyonlarını seçmektedirler.
Her ne kadar üç yönetim sistemi birbirinden ayrı sistemler olarak görülürsede aralarında birbrlerine sinerjik etki yapabilecek organik bağlar mevcuttur. Yedi yılda bir yapılan revizyonlarda her bir sistemin birbirine yakınsadığı görülmektedir. Bu konuya ilerleyen bölümlerde değinilecektir.
Ne yazık ki çevreyi korumak için alınması gereken önlemlerde ülkemizde de gelişmeler olsada yeterli olmadığı uzmanlar tarafından belirtilmektedir.
Bunun en önemli göstergelerinden biri iş kazalarıdır. İş kazaları sadece can ve mal kayıpları ile sınırlı kalmamakta çevresel felaketlerede neden olmaktadır.
Bu gibi durumları önlemek veya derinlemesine bir iyileştirme faaliyeti içinde olabilmek için firmalar veya tesislerde kanun ve yönetmeliklerin belirlediği kurallara uymak durumundadır.

Bu kuralların uygulanmasındaISO 9001 ve buna entegre OHSAS 18001 sistemleri uygulayıcılara ve çalışanlara kolaylık ve düzen sağlayabilir.
Böylece iş kazaları sebebi ile zaman ve mekan düzleminde oluşan büyük maliyetlere neden olan kayıpların önüne geçilebilir. Bu düzenleme ile aynı zamanda insan hatası sebebi ile çevreyi etkileyebilecek potansiyelkazalarında önüne geçilebilir.
Çevresel felaketleri önleme toplumun çalışanları ile birlikte toplumun tüm bireylerinide kapsamaktadır. Bu çevre bilinci kavramını öne çıkarmaktadır.
Bu bilinç belkide her yıl tekrarlanan insan kaynaklı orman yangınlarını engelleyebilir.Ya da atık yönetiminde veya geri kazanım konusunda topluma bir ivme kazandırabilir.
Diğer taraftan var olan ve/veya kurulacak yeni tesislerin faaliyetlerinde fayda ve zarar ilişkileri iyi değerlendirilmelidir. Bunun için günümüzde Çevre Etki Değerlendirilmesi (ÇED) yapılmaktadır.
Bu tesislerin faaliyetlerinden kaynaklanan çevre etkilerinin yerel olmadığı aksine global olduğu bilim insanlarınca kabul edilmiş bir gerçektir.
Günümüzde insalar beklenti ve ihtiyaçlarının en üst düzeyde karşılanmasının yanı sıra , yaşadığı çevrenin korunması hatta daha iyi hale getirilmesi ve yaşadığı çevreyedeğer verilmesinitalep etmektedirler. Bu husulara aykırı olan uygulama ve eylemlere karşı itiraz etmekte hatta direnmektedirler.
Bu gelişmeler kuruluşların çevre ile etkileşimlerini kontrol altında tutabilmelerini ve çevre icraat ve başarılarını sürekli iyileştirebilmelerini sağlayacak yönetim sistemlerine ihtiyaç bulunduğu gerçeğini ortaya çıkarmıştır.
Çevre Yönetim Sistemi tüm dünyada ISO 14001 Standardı ile bilinmektedir. Çevre Yönetim Sisteminin, ISO 9001 Kalite Yönetim Sistemi Standardından sonra uluslararası kuruluşlarda tanınması ve uygulanması çok hızlı olmuştur.
1969 yılında ABD'de yürürlüğe giren Ulusal Çevre Politikası Kanunu (National Environmental Policy Act)gerek AB ülkeleri, gerekse diğer dünya ülkelerinde halen en etkin çevre yönetim aracı olarak yerini alan ve gün geçtikçe de bu yeri sağlamlaştıran ÇED, Ülkemizde 1998 yılından bu yana 18/12 sayılı Çevre Yasasının 52. maddesi uyarınca hazırlanan ÇED Tüzüğü kapsamında uygulanmaktadır.
Bilindiği gibi Çevre Etki değerlendirmesi belirli bir projenin veya faaliyetin çevre üzerindeki etkilerin belirlendiği bir süreçtir.
Bu süreç, karar verme süreci olmayıp karar verme sürecine etki eden ve bunu destekleyen bir süreçtir.
ÇED ; yeni projelerin ve gelişmelerin, çevreye verebileceği süreli veya süresiz potansiyel etkileri, ekonomik katma değerinin, sosyal etkisinin sonuçlarını ve çözümlerinin değerlendirmesi analizini kapsamaktadır.Bu çalışmalara katkı sağlamak amacıyla bir model oluşturulmuştur.
Çevresel etki büyüklüğünü ortaya çıkarabilmek için, endüstriyel gelişim ve çevresel kirlilik çelişkisine sebep olan ana parametreler göz önüne alınmıştır.
Elde edilen çevresel Etki Büyüklüğü Çevre Yönetim Sistemleri (ÇYS) kullanılarak azaltılmıştır.
Bu çalışmalar surecinde kullanılabilecek en uygun yöntemlerin Analitik Hiyerarşi Prosesi (AHP) ve Bulanık Mantık modellerinin olacağı düşünülmüştür.
Analitik Hiyerarşi Modelinin seçilme nedeni, çevresel Etki Büyüklüğünü ortaya çıkaracak alt faktörlerin hiyerarşisine sistematik bir yaklaşım sağlamaktır.
AHP temel özelliği olan ikili karşılaştırma yöntemi ile tüm alt faktörleri birbirleriyle ikili olarak karşılaştımıştır.

Kullanılan yöntemler klasik mantık teorilerini temel alan yöntemlerdir. Bu nedenle çevresel faktörler genellikle sayısallaştırılamayan, eksik, kusurlu ve elde edilemeyen bilgilerden dolayı net ve açık bir şekilde değerlendirilememektedir.
Bu sebeplerle belirsiz ve şüpheli olan değerlendirmelerde, Bulanık Mantık tabanlı modelleme kullanılmıştır.
Bulanık Mantık modeli ile uzman görüşlerinin dilsel değişkenleri, belirsizliklerin ve eksik verilerin yerine bir girdi olarak kullanılmıştır. Böylece çevresel Etki Büyüklüğünü hesaplamada kullanılan Faktör indeksi ve üyelik dereceleri bulunmuştur.
Önerilen yaklaşımın uygulama adımlarında, bir işletmenin çevreye verdiği etkiler ve çevre değerlerinin işletmeden etkilenmesi "büyük" ve "küçük" nitelemeleriyle değerlendirilmiştir.
Olası kombinasyonların elde edilen Etki Büyüklükleri hesaplanmıştır. Hesaplanan etki büyüklüğünü Çevre Yönetim Sistemi kombinasyonları olan ISO 9001, ISO 14001 ve OHSAS 18001 ile azaltma yöntemi geliştirilmiştir.
Bu çalışmada kullanılan yöntemler ve değerlendirmeler, herhangi bir işletmenin çevresel etkilerinin değerlendirilmesinde somut, anlaşılır ve sayısal bir modellendirme gerektirdiğini ortaya çıkarmıştır. Çevre ve ilgili çevrede bulunan işletmenin etki değerlendirmelerinde ekosistem ve işletme arasında sayısız oranda etkileşim faktörleri, çevresel etki büyüklüğünü elde etmede ana eksen olarak ele alınmıştır.
Diğer taraftan çevresel etki değendirmesinde elde edilen etki karekterizasyonları ile, karar vericiye, resmi ve hukuki çevreye,karar verme aşamalarında kullanılabilecekleri ,dilsel ve insani koşulların neden olduğu belirsizlikler, somut, sayısal ve ölçülebilir bir değer haline getirilmiştir.
Böylece karar vericinin, elde edilen bu somut verilerle herhangi planlı veya izinli bir faaliyetin yada projenin, çevre yönetim değerlendirmesini kolaylıkla yapabileceği aşıkardır.
Önerilen modelde bir işletmenin çevre ile ilişkileri dört kombinasyon halinde ele alınmıştır. Bu kombinasyonlardan birincisi, işletmenin çevreye etkisinin büyük ve çevresel etkilenmeninde büyük olduğu, ikinci kombinasyon işletmenin çevreye etkisi büyük ve çevresel etkilenmenin küçük, üçüncü kombinasyon işletmenin çevreye etkisinin küçük ve çevresel etkilenmenin büyük, dördüncü ve son kombinasyon işletmenin çevreye etkisinin küçük ve çevresel etkilenmenin küçükolduğu durumlardır.
Uygulama sonucunda ortaya çıkan etki büyüklüğünün sınıfı ve derecesi belirlenmiştir. Ortaya çıkan etki büyüklüğünün Kalite, çevre yönetim , iş sağlığı ve güvenliği yönetim sistemlerinin kombinasyonları ile nasıl azaltılabileceği yöntemi gösterilmiştir. Bu seçimlerde işletmeye hesaplamalarda ortaya çıkan etki büyüklüğünün azaltılmasında maliyetleri azaltabilecek optimum çözüm yoluda gösterilmiştir.
Modelde, Çevresel Etkilerin azaltılmasına katkı sağlamak amacıyla, işletmenin özelliğine göre iyileştirme aracının Çevre Yönetim Sistemlerine destek olarak kullanılması tavsiye edilmektedir.
Çevresel Etkileri azaltılmada Çevre Yönetim Sistemlerinin araçlarından faydalanılan bir derecelendirme skalası elde edilmiştir.
Böylece Çevresel Etki değerlendirmeleri için, karar vericiye esnek alternatifler sunulmuştur. Modelin, Projelerin planlama aşamasındaki ÇED çalışmalarında kantitatif destek olarak kullanılması önerilmektedir. Çalışmada kullanılan modelle işletme ve bulunduğu çevrede oluşan karşılıklı etkileşimlerin, kullanılacak Entegre

Yönetim sistemleri ile işletmelerin yarattığı olumsuz çevresel etkilerinazaltılabileceği veya kabul edilebilir sınırlara getirilebileceği umut edilmektedir.

1. INTRODUCTION

Environmental resources have been induced by human activity and it has been steadily growing concern in a few decades. Such concerns made an evident the necessity for preventive and corrective actions for the executive organs and/or authorities on a sound basis implementation regarding the possible environmental consequences of development actions.

In order to perform and satisfy this need, the most import tools is Environmental Impact Assessment (EIA).

This content of EIAinvolves the systematic identification and evaluation of the impacts on the environment caused by a proposed project. Its potential role in attaining sustainable development objectives was explicitly recognized during the 1992 Earth Summit held in Rio de Janeiro (United Nations 1992).

The Environmental Impact Assessment (EIA) process is an interdisciplinary and multistep procedure to ensure that environmental considerations are included in decisions regarding projects that may impact the environment. Simply defined, the EIA process helps identify the possible environmental effects of a proposed activity and how those impacts can be mitigated. The purpose of the EIA process is to inform decision-makers and the public of the environmental consequences of implementing a proposed project.

The EIA document itself is a technical tool that identifies, predicts, and analyzes impacts on the physical environment, as well as social, cultural, and health impacts. If the EIA process is successful, it identifies alternatives and mitigation measures to reduce the environmental impact of a proposed project.

The EIA process also serves an important procedural role in the overall decision-making process by promoting transparency and public involvement. It is important to note that the EIA process does not guarantee that a project will be modified or rejected if the process reveals that there will be serious environmental impacts. In some countries, a decision-maker may, in fact, choose the most environmentally-harmful alternative, as long as the consequences are disclosed in the EIA. In other words, the EIA process ensures an informed decision, but not necessarily an environmentally beneficial decision (Elaw, 2010).

1.1 Aim & Scope

The objective of this study is modeling of integration of the Environmental Management System (EMS) for providing a solution to the controversial subject such as discussions, uncertainties or civil disobedience about Environmental Impact Assessment (EIA) reports or its acceptance. An official EIA permission (or report) is usually caused some problems such as sensitive eco-system characteristics, public rejection regarding side selection etc.. In order to eliminate those questionable and complex issues, an analytic scale system is generated within this study which has an objective to help the decision makers. It is thought that this scale may contribute also to clarify or remove to uncertainty at applicable legislation.

Within the framework of the purposes given above;

- A problem is defined by investigating of historical, scientific and legal development on EIA.
- Various methodologies are integrated on impact assessment results for solving problem.
- The constituent of formulation are applied to FAHP which is one of the elements of Multi Criteria Decision Analysis (MCDA).
- The constituent of environmental management are given in the model as ISO 9001, ISO 14001, OHSAS 18001 and Remediation.
- In order to realize the integration issues which are stated in a theoretical base, a model is developed.
- For priority numbers which will be obtained by fuzzification, a FAHP is installed and a range is obtained for providing maximum and minimum values of impact magnitude.
- The correlation between BoP and EEI are made base on small and large state of the combination.
- According to the result of three different states, EIA report can be rejected or accepted directly or revised by correction of EMS.

To sum up the purposes of the study are as follows:

- Provide information for decision-making on the environmental consequences of proposed actions; and
- Promote a management methodology for obtaining most appropriate environmental impact.

It is hoped or expected to put the individuals at ease with scientific norms and to omit uncertainties and conflicts with decision makers, state direction investor or third party who represent generally the public.

In addition, the another aim of this study, the impacts of any strategic point source such as nuclear power plant, thermal power station, mining etc which will be caused to environmental degradation and the depletion of environmental resources can be also taken into account. In the study, two significant constituent takes places, first is Benefit of Project (BoP) on technical, socio-political and environmental factors and second is Estimated Environmental Impact (EEI) on Flora, Fauna – Forest, Water – Watershed, Surface & Groundwater, Agricultural Area, Recreational Area, Urbanization, Climate, Air Quality, Historical & Touristic Area and Geomorphologic Structural Area. In practice, range of impact magnitude can be easy applied for all proposal projects for helping to decision makers especially in EIA permission and acceptance step. In this connection, immediate objectives of EIA are to:

- improve the environmental design of the proposal;
- ensure that resources are used appropriately and efficiently;
- identify appropriate measures for mitigating the potential impacts of the proposal; and
- facilitate informed decision making, including setting the environmental terms and conditions for implementing the proposal.

Long term objectives of EIA are to:

- protect human health and safety;
- avoid irreversible changes and serious damage to the environment;
- safeguard valued resources, natural areas and ecosystem components;

and

- enhance the social aspects of the proposal (UNU, 2106)

2. ENVIRONMENTAL IMPACT ASSESSMENT

2.1 History and Evaluation of Environmental Impact Assessment

To give a general idea of the historical development of EIA is shown in Table 2.1. Introduced in the US as its beginning, several countries have followed and applied EIA systems. At the same time, international efforts in sustainable development have been promoting to assist developing nations. In recent years, the concept of strategic environmental assessment (SEA) – applying EIA consideration in earlier stage of policy-making, become prevailing and some practical cases are reported.
US was the first country to develop a system of environmental impact assessment (EIA). When “Silent Spring” written by Rachel Carson was published in 1962, social awareness to environmental issues in the US had reached high proportions and grew as very intense movements at the latter half of 1960’s. With these social backgrounds, the National Environmental Policy Act (1969) of the United States of America (NEPA) was constituted and for the first time, EIA requiring environmental consideration in large-scale projects was enforced as legislation. The influence of NEPA in which the concept of EIA system as its bedrock was extended beyond the US and provoked the introduction of EIA policy in many countries in Europe and Asia. Following the US initiative, several countries began to provide EIA systems; for example Australia (1974), Thailand (1975), France (1976), Philippines (1978), Israel (1981) and Pakistan (1983). Generally, EIA is more efficient and effective to be implemented as early as possible, for example at the policy or project-planning phase. In practice however, the implementation period of the EIA, as well as its scope and procedures vary by each country and agency, and each system holds their own unique characteristics.(EAGoJ 2000)
The evolution of EIA can be divided into four overlapping phases:

- Introduction and early development (1970-1975) – mandate and foundations of EIA established in the USA; then adopted by a few other countries (e.g. Australia, Canada, New Zealand); basic concept, procedure and methodology still apply.

- Increasing scope and sophistication (mid ’70s to early ’80s) – more advanced techniques (e.g. risk assessment); guidance on process implementation (e.g. screening and scoping); social impacts considered; public inquiries and reviews drive innovations in leading countries; take up of EIA still limited but includes developing countries (e.g. China, Thailand and the Philippines).
- Process strengthening and integration (early ‘80’s to early ’90s) – Review of EIA practice and experience; scientific and institutional frameworks of EIA updated; coordination of EIA with other processes, (e.g. Project appraisal, land use planning); ecosystem-level changes and cumulative effects begin to be addressed; attention given to monitoring and other follow-up mechanisms. Many more countries adopt EIA; the European Community and the World Bank respectively establish supra - national and international lending requirements.
- Strategic and sustainability orientation (early ’90s to date) EIA aspects enshrined in international agreements (see Topic 2 – Law, policy and institutional arrangements); marked increase in international training, capacity building and networking activities; development of strategic environmental assessment (SEA) of policies and plans; inclusion of sustainability concepts and criteria in EIA and SEA practice; EIA applied in all OECD countries and large number of developing and transitional countries. (Sadler, 1996)

The UN Conference on Environment and Development (UNCED), the Earth Summit, established a number of international agreements, declarations and commitments. Agenda 21, the global action plan for sustainable development, emphasizes the importance of integrated environment and development decision-making and promotes the use of EIA and other policy instruments for this purpose.
As a summary, four cornerstones of the Earth Summit is given below;

- The Rio Declaration on Environment and Development – a set of Principles which provide guidance on achieving sustainable development.

Table 2.1: History of Environmental Impact Assessment.

History	Development of EIA
Pre-1970	Project review based on the technical/engineering and economic analysis.Limited consideration given to environmental consequences.
Early/Mid-1970s	EIA introduced by NEPA in 1970 in US. Basic principle: Guidelines, procedures including public participation requirement instituted.Standard methodologies for impact analysis developed (e.g. matrix, checklist and network).Canada, Australia and New Zealand became first countries to follow NEPA in 1973-1974. Unlike Australia, which legislated EIA, Canada and New Zealand established administrative procedures.Major public inquires help to shape the process development.
Late 1970 and Early 1980s	More formalized guidance.Other industrial and developing countries introduced formal EIA requirements (France, 1976; Philippines, 1977) began to use the process informally or experimentally (Netherlands, 1978) or adopted elements, such as impact statements or reports, as part of development applications for planning permission (German states, Ireland). Use of EA by developing countries (Brazil, Philippines, China, Indonesia).Strategic Environment Assessment (SEA), risk analysis included in EA processes.Greater emphasis on ecological modeling, prediction and evaluation methods.Provision for public involvement.Coordination of EA with land use planning processes.
Mid 1980s to end of decade	In Europe, EC Directive on EIA establishes basic principle and procedural requirements for all member states.Increasing efforts to address cumulative effects.World Bank and other leading international aid agencies establish EA requirements.Spread of EIA process in Asia.
1990s	Requirement to consider trans-boundary effects under Espoo convention.Increase use of GIS and other information technologies. Sustainability principal and global issues receive increased attention. India also adopted the EIA formally.Formulation of EA legislation by many developing countries. Rapid growth in EA training.

- Framework Convention on Climate Change – an international treaty to stabilize greenhouse gas concentrations in the atmosphere.
- Convention on Biological Diversity – an international convention with three objectives: the conservation of biodiversity, the sustainable use of its components, and the equitable sharing of benefits from genetic resources.
- Agenda 21 – a global program of action for achieving sustainable development to which countries are 'politically committed' rather than legally obligated.(UNEP, 2002)

2.2 Definition of Environmental Impact Assessment

Environmental Impact Assessment (EIA) is a process of evaluating the likely environmental impacts of a proposed project or development, taking into account inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse.

United Nation Environment Program (UNEP) defines Environmental Impact Assessment (EIA) as a tool used to identify the environmental, social and economic impacts of a project prior to decision-making. It aims to predict environmental impacts at an early stage in project planning and design, find ways and means to reduce adverse impacts, shape projects to suit the local environment and present the predictions and options to decision-makers. By using EIA both environmental and economic benefits can be achieved, such as reduced cost and time of project implementation and design, avoided treatment/clean-up costs and impacts of laws and regulations.

Although legislation and practice vary around the world, the fundamental components of an EIA would necessarily involve the following stages:

Screening to determine which projects or developments requires a full or partial impact assessment study;

Scoping to identify which potential impacts are relevant to assess (based on legislative requirements, international conventions, expert knowledge and public involvement), to identify alternative solutions that avoid, mitigate or compensate adverse impacts on biodiversity (including the option of not proceeding with the development, finding alternative designs or sites which avoid the impacts, Assessment and evaluation of impacts and development of alternatives, to predict and identify the likely environmental impacts of a proposed project or development, including the detailed elaboration of alternatives;

Reporting the Environmental Impact Statement (EIS) or EIA report,

including an environmental management plan (EMP), and a non-technical

summary for the general audience.

Review of the Environmental Impact Statement (EIS), based on the terms of reference (scoping) and public (including authority) participation.

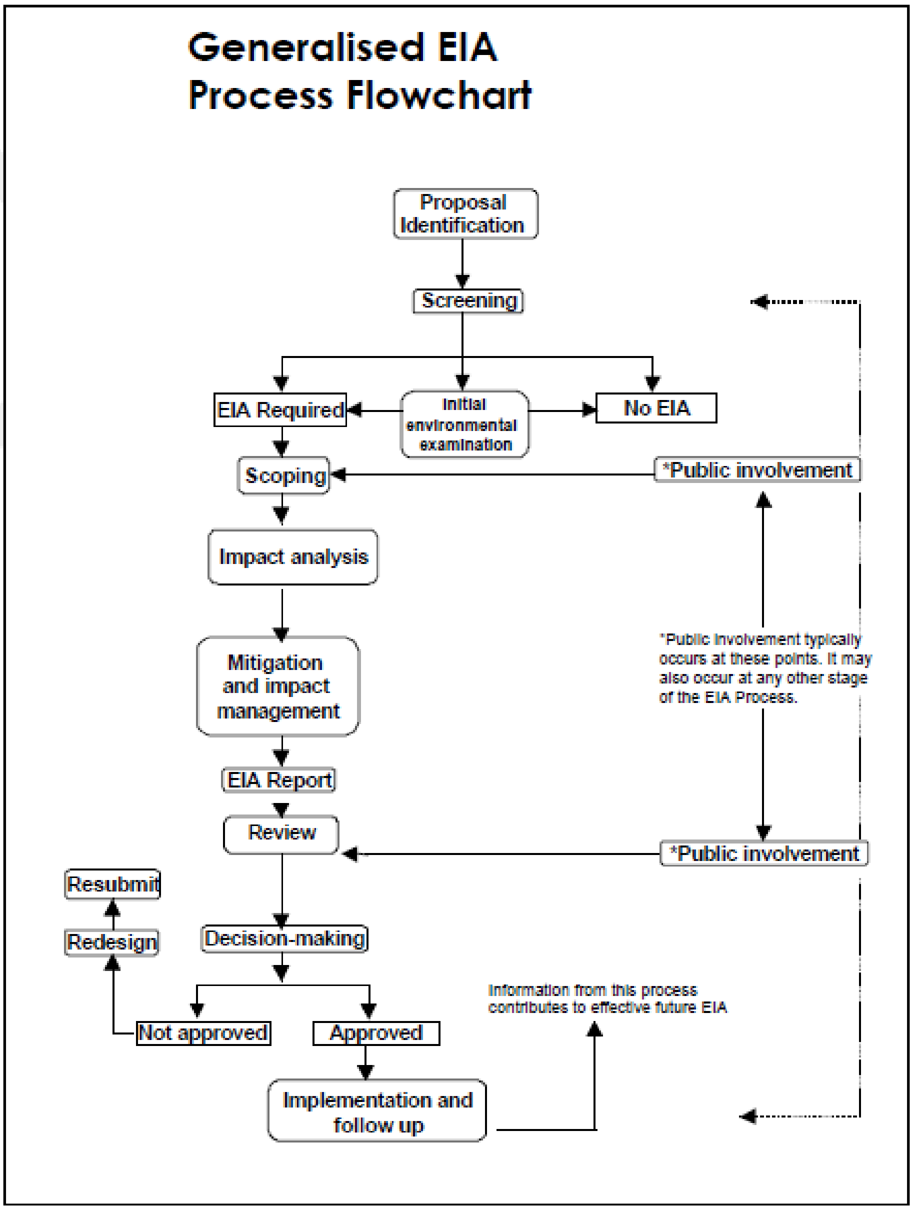

Figure 2.1: Flow chart of Environmental Impact Assessment(UNEP, 2002).

Decision-making on whether to approve the project or not, and under what conditions; and

Monitoring, compliance, enforcement and environmental auditing**;** Monitor whether the predicted impacts and proposed mitigation measures occur as defined in the EMP. Verify the compliance of proponent with the EMP, to ensure that unpredicted impacts or failed mitigation measures are identified and addressed in a timely fashion. A general process flowchart is shown in Figure 2.1(CBD, 2016)

It is the iterative, early planning and design stages of a major project that frequently involve, or interact with, EIA studies. During these periods in the project cycle, th proponent tends to allocate a modest budget to develop sufficient information about the project's design, construction and operations to feed into the EIA process and to use to make recommendations for impact mitigation and monitoring.

All of these statements can be said as the benefits of EIA. In addition that another benefits of EIA are as follows.

- Potentially screens out environmentally-unsound projects
- Proposes modified designs to reduce environmental impacts
- Identifies feasible alternatives
- Predicts significant adverse impacts
- Identifies mitigation measures to reduce, offset, or eliminate major impacts
- Engages and informs potentially affected communities and individuals
- Influences decision-making and the development of terms and Conditions (ELAW, 2010)

2.2.1 Environmental impact values

Environmental impacts are categorized as primary or secondary. Primary impacts are those that can be attributed directly to the proposed action. If the actions involve construction of a facility, such as a wastewater treatment plant or a residential colony, the primary impacts of the action would include the environmental impacts related to the construction and operation of the facility and land use changes at the facility site.

Secondary impacts are indirect or induced changes, typically including associated investments and changed patterns of social and economic activities likely to be stimulated or induced by the proposed action. If the action involves the construction of a facility, the secondary impacts would include the environmental impacts related to induced changes in the pattern of land use, population density, and related effects on air and water quality or other natural resources (*Rau*, 1980).

The three core values of any EIA study that have been identified till date are;

- Integrity: The EIA process should be fair, objective, unbiased and balanced.
- Utility:The EIA process should provide balanced, credible information for decision-making.
- Sustainability :The EIA process should result in environmentalsafeguards which are sufficient to mitigate serious adverse effects and avoid irreversible loss of resource and ecosystem functions.

2.2.2 Strategic environmental assessment

Sadler and Verheem (1996) define Strategic Environmental Assessment (SEA) as the formalized, systematic and comprehensive process of identifying and evaluating the environmental consequences of proposed policies, plans or programs to ensure that they are fully included and appropriately addressed at the earliest possible stage of decision-making on a par with economic and social considerations.

Since this early definition the field of SEA has rapidly developed and expanded, and the number of definitions of SEA has multiplied accordingly. SEA, by its nature, covers a wider range of activities or a wider area and often over a longer time span than the environmental impact assessment of projects.
SEA might be applied to an entire sector (such as a national policy on energy for example) or to a geographical area (for example, in the context of a regional development scheme). SEA does not replace or reduce the need for project-level EIA (although in some cases it can), but it can help to streamline and focus the incorporation of environmental concerns (including biodiversity) into the decision-making process, often making project-level EIA a more effective process.
SEA is commonly described as being proactive and 'sustainability driven', whilst EIA is often described as being largely reactive (CBD, 2016).

2.2.3 Milestone and typology of EIA

The way of subdividing environmental issues is to group them under '*green*' and '*brown*' agendas. The green agenda focuses on natural resource management and environmental protection issues, such as rural land and water use, forestry and fisheries and habitat and species conservation. The brown agenda is concerned with issues of industrial pollution, waste management and urban development.

When undertaking EIA, a comprehensive view should be taken of the linkages and interactions among the issues under review. Also, the EIA should identify both the benefits and costs of development. In practice, EIA often focuses on the adverse environmental impacts of proposed actions. This is done by reference to certain key characteristics, which establish the potentially significant effects (see below).

Environmental impacts can vary in:

- type – biophysical, social, health or economic
- nature – direct or indirect, cumulative, etc.
- magnitude or severity – high, moderate, low
- extent– local, regional, transboundary or global
- timing – immediate/long term
- duration – temporary/permanent
- uncertainty – low likelihood/high probability
- reversibility – reversible/irreversible
- significance[1] – unimportant/important

The impacts of a development proposal examined in EIA can be direct, such as the effect of toxic discharge on air and water quality, or indirect, such as the effect on human health from exposure to particulates or contaminants, which have built up in food chains. Other environmental and social impacts are induced, for example by a new road opening up an undeveloped area to subsequent settlement or by involuntary resettlement of people displaced by the construction of a large reservoir. Certain adverse impacts may appear relatively insignificant when considered in the context

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[1]*Impact significance is not necessarily related to the impact magnitude. Sometimes very small impacts, such as the disturbance of the nest of a pair of endangered birds, may be significant.*

of an individual action or proposal but have a cumulative effect on the environment when added to all other actions and proposals; for example, deforestation resulting from plot by plot clearance for subsistence agriculture (UNEP, 2002).

2.3 Environmental Impact Assessment Methods

EIA methods range from simple to complex, requiring different kinds of data, different data formats, and varying levels of expertise and technological sophistication for their interpretation. The analyses they produce have differing levels of precision and certainty. All of these factors should be considered when selecting a method.

The EIA practitioner is faced with a vast quantity of raw and usually unorganized information that must be collected and analyzed in preparation of an EIA report. The best methods are able to:

- organize a large mass of heterogeneous data;
- allow summarization of data;
- aggregate the data into smaller sets with least loss of information;
  display the raw data and the derived information in a direct and relevant fashion.

The situation of environment and environmental values should also be considered when choosing a method. At preliminary evaluation of facility and environment need to have clear information about solution method alternatives.

Whatever methods are chosen, the focus of impact assessment of any facility and surround of facility should be considered all possible potential impacts on selected environmental components. Before a comprehensive study on EIAs, decision makers needs to understand and evaluate the combination of facility and environment base on benefit and loss. Today’s methods consider the environment to be a dynamic, integrated group of natural and social systems.

Impacts occur over time and space. Some impacts are immediate while others are delayed. Some impacts occur as a direct result of an activity; others occur as secondary or higher order impacts resulting from changes in other environmental components.

In selecting assessment methods, it helps to understand two perspectives underlying the utility of EIA. From the first perspective, EIA is a technique to analyze the impacts of project activities, and is a complex and complicated procedure. The complexity is increased by the diversity of the disciplines involved; social, physical, and biological. This perspective holds that scientific experts should be responsible for conducting and reviewing EIAs, and that the maximum possible quantification should be accomplished. This element of decision-making should be incorporated into the EIA process. From a second perspective, EIA is primarily an opportunity to allow groups that are potentially affected populations, development agencies, and project proponents to participate in the decision-making process. This perspective suggests that;

- decision making should not be restricted to scientific opinions alone, but should also reflect social and cultural viewpoints; and
- a key role of EIA is to identify and communicate potential impacts to the concerned people and encourage rational discussion.

2.3.1 Methods for organizing and presenting information

Checklists and matrices are commonly used to organize and present information. Many of the more sophisticated methods and techniques often use checklists and matrices as a starting point for analysis.

Information Presented in Checklists and Matrices; All checklists and matrices have boxes or cells that must be filled with information about the nature of the impact. Depending on the method, this information can be descriptive or evaluative Table 2.2. The simplest methods merely determine the possibility or potential existence of an impact, while others, like weighting-scaling checklists, make judgments about the magnitude and importance of the impact. Matrix methods identify interactions between various project actions and environmental parameters and components. They incorporate a list of project activities with a checklist of environmental components that might be affected by these activities.

A matrix of potential interactions is produced by combining these two lists (placing one on the vertical axis and the other on the horizontal axis). One of the earliest matrix methods was developed by Leopold et al. (1971). In a Leopold matrix and its variants, the columns of the matrix correspond to project actions (for example, flow alteration) while the rows represent environmental conditions (for example, water temperature). The impact associated with the action columns and the environmental condition row is described in terms of its magnitude and significance.

Table 2.2: Information Presented in Checklists and Matrices.

Impact Characteristic Identified or Evaluated	Descriptive or Evaluative Measure	Type of Scale	Determined By	Used By Method
Existence	yes or no	nominal	Expert Judgement	Simple Checklist
Duration	short term or long term	nominal	Expert Judgement	Descriptive Checklist (Oregon Method) (Smardon et al., 1976)
Reversibility	reversible or irreversible	nominal	Expert Judgement	Descriptive Checklist (Oregon Method) (Smardon et al., 1976)
Magnitude	minor, moderate or major	nominal	Expert Judgement	Descriptive Checklist (Oregon Method) (Smardon et al., 1976)
	1 to 10, with 1 representing small, 5 representing intermediate, 10, representing large	nominal		Leopold Matrix (Leopold et al, 1971)
Causal relationship	direct, indirect, or synergistic	nominal	Expert Judgement	Descriptive Checklist (Oregon Method) (Smardon et al., 1976)
Importance	1 to 10, with 1 representing low, 10 representing high	interval	Subjective Judgement	Descriptive Checklist (Oregon Method) (Smardon et al., 1976)
	0 to 1000, where the sum of the importance weights is equal to 1000	interval	Subjective Judgement	Battelle Environmental Evaluation System (Dee et al., 1972)
Environmental Impact Units (EIU)	0 to 1, with 0 representing poor quality, 1 representing very good quality	interval	Value Functions based on expert or subjective jugment	Battelle Environmental Evaluation System (Dee et al., 1972)
Benefit/Cost	+ for benefit - for cost	nominal	Subjective jugment	Fisher and Davis (1973)
Significance	no impact insignificant impact significant impact mitigated impact unknown impact	nominal	subjective and expert judgment	H.A. Simons (1992)

Most matrices were built for specific applications, although the Leopold Matrix itself is quite general. Matrices can be tailor-made to suit the needs of any project that is to be evaluated.

They should preferably cover both the construction and the operation phases of the project, because sometimes, the former causes greater impacts than the latter. Simple matrices are useful:

- early in EIA processes for scoping the assessment;
- for identifying areas that require further research; and
- for identifying interactions between project activities and specific environmental components.

However, matrices also have their disadvantages: they tend to overly simplify impact pathways, they do not explicitly represent spatial or temporal considerations, and they do not adequately address synergistic impacts.

Matrices require information about both the environmental components and project activities. The cells of the matrix are filled in using subjective (expert) judgment, or by using extensive data bases. There are two general types of matrices:

- simple interaction matrices;
- significance or importance-rated matrices.

Simple matrix methods simply identify the potential for interaction Significance or importance-rated methods require either more extensive data bases or more experience to prepare.

Values assigned to each cell in the matrix are based on scores or assigned ratings, not on measurement and experimentation. For example, the significance or importance of impact may be categorized (no impact, insignificant impact, significant impact, or uncertain).

Alternatively, it may be assigned a numerical score (for example, 0 is no impact, 10 is maximum impact).

These numerical scores are often used in FAHP applications to be described in Chapter 5 and 6.

3. INTEGRATED MANAGEMENT SYSTEM (IMS)

The global competition has compelled organizations to invest their resources in enhancing their management efficiency and this has resulted in profound changes affecting every aspects of business including customer care, supplier management, strategy identification and implementation, process engineering and human resources (Renzi, &Cappelli, 2000).

Organizations implement available methods and approaches as a means of improving their performance and business system. There are various practices, disciplines and processes within an organization each meant for a separate objective. Combining all those practices, principles processes into one system so as to address a particular objective is known as their integration into a system (Hoyle, 2009). Integrated management system is an important tool for an organization which helps in improving process, increasing competitiveness and strategy realization (Spilka, Kania, &Nowosielski, 2009). According to Hoyle (2009), the term "integration" itself is a vague topic and should explicitly refer about what is being integrated.

For example, integration can be perceived as integrating documentation, integrating management, integrating standards, integrating functions or integrating systems.

Organizations adopt management systems according to their need and scope. ISO 9001serves for the requirement of quality management, ISO 14001 for the environmental management system and OHSAS 18001 addresses occupational health and safety issues (McDonald, Mors, & Phillips, 2003). It is likely that organizations implementing ISO 14001 have an existing quality management system meeting the requirements of ISO 9001 in place.

Management systems are sometimes obligations of customers to the suppliers which require suppliers to be registered to a quality standard such as ISO 9001 or QS-9000 in addition to ISO 14001 (McDonald et al., 2003). According to Whitelaw (2004), the need for integrated management systems has long been felt and there have been attempts on the development of one definitive standard that could address all of an organization's activities and could be used as a model for the successful running of the business. The degree to which an organization integrates its management systems depends on its specific needs and the organization is required to evaluate the management systems and plan for their integration as per the business needs. The organizations that successfully integrated portions or all of their management systems have reported to have achieved significant returns on their investment due to reduced operating cost and increased overall performance (Bishal, 2010).

3.1 Dimensions of Integration

Integrated Management System (IMS) makes sense to break down the successful integration of a management system into several dimensions (Figure 3.1).

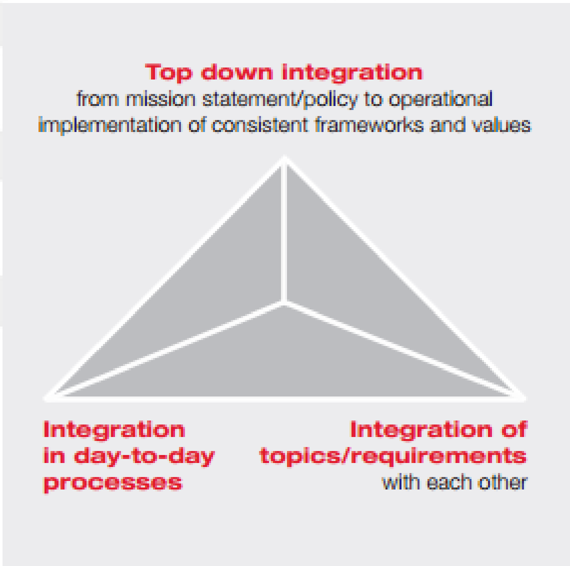


Figure 3.1: Top Down Integration.

The integration of topics and requirements such as Quality, the Environment, Occupational Health and Safety, risks, social responsibility and industry-specific requirements is, in most cases, given utmost priority when designing an IMS. The different requirements resulting from standards and industry standards often also correspond to the demands made by the individual stakeholders.

In the past, these requirements were often viewed in an isolated manner and presented in separate systems and structures. In an increasingly complex and challenging environment, qualities like speed, flexibility, operational perfection and agility are expected from organizations. This can be best guaranteed by understanding the connections and interrelations of processes, integrating the different requirements and keeping the documentation simple and comprehensible as well as easy to amend and improve.

3.2 The Development towards Integrated Management Systems

The development of today's integrated management systems can be roughly divided into the following characteristic development periods: With the onset of the industrial boom after World War 2, awareness that "quality testing" alone would not be enough to support professional product manufacturing arose. The motto of those times was "You cannot test quality into a product. It has to be built in during the manufacturing process". This marked the beginning of quality assurance and quality assurance systems. This principle was supported by numerous representatives of interests and the first rules and standards on quality assurance systems came into being. In 1987, the ISO 9000 standard was published. The basic requirements laid down in the different quality assurance rules and regulations were integrated in this standard. ISO 9001 gained wide acceptance within a short period of time. Based on this standard, a third-party certification system with international validity was established and, with a view to revising and enhancing this certification system, an internationally harmonized accreditation system was created. These were the basics that contributed to the global spreading of ISO 9001 certification. According to the ISO Survey, more than 1.1 million organizations had obtained an ISO 9001 certification until 2011. In 1992, the EU published the EMAS ("Environmental Management Audit Scheme") Regulation on environmental management and, in 1996, the global environmental management standard ISO 14001 followed. Both environmental management systems have their roots in the 1992 World Summits on Sustainable Development in Rio de Janeiro. The OHSAS 18001 standard on occupational health and safety was issued by the OHSAS consortium in 1999. In 2000, the system-process model was integrated in a new version of ISO 9001, the most widespread Standard on management systems, as a basic requirement. Priority was given to orientation towards customers, processes and staff. The process-oriented approach still forms a strong base for designing and certifying management systems of organizations. Coordinated processes with control criteria for essential aspects and their internalization in day-to-day routines are the basis for all management areas. The basic understanding enshrined therein is also the basis for additional system standards, e.g. for environmental management and safety management. The newly developed strategies and the programs, projects and/or measures derived from such strategies have an impact both on the process goals and the realization processes and thus also on process performance. The priorities within the system might change, resulting in strong interrelations between the goals set, the provision of resources and the supervision and measuring of the realization processes.

Implementing measures do not only refer to quality aspects but also to environmental aspects such as energy and material efficiency, water consumption, waste, land consumption and emissions and occupational health and safety aspects. The situation is similar when it comes to new and changed procedures and/or the use of new hazardous substances in the field of occupational health and safety. As a consequence, new internal and external staff training may become necessary.

3.3 Plan-Do-Check-Act

In practice, quality management lends itself to being a good integration platform for standardized management areas. As the process-oriented approach is comprehensively embedded, the entire organization is already mapped in a quality management system. The PDCA (Plan-Do-Check-Act) cycle plays a major role in this connection. In practice, this cycle serves as a model for the continuous improvement process.

As the management system standards ISO 14001:2004 and OHSAS 18001:2007 follow the same approach, their requirements can be well integrated into an existing classification of a quality management system.

There are interrelations between the different core and support processes, e.g. between product specification, production and marketing or sales, but also between distribution and procurement. Other interrelations might arise from the additional perspectives of environmental protection and occupational health and safety.

Practical approaches to integration are presented in the next section. “Systemic Management” means setting system goals and aligning the relevant processes and required resources accordingly. Basically, it is always about satisfying requirements, be they customer requirements or legal requirements regarding the product or, as in the case of standards on environmental aspects or occupational health and safety, legal requirements referring to the organization itself.

3.4 Integration Models

When it comes to the integration of management systems, in the course of practical use in businesses, the following three models, which differ in terms of depth of integration, can be observed:

- Summary integration model
- Adaptive integration model
- Process-oriented integration model

In particular the adaptive and the process-oriented integration models are characterized by an increase in efficiency in the control of the management systems. Synergies regarding the same or similar requirements of various management systems can be used in a reasonable and effective manner (e.g. CIP, corrective and preventive measures, control of documents and records, etc). The process integration model has the highest depth of integration and/or maturity.

If all management system models of relevance to the company are summed up in a single management system documentation, this may be referred to as IMS documentation.(Integrated Management Systems- The Position of Austria)

In practice, there might be the risk that internal business requirements and external necessities result in a strong increase in system documentation (upsizing). As a consequence, the problem of over-regulation might occur after some time.

One possible measure against upsizing of documentation is targeted downsizing. In the course of system integration this may be achieved by defining deliberate downsizing as a target for the management system integration project.

In the course of audits, specific audit targets and priorities may be defined in order to make the management system leaner. To this end, simple auditing questions may be used for the purpose of downsizing, e.g.:

- With your current knowledge, which documents would you no longer prepare and/or introduce?
- Which documents have you not used for more than one year?

- Where in your company are there documents which are uncontrolled, due to the fact that the controlled documents no longer match the practical use within the company? (AUT, 2003)

3.5 Integration of ISO 9001 and ISO 14001 Management Systems

In this study, IMS which consists of ISO 9001, ISO 14001 and OHSAS 18001 will be considered as a solution to the negative environmental effect. The main elements are given in Figure 3.2.

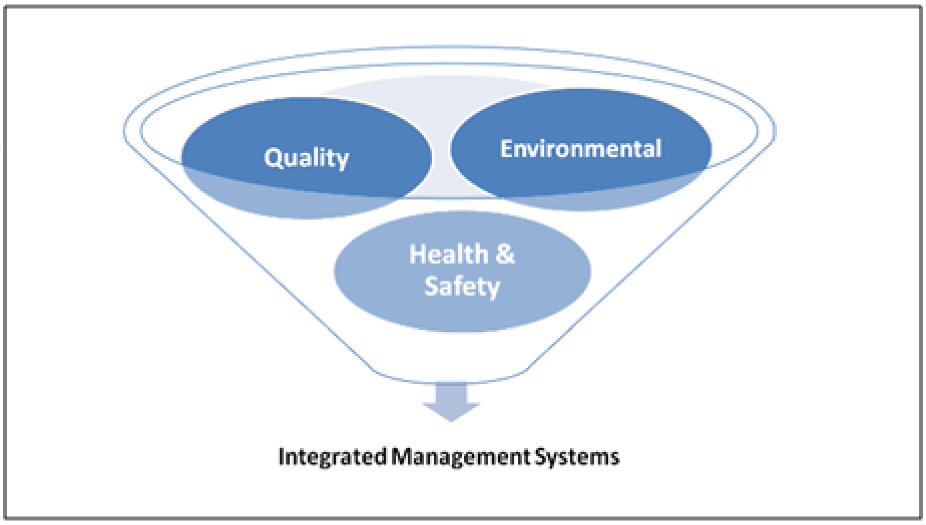


Figure 3.2: IMS for Facility (IMS, 2016).

The latest version of both standards, ISO 9001:2008 and ISO 14001:2004 have been developed with the specific intent to be compatible with each other (Cianfrani et aI., 2008). The correspondence between the two standards can be seen in Appendix C and Appendix D. According to Cianfrani et al.,(2008), the drafters of two families had worked together in developing ISO 9001:2000 and ISO 14001:2004 so that both the standards would be compatible and during the development of ISO 9001:2008, following considerations related to the compatibility of both the standards were emphasized:

- ISO 9001:2008 is structured to enhance its usability with ISO 14001:2004.
- ISO 9001:2008 and ISO 14001:2004 can be used together without unnecessary duplication or conflicting requirements.

- Common requirements can form a basis for integrated management systems.
- Quality management system processes need not be established separately from an existing management system.

The degree of integration of quality and environmental management systems into a single system must be based on the specific needs and values of business and should be carried out as long as it is functional to the organization (Jackson, 2001; Renzi, & Cappelli, 2000). The fact that both the standards comply with the definition of "system" and share some common elements makes it possible for their integration (Renzi, & Cappelli, 2000). Renzi and Cappelli (2000) further pointed out that the maximum benefit could be achieved by better exploiting the common aspects and synergies in the two standards.

ISO 9000 and ISO 14000 series are based on a proactive standpoint emphasizing prevention rather than corrective action and both focus on general management issues with an emphasis on systems (Von Zharen, 2001). ISO 9001 and ISO 14001 standards are based on plan-do-check-act (PDCA) model and focus on continual improvement (McDonald et al., 2003).

The elements of ISO 14001 standard under the implementation and evaluation requirement are almost identical to those of ISO 9001 standard (Block, 2000). The need for documents, document control, training, control of non-conformances, corrective and preventive action, internal audits, management review and records have similar requirements and have similar title (Hartstern, 1997). Both of the standards have requirement of commitment from the top management of the organization in the form of a policy statement and establishment of objectives (Black, 2000; Jackson, 2001).

In summary, there are sufficient requirements common to ISO 9001 and ISO 14001 standards that provide the basis for the integrated management system (Bishal, 2010)

Possible Barriers of Integration; Even though ISO 9001 and ISO 14001 standards emphasize on process approach, some differences still exist between the standards. For example, ISO 9001 does not provide specific performance specifications whereas ISO 14001 strictly requires such specifications (Hoyle, 2009). Hartstern (1997) has pointed out identification of the distinct differences between the two standards and incorporation of all the requirements into a business strategy of an organization as the major challenge for integration process. ISO 9001 requires system documentation in the form of a manual, whereas ISO 14001 does not specify for the need of such manual even there is the requirement for system documentation (Block, 2000).

Even though ISO 9001 and ISO 14001 require management to establish policy identifying objectives and implementation of the specific management system of the organization, only ISO 14001 requires such policy to be made available to public (Hartstern, 1997).

ISO 9001 has a specific requirement for a contract review procedure required to perform reviews prior to accepting any contract and to identify that the requirements for the contract are adequately defined and documented (Hartstern, 1997; Jackson, 2001). On the other hand ISO 14001 requires a procedure to identify legal and other requirements which are related to environmental aspects of an organization's activities, products or services (Hartstern, 1997).

ISO 9001 has a specific requirement for design control which is applicable to the product design process and requires a design control procedure for the purpose (Hartstern, 1997). ISO 14001 standard requires a procedure to identify the environmental aspects of an organization's activities, products and services and system to respond in case of an emergency (Hartstern, 1997; Jackson 2001).

Quality management system focuses on customer satisfaction and quality 'Of product or service whereas environmental management system emphasizes in satisfying requirements for stakeholders, regulatory bodies, local communities and minimizing environmental impacts (Hoyle, 2009; Von Zharen, 2001).

In summary, even some of the requirements of ISO 9001 and ISO 14001 standards are somewhat different and specific to each management standards; they are not mutually exclusive and can fit into the integrated management system to achieve both quality and environmental performance (Hartstern, 1997).

In this context, the benefit of the integrated management system can be mentioned as following;

Implementing separate ISO programs within an organization to meet the organizational needs is likely to result into massive document system, increased financial burdens and increased implementation time (Culley, 1996). Parallel management systems lead to separate and independent implementations of each system which suffer from several drawbacks like the duplication of management tasks, such as written procedures, checking, control forms and other documents as required by each system (Spilka et al., 2009). With one system in place, it is likely to be more effective and efficient in making everyone in the organization responsible for product or service quality and environmental performance with continuous improvement in all operations (Hart stem 1997). According to McDonald et al. (2003) integrating management systems helps organization by simplifying systems, optimizing resources, providing common framework for continual improvement and improving overall organizational performances.

As a summary, the comprehensive study of the literature provided the information related to the history ISO, ISO standards and their development processes, and benefits of standards to organization, public, individuals, countries and the world. The literature review of related articles and journals also provided information regarding the similarities and differences between the ISO 9001 and ISO 14001 standards and highlighted on the possibility of integrating quality management system and environmental management system, its benefits and possible barriers for such approach.

All approach which stated above, it is valid for existing and current application with old version of ISO 9001 and ISO 14001.

As it is shown on Table 3.3 on the new revisions of ISO 9001:2015, products, work environment, Monitoring and measuring equipment, Purchased product, Supplier were changed with Products and services, Environment for the operation of processes, Monitoring and measuring resources andexternally provided products and services respectively.

It means that ISO 9001: 2015 revision will be combine with ISO 14001 more easily than old version of ISO 9001 (Bishal, 2010).

OHSAS 18001 is fairly new standard if it is compared to ISO 9001 and ISO 14001.

The OHSAS Project Group published the OHSAS 18000 Series in 1999. The Series consisted of two specifications: 18001 provided requirements for an OHS management system and 18002 gave implementation guidelines.

OHSAS 18001:2007 is the current international standard for occupational health and safety management systems. This standard is soon to be replaced by ISO 45001, which is currently in committee draft form and is expected to be ready for final publication in fall 2016. ISO 45001 is being written based on Annex SL and is shaping up to look very similar to ISO 14001, as the OHSAS 18001 standard does now. This will ease integration of the two systems(WENCK, 2016).

3.6 Combination of ISO 9001 & ISO 14001 & OHSAS 18001 into an IMS

An integrated management system (IMS) combines all related components of a business into one system for easier management and operations. Quality (QMS), Environmental (EMS), and Safety (OHSMS) management systems are often combined and managed as an IMS. Examples of existing processes can include:

- Quality Management Systems (QMS)
  - ISO 9001
  - ISO 17025 (Laboratory)
  - ISO 22000 (Food Safety) etc
- Environmental Management Systems (EMS)
  - ISO 14001:2015
- Occupational Health & Safety (OHSMS or SMS or HMS)
  - OHSAS 18001:2007

These are not separate systems joined together, rather they are an integrated management system with linkages so that similar processes are seamlessly managed and executed without duplication. IMS components common to all the systems include the resources (people, facilities & equipment, etc.) and processes (documented in the QMS/EMS/OHSMS and applied throughout the organization).

In this case, the realization of IMS provides some benefits.These benefits are as follows:

- Consistent objectives, planning, and document management
- Implementation and Operation of the system cost less.
- Easier internal audits
- No Redundancies, reducing the chance of conflict.

On the other hand, the disadvantages of IMS are also available. These include the following;

- Responsibility of QMS and EHS can be conflicted in some organizational structures
- Documentation can be more intricate.
- External third party audits can be more difficult.

The three management systems share many common requirements and the continual improvement goal. They differ in their approach and degree of prescription, but the

ISO 9001, the ISO 14001 and OHSAS 18001 standards are compatible in content, terminology & many of the requirements as shown on Table 3.1 below:

Table 3.1: Common Requirements of ISO 9001- ISO 14001- OHSAS 18001.

Comman Requirement	ISO 9001 Clause	ISO 14001 Clause	OHSAS 18001 Clause
Manual	5.3	4.4.4.	4.4.4.
Document control	4.2.3	4.4.5	4.4.5
Control of records	4.2.4	4.5.4	4.5.4
Responsibilty and authority	5.5.1	4.4.1	4.4.1
Management review	5.6	4.6	4.6
Training, competency and awereness	6.2.2	4.4.2	4.4.2
Infrastructure	6.3	4.4.1	4.4.1
Work environment	6.4	4.4.1	4.4.1
Design and development	7.3	4.4.6	4.4.6
Purchasing and outsourcing	7.4	4.4.6	4.4.6
Control of measuring equipment	7.6	4.5.1	4.5.1
Internal audit	8.2.2	4.5.5	4.5.5
Corrective action	8.5.2	4.5.3	4.5.3
Preventive action	8.5.3	4.5.3	4.5.3
Operational controls depending on the nature of your business	----	4.4.6	4.4.6
Special process validation	7.5.3	4.4.6	4.4.6
Incoming inspection	8.2.4	4.4.6	4.4.6

If your organization wants to have one comprehensive management systems covering Health and Safety, Environmental, and Quality there are many common requirements, which do not need to repeat.

It is often more efficient to combine the three systems (QMS, EMS and OHSMS) into one and sharing the common clauses and procedures. We have considered this when creating packages to simplify the implementation for an organization.

Rather than have parallel (duplicate) Manuals and other documentation we note where the user can just add OHSMS and EMS requirements to the common QMS Manual, procedures and instructions.

As a summary; Contrary to many other types of standards, management system standards cover multiple aspects, levels and functions of an organization and, therefore, their implementation can have a substantial impact on how an organization operates and manages its business processes.

In addition, more and more organizations are applying not only one, but a range of management system standards to satisfy their own needs as well as those of negative external Impact to the environment (US Integrated standard, 2016).

Integration of ISO 9001, ISO 14001 and OHSAS 18001 may combine to depends on facilities and their needs. The best and expected combinations are appliying three of them. But they may apply the different standards in a combined way, integrated with their business processes in one, two or three combinations as well.

3.7 Background of ISO

ISO is a short form of International Organization for Standardization, a nongovernmental organization with a Central Secretariat located in Geneva, Switzerland (International Organization for Standardization, 2010). ISO was created in 1946 with an aim to facilitate the international coordination and unification of industrial standards and officially started functioning from February, 1947 (Zuckerman, 1997). ISO, a word derived from the Greek "isos" which means equal was chosen as the short form because the name International Organization for Standardization would have resulted in different acronyms in different languages (Von Zharen, 2001). ISO is comprised of 163 national standards bodies, each representing a country and it exists for designing, developing and promoting standards that are acceptable and applicable to every organization in the world (ISO, 2010). According to Von Zharen (2001), ISO exists to facilitate the trade of goods and services by encouraging standardization and related activities all over the globe, and to develop cooperation in science, technology, academic sector and economic activity.

3.8 ISO 9001 Standard

ISO 9000 standards series is the most popular and widely adopted standard representing all international standards relating to quality management systems, released by ISO in 1987 with an aim of assisting organizations in fulfilling the needs of their customers and stakeholders (Zuckerman, 1997). ISO 9000 standards furnish the essence of quality management for an organization which is required for fulfilling its customers' quality needs, meeting applicable regulatory requirements and achieving continual improvement of its performance in the pursuit of its set objectives (Hoyle, 2009). A Technical Committee (TC) 176 named as the International Technical Committee on Quality Assurance and Quality Management was formed by ISO in 1980 and the first ISO 9001 standard was published in 1987. After the first publication in 1987, ISO 9001 standard has been revised in 1994, 2000 and 2008 (Hoyle, 2009).

Organizations use ISO 9000 system not only as a foundation for quality management and continual improvement but also as a solid benchmark tool in establishing an internal auditing system and assessing its consistency (Zuckerman, 1997).

According to Hoyle (2009), ISO 9000 family of standards includes four international standards for quality management system which specify requirements and recommendations for the design and assessment of management systems and are as follows:

- ISO 9000:2005 - Fundamentals and vocabulary for quality management system
- ISO 9001:2008 - Requirements for quality management system
- ISO 9004:2009 - A quality management approach for managing the sustained success of an organization
- ISO 19011: Guidelines for quality and/or environmental management systems auditing given though the ISO 9000 family comprises of other standards, ISO 9001 is the only standard used for certification (Hoyle, 2009).

Before the year 2000, ISO 9001, ISO 9002 and ISO 9003 assessment standards were being used for certification and hence the term "ISO 9000 certification" was applicable to any of the three standards' certification. However, after the declaration of ISO 9002 and ISO 9003 as obsolete in 2003, certification has been explicitly referenced as ISO 9001certification. The revisions of ISO 9000 standards were carried so that resulting ISO 9001 standard would be compatible with other ISO standards specifically ISO 14001 environmental management system (Von Zharen, 2001).

ISO standards serve as technical agreements providing framework for compatible technology and are applicable across the globe. ISO has more than 18000 international standards and related documents that are applicable to various business and service sectors including agriculture, construction, engineering, manufacturing and distribution, transportation, medical and health care, and communication and information (ISO, 2010).

ISO 9001 standard development, Technical Committees (TC) and Sub- committees (SC) play an important role**.**

ISO technical committees (TC) and subcommittees (SC) are involved in the international standard development process that takes place in following six-steps (ISO, 2010):

- Proposal Stage: This is the first stage and at this stage the need for a particular international standard is confirmed and the proposal of its development is presented for approval by the members of relevant Technical Committee (TC) or Sub Committed (SC). The proposal is approved if the majority of the permanent members of the TC/SC agree and at least five permanent members commit to actively participate in the project. The project is led by a project leader.
- Preparatory Stage: This is the second stage and at this stage, a working group of experts from the TC/SC prepare a working draft under the chairmanship of the project leader and prepare several working drafts until the one with best technical solution is finalized. The draft is then forwarded to the parent committee of the working groups for the consensus building phase.
- Committee Stage: This is the third stage and at this stage, the first committee draft is registered and then distributed for comments and recommendations by the ISO Central Secretariat. Consensus for the technical content is reached if successive committee drafts are presented and finally the text is finalized as a draft international Standard (DIS) for submission.
- Enquiry Stage: This is the fourth stage. Within the period of five months, the draft international standard (DIS) is circulated among all ISO member bodies for comment and approval. It is considered

approved if a two-thirds majority of the permanent members of TC/SC cast their vote in favor and not more than one-quarter of the total votes cast are against the draft. The draft is sent back to the originating TC/SC for revision if the approval criteria are not met. Once the draft is approved, it becomes final draft international standard and proceeded for submission.

- Approval Stage: This is the fifth stage. At this stage, the final draft international Standard (FDIS) is circulated to all ISO member bodies for final Yes | No vote and this takes place within two months period. The comments received at this stage are not entertained, but are registered for consideration during a future revision. The draft has to be approved by two-thirds majority of the permanent members of TC/SC with not more than one-quarter of the total votes cast in against. In case the draft is not approved, it is sent back to the originating TC/SC for revision.
- Publication Stage: This is the final and the sixth stage. After the approval, the final draft international standard is sent to the ISO Central Secretariat for publication. ISO member bodies review all international standards at least once after three years of publication and every five years after the first review. The fate of confirmation, revision or withdrawal is decided by the majority of the permanent members of TC/SC.

Benefits of ISO Standards; ISO standards provide technological, societal and economic assistance which are beneficial for innovators, customers, businesses, trade officials, developing countries, general people and the whole planet (ISO, 2010). some of the benefits of ISO can be highlighted as follows:

- Facilitates in trade between countries
- Helps governments by providing technical support in the sector of health, safety and environmental legislation
- Assists in making the process of product manufacturing, its distribution and other services more efficient, safer, and profitable

- Assists in providing technical guidance and sharing good management practices
- Safeguards consumers and users of products and services
- Assists in providing solutions for common problems
- Disseminates innovation and technological achievements for the welfare of People.

Management System; A management system is a proven set of framework that an organization uses for managing and continually improving its policies, programs and processes and achieving its objectives. According to ISO (2010), management system refers to everything that an organization does to manage its processes or activities so that its products or services meet the objective of satisfying the customer's quality needs, complying with regulations, or meeting environmental objectives.

A management system helps an organization to achieve its goals through effective utilization of resources, optimization of process and disciplined management thinking and helps to address the issues related to profitability, competitiveness, globalization, adaptability, technology and growth (BSI, 2010). An effective implementation of a management system helps in managing social, environmental and financial risk, improving operational excellence, reducing cost, increasing customer satisfaction, eliminating trade barriers, fostering innovation, ensuring continual improvement, protecting brand integrity and bringing clarity in the marketplace.

Adoption of newer concepts of management by the organizations is guided by increasing global competition and rapidly changing industrial environment (Badreddine, Romdhane, &Amor,2009).

In order to make the effective management system in the Organization, management systems standard is required.

Management system standards are general principles that are applicable to any organization whether a business enterprise, a public administration or a governmentdepartment irrespective of its size, nature and type of product or service it offers. An ISO management system standard which is shown in Table 3.3 are based on the operating principles of Plan-Do-Check- Act (PDCA) cycle which provide guidelines in establishing and operating a management system and are as follows (ISO, 2010) and its sketch is shown Figure 3.3:

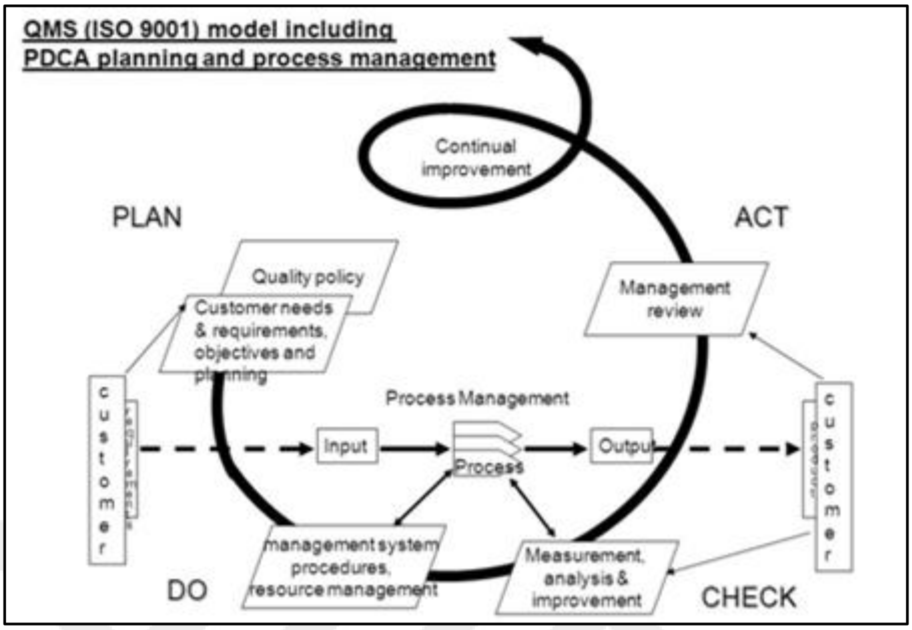


Figure 3.3: Quality Management System Model (ISO 9001).

- Plan: This is the first phase of a cycle where requirements of an organization are identified, targets and objectives are established and plans are set up to achieve such targets and objectives.
- Do: This is the execution phase where the developed plans are implemented to achieve the targets and goals.
- Check: This the evaluation phase where actual achievements are monitored, measured and compared against planned objectives and targets.
- Act: In this phase, corrections and improvements are made in the plans when they fail to meet the set objectives and goals.

This phase is considered as an opportunity for learning from the mistakes and preparing for improvement in the future. After completing this phase, the cycle again enters plan phase and keeps on continuing. (Bishal**,** A, 2010)

Quality management principles are one of the most important elements in the implementation of Quality management systems.

According to Hoyle (2006), the quality management system standard ISO 9001:2008, which is the succession of ISO 9001:2000 version, is based on eight quality management principles that assist senior management in guiding their management towards continual improvement and those principles are as follows:

- Customer focus: Organization must put its effort in satisfying the customer needs and should organize work as a process that meets or exceeds customer expectation
- Leadership: Leaders are the ones who are consistent with the organizational values and drive organization by uniting everybody within the organization towards achieving objectives.
- Involvement of people: People at every levels of an organization are equally important and their active participation as a work force is crucial for organizational benefits
- Process approach: For achieving a desired result, the available resources and activities are required to be managed as a process
- System approach to management: Organization should identify, understand and manage interrelated processes as a system so as to enhance its effectiveness and efficiency in achieving its objectives
- Continual improvement: Organization should consider continual improvement of its overall performance as the most important objective
- Factual approach to decision-making: The decisions based on the analysis of data and information are effective and assist in simplifying organizational procedure for decision making
- Mutually beneficial supplier relationships: A mutually beneficial relationship between an organization and its suppliers enhances the capability of both to improve performance and create value

These eight principles are embedded within the clauses of ISO 9001 and together describe the quality management n an organization. The ISO 9001 standard does not necessarily demand for certification, however, an organization may seek certification from an independent quality system certification body after it has successfully implemented quality management system (Hoyle, 2009). ISO 9001 certification does not make any difference to the way the organization is managed, neither does it provide a guarantee of quality product or service, but it is likely to add significant value to the organization which helps in winning confidence of customers and suppliers (Hoyle, 2009). ISO 9001 certification is also used to gain market advantage and as a means of advertisements promoting the business (Cianfrani et al.,2009).

A new version of ISO 9001 appears about every seven years. It is first issued in 1987 at that time; you had to describe in detail what your business did. What applied in the 1994 version was 'say what you do and do what you say'.In the 2000 version, you had to focus on proper processes in order to continually improve and thereby increase your customer satisfaction. There was nothing added in 2008, but it was more precise about the interpretation of the standard. ISO 9001:2015 published on 23 September 2015.ISO 9001:2015 has ten clauses instead of eight.

Table 3.2: Comparison of ISO 9001:2008 and ISO 9001:2015.

ISO 9001:2008	ISO 9001:2015
0. Introduction	0. Introduction
1. Scope	1. Scope
2. Normative reference	2. Normative reference
3. Terms and definitions	3. Terms and definitions
4. Quality management system	4. Context of the organization
5. Management responsibility	5. Leadership
6. Resource management	6. Planning
7. Product realization	7. Support
8.Measurement, analysis and improvement	8. Operation
	9. Performance evaluation
	10. Improvement

Table 3.2 shows the relationship of the ISO 9001:2008 clauses to those in the new ISO 9001:2015. The first three clauses in ISO 9001:2015 are largely the same as those in ISO 9001:2008, but there are considerable differences between ISO 9001:2008 and

ISO 9001:2015 from the fourth clause onwards.

The last seven clauses are now arranged according to the PDCA cycle (Plan, Do, Check, Act). Figure3.2 shows this.

Clauses 4, 5, 6 and 7 of ISO 9001:2015 come under PLAN, clause 8 comes under DO, clause 9 comes under CHECK and clause 10 is covered by ACT.

With this new arrangement, the new ISO 9001:2015 strives to give additional momentum to the continuous and systematic improvement of processes within organizations (ISO, 2016).

Table 3.3: Comparison of ISO 9001:2008 & 2015 base on important change.

ISO 9001:2008	ISO 9001:2015
Products	Products and services
Documentation, quality manual, documented procedures, records, instructions	Documented information
Work environment	Environment for the operation of processes
Monitoring and measuring equipment	Monitoring and measuring resources
Purchased product	Externally provided products and services
Supplier	External provider

Table 3.3 is a brief summary of a number of important changes to the terminology compared with ISO 9001:2008.

This is not an exhaustive list of the differences between ISO 9001:2008 and ISO 9001:2015, but it does show the main points. The most noticeable change to the standard is its new structure. ISO 9001:2015 now follows the same overall structure as other ISO management system standards (known as the High-Level Structure), making it easier for anyone using multiple management systems.

Establishing ISO 9001 quality management system effectively helps an organization in following ways.

These are output of the benefits that adds an organization of the ISO 9001 quality system.

- Provides for work performance consistency
- Enables to discover causes of poor performances
- Helps in defining goals and objectives
- Stresses in process approach
- Provides benchmarks to measure improvements
- Helps to gain customer confidence
- Helps in maintaining clarity of responsibility and authority
- Helps in maintaining consistent quality

- Helps in international trade
- Helps in improving cycle time and efficiency (Bishal**,** A, 2010).

3.9 ISO 14000 Series and Environmental Management System

ISO 14000 is a series of international standards on environmental management that provides a framework for the development of an environmental management system and respective audit program (Von Zharen, 2001). After the success of ISO 9000 standards and increase in awareness of the environmental protection, ISO formed the Strategic Advisory Group on the Environment (SAGE) in 1991 which carried out intensive conversations among countries, 11 international organizations and more than 100 environmental experts to define the basic requirements of a new approach to environment related standards (Von Zharen, 2001). The development of ISO 14000 seem to have begun after ISO's commitment to support the sustainable development in United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992 (Von Zharen, 2001).

In 1993, after the recommendation of SAGE, ISO launched the new technical committee ISO/TC 207 for environmental management comprising representatives from industry, standardization organizations, governmental and environmental organizations from various countries of the world (Environment Protection Agency, 2010). ISO published ISO 14001 and ISO 14004 standards in 1996 for the first time (Von Zharen, 2001). Currently, ISO TC 207 comprises of delegations of business and government experts from 75 countries, observers from another 25 countries and 41 international or regional organizations including United Nations Conference on Trade and Development (UNCTAD), United Nations Environment Program (UNEP), World Health Organization (WHO) and World Trade Organization (WTO). The ISO 14000 family consists of standards and guidelines relating to environmental management systems which essentially focus on what an organization does to minimize harmful effects on the environment caused by its activities and achieve continual improvement of its environmental performance (ISO, 2010). ISO 14001 is the only specification standard which provides the requirements of an environmental management system (EMS) whereas ISO14004 provides the guidelines required for EMS (Von Zharen, 2001).

The other standards in the family address specific environmental aspects including labeling, life cycle analysis, performance evaluation, communication and auditing. ISO 14000 families are shown in Table 3.4 (Christini et al, 2004)

Table 3.4: ISO 14000 Families.

Standard No.	Title
14000	Guide to Environmental Management Principles, Systems and Supporting Techniques
14001	Environmental Management Systems: Specification with Guidance for use
14004	Guidelines on the Elements of an Environmental Management System
14010	Guidelines for Environmental Auditing: General Principles of Environmental Auditing
14011	Guidelines for Environmental Auditing: Audit Procedures - Part 1: Auditing of Environmental Management Systems
14012	Guidelines for Environmental Auditing: Qualification Criteria for Environmental Auditors
14013/15	Guidelines for Environmental Auditing: Audit Programmers, Reviews and Assessments
14020/23	Environmental Labeling
14024	Environmental Labeling: Practitioner Programs Guiding Principles, Practices, and Certification Procedures of Multiple Criteria Programs
14031/32	Guidelines on Environmental Performance Evaluation
14040/43	Life Cycle Assessment General Principles and Practices
14050	Glossary
14060	Guide for the Inclusion of Environmental Aspects in Product Standards

An environment management system (EMS) based on the requirements of ISO 14001 is a management tool that enables an organization of any type or size in identifying and controlling the environmental impacts of its activities, continually improving its environmental performance implementing a systematic approach in setting environmental objectives and demonstrating that such objectives have been successfully achieved (ISO, 2010).

ISO 14001 is applicable to all types and sizes of organizations including service and business sectors and is the only specific standard of ISO 14000 series against which an organization's EMS is evaluated and certified (Von Zharen, 2001).

At present, ISO 14001:2004 version of the standard is being used for the certification purpose and the main intention of this standard is to provide a framework for a holistic and strategic approach to the organization's policy, plans and actions (ISO, 2010). ISO 14001 requires the commitment of management and employees for the protection of environment with clear assignment of accountability and responsibility (Voorhees, & Woellner, 1998).

ISO 14001 specifies EMS requirements that an organization should meet in order to get certified from a certification body (Whitelaw, 2004). According to EPA (2010), the essential requirements of an environment management system (EMS) under ISO 14001 include:

- A policy statement that includes commitment to prevention of pollution, continual improvement of EMS and compliance with all applicable statutory and regulatory requirements
- Identification of all the aspects of an organization’s activities, product and services that can have significant impact on the environment
- Setting environmental objectives and targets
- Implementing the EMS to meet the objectives
- Establishing an internal audit program
- Monitoring and measurement of the performance of the system and taking subsequent corrective and preventive action when the deviations occur in the system
- Periodic reviews of the EMS by top management to ensure its continual improvement

The key elements of ISO 14001 essential for implementing environmental management system are environmental policy, planning, implementation and operation, checking and corrective action and management review (Von Zharen, 2001). According to Whitelaw (2004), ISO 14001 standard is comprised of following clauses: General Requirements (clause 4.1), Environmental Policy (clause 4.2), Planning (clause 4.3), Implementation and operation (clause 4.4), Checking and corrective actions (clause 4.5), and Management review (clause 4.6).

Planning further consists of environmental aspects, legal and other requirements, objectives, targets and program(s); implementation and operation consists of resources, roles, responsibility and authority, competence, training and awareness, communication, documentation, control of documents, emergency preparedness and response; checking consists of monitoring and measurement, evaluation of compliance, nonconformity, corrective action and preventive action, control of records, internal audit (Whitelaw, 2004).

An environmental management system is developed and implemented by an organization to achieve sound environmental performance. It provides a structure in which the organization addresses environmental issues by allocating resources, assigning responsibilities, and evaluating practices, procedures and processes for developing, implementing, achieving, reviewing and maintaining the policy and legal setting.

Environmental Management System (EMS)

- serves as a tool to improve environmental performance
- provides a systematic way of managing an organization's environmental affairs is the aspect of the organization's overall management structure that addresses immediate and long-term impacts of its products,
- services and processes on the environment gives order and consistency for organizations to address environmental concerns through the allocation of resources, assignment of responsibility and ongoing evaluation of practices, procedures and processes
- focuses on continual improvement of the system.

An EMS follows a Plan-Do-Check-Act Cycle, or shorlty PDCA which is shown in Figure 3.4. The pathway is like; the process of first developing an environmental policy, planning the EMS, and then implementing it. The process also includes checking the system and acting on it. The model is continuous because an EMS is a process of continual improvement in which an organization is constantly reviewing and revising the system.

This is a model that can be used by a wide range of organizations from manufacturing facilities to service industries to government agencies.

An EMS is flexible and does not require organizations to necessarily "retool" their existing activities. An EMS establishes a management framework by which an organization's impacts on the environment can be systematically identified and reduced. For example, many organizations, including countries and municipalities have active and effective pollution prevention activities underway. These could be incorporated into the overall EMS.

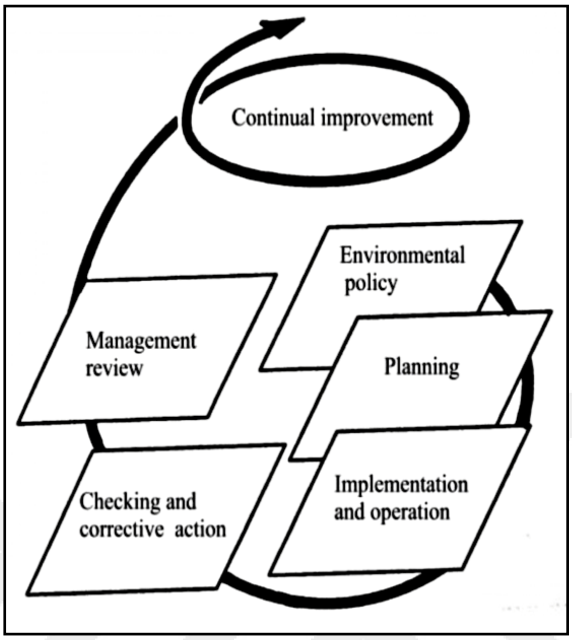


Figure 3.4: Environmental Management System Model (ISO 14001).

All ISO standards are reviewed every five years to establish if a revision is required in order to keep it current and relevant for the marketplace. ISO 14001:2015 is designed to respond to latest trends and ensure it is compatible with other management system standards.

The key changes relate to:

- Increased prominence of environmental management within the organization's strategic planning processes
- Greater focus on leadership
- Addition of proactive initiatives to protect the environment from harm and degradation, such as sustainable resource use and climate change mitigation
- Improving environmental performance added
- Lifecycle thinking when considering environmental aspects
- Addition of a communications strategy

In addition, the revised standard follows a common structure, with the same terms and definitions as a number of other management system standards such as ISO 9001. This makes them easier, cheaper and quicker for those companies who use more than one, not to mention helping out the auditors.
ISO 14001 encourages top management to have a critical look at areas that are vulnerable to environmental impacts. According ISO (2010) some of the potential benefits of an EMS based on ISO 14001 are as follows:

- Framework for meeting EMS objectives and continual improvement of environmental performances
- Increased efficiency and potential cost savings
- Optimized used of environmental management resources
- Improved corporate image among customers, regulators, stakeholders and public
- Consistency in managing environmental obligations
- Lower distribution cost

3.10 OHSAS 18001

The OHSAS 18001 standard was developed to bridge the gap where no international standard existed for occupational health and safety. Development involved input from a number of leading bodies, including certifiers, trade bodies and expert consultancies (OHSAS 18001, 2016).
The first version of the standard appeared in 1999 and was based on a number of existing standards (including BS8800:1996) that had been developed by the leading national certification bodies.
OHSAS 18001 is an international occupational health and safety management system specification. It comprises two parts, 18001 and 18001 and embraces a number of other publications. For the record, the following other documents, amongst others, were used in the creation process:

- BS 8800:1996 Guide to occupational health and safety management systems
- DNV Standard for Certification of Occupational Health and Safety Management Systems (OHSMS)-1997

- Technical Report NPR 5001:1997 Guide to an occupational health and safety management system
- Draft LRQA SMS 8800 Health and safety management assessment criteria
- SGS&ISMOL ISA 2000:1997 Requirements for Safety and Health Management Systems
- BVQI Safety Cert: Occupational Safety and Health Management Standards
- Draft AS/NZ 4801 Occupational health and safety management system Specification with guidance for use
- Draft BSI PAS 088 Occupational health and safety management systems
- UNE 81900 series of pre-standards on the Prevention of occupational risks
- Draft NSAISR 320 Recommendation for an Occupational Health and Safety (OH and S) Management System

OHSAS 18001 is an Occupation Health and Safety Assessment Series for health and safety management systems. It is indented to help organizations to control occupational health and safety risks. It was developed in response to widespread demand for a recognized Standard against which to be certified and assessed (OHSAS Guide, 2007).

The current version of the standard is OHSAS 18001:2007. This supersedes OHSAS 18001:1999, which was phased out in July 2009.

Despite not currently being an ISO standard, OHSAS 18001 has been designed to be compatible with the ISO 9001 (Quality) and ISO 14001 (Environmental) standards, thus helping organizations to achieve an integrated management strategy. In 2016, a new Health and Safety Management System standard called ISO 45001 is expected to be published - this will then supersede OHSAS 18001.

The OHSAS 18001 standard specifies a number of key criteria for an organization to demonstrate and includes:

- Planning for hazard identification, risk assessment and risk control
- Structure and responsibility

- Training, awareness and competence
- Consultation and communication
- Operational control
- Emergency preparedness and response
- Performance measuring, monitoring and improvement
 (OHSAS 18001, 2016).

Establishing ISO 9001 quality management system with OHSAS 18001 effectively helps. The key criteria of OHSAS 18001 standard helps an organization in following ways. These are the benefits that adds an organization of the ISO 9001 quality system:

- Improved corporate image and credibility among stake holders, regulators, customers,
- Prospective clients and the public
- Adoption of international best practice in relation to risk management
- Minimization of liability of employers through adoption of proactive rather than reactive controls
- Ensures health and well-being of employees, sub-contractors and the public
- Ensures legislative awareness and compliance
- Reduces accident and incident rates by reducing and elimination workplace hazards
- Improves the incident investigation process
- Increases employee motivation through the provision of a safer workplace and participation process (Benefit of OHSAS, 2007)

ISO 18001 of practical benefits can be summarized as follows briefly.

- reduced risk: improved safety management of health and safety risks
- competitive advantages: demonstration of commitment to health and safety
- improved performance: improved operational efficiency through accident
- management reduction and reduced downtime

- reduced costs**:** reduced insurance premiums and compensation / penalties for breached legislation/etc..

3.11 Environmental Remediation

Environmental remediation deals with the removal of pollution or contaminants from environmental media such as soil, groundwater, sediment, or surface water. This would mean that once requested by the government or a land remediation authority, immediate action should be taken as this can impact negatively on human health and the environment (Wikipedia, 2016). Traditional Remediation is that Excavation, incineration, burning, chemical remediation, microbial bioremediation, and phytoremediation reduce risks by removing contamination or actively reducing chemical concentrations in environmental media. Excavation is the most common option for remediating contaminated soils if the scale of contamination does not make the cost prohibitive. A physically harsh remedial alternative, such as soil excavation, would usually have greater, immediate adverse impacts to ecological receptors than concentrations of petroleum hydrocarbons at many spill sites, especially given that many semi-volatile hydrocarbons and their metabolites are not highly toxic to plants. Facilitated bioremediation can range from simple aeration (tilling) of soil to the addition of electron donors or microorganisms. Phytoremediation of petroleum hydrocarbons enhances rates of degradation in rhizosphere soil (Susarla et al. 2002). Some remedial alternatives, such as burning of spills in marshes and fields are used only in emergency management situations (API 1999). Potential hazards posed by remedial interventions are listed in Table 3.5. Rigorous assessments are not typically required to evaluate risks associated with remedial alternatives, and few guidance documents emphasize the importance of comparing risks from various remedial alternatives and no-action alternatives (Suter et al. 2000, Reagan 2000). Remediation is assumed to reduce risk. Remedial goals are defined based on health or ecological risks from the contaminants, but the remedial technologies are chosen based primarily on two engineering criteria: the ability to achieve those goals and cost-effectiveness. This focus on engineering criteria rather than environmental goals tends to restrict the range of options considered (Efraymson, R et al, 2003).

Table 3.5: Examples of ecological hazards posed by terrestrial remedial action.

Remedial Action	Hazards
Microbial Bioremediation and Phytoremediation	Possibly increased bioavailability or toxicity of hydrocarbons or products Devegetation due to tilling Decreased plant diversity and aqueous contamination due to fertilization
Excavation or Isolation (capping) of Soil	Destruction of vegetation Destruction of habitat and outmigration by vertebrates in excavated area Removal of nutrient-rich surface soil and associated microorganisms and İnvertebrates Failure of soil ecosystem and vegetation to recover if nonindigenous fill soil is used Destruction of ecosystem at borrow pit where fill is obtained and at landfill where excavated soil is deposited. Alarm and escape behavior of wildlife due to construction activity and noise
Burning of Spills, Soil Incineration or Thermal Desorption	Decrease in air quality and associated risk to wildlife or plants Destruction of above-ground vegetation, below-ground seeds and root material from severe heat Destruction of soil organic matter and potential loss of productivity Change in chemistry of oil residue which may prevent emergence of new shoots Secondary fires, extending area of habitat destruction Outmigration by vertebrates in burned area
Most Remedial Actions	Destruction of vegetation and outmigration by vertebrates in areas where roads, parking areas or laydown areas are developed, or foot traffic is frequent Reduction in biodiversity and wild life forage from mowing of excavated area, cap or landfarm to maintain lawn Decrease in air quality associated with increased truck traffic

In the USA the most comprehensive set of Preliminary Remediation Goals (PRGs) is from the Environmental Protection Agency (EPA) Region 9. A set of standards used in Europe exists and is often called the Dutch standards. The European Union (EU) is rapidly moving towards Europe-wide standards, although most of the industrialized nations in Europe have their own standards at present. In Canada, most standards for remediation are set by the provinces individually, but the Canadian Council of Ministers of the Environment provides guidance at a federal level in the form of the Canadian Environmental Quality Guidelines and the Canada-Wide Standards Canada-Wide Standard for Petroleum Hydrocarbons in Soil (Wikipedia, 2016).

3.12 Incremental Health Risk

Incremental health risk is the increased risk that a receptor (normally a human being living nearby) will face from (the lack of) a remediation project. The use of incremental health risk is based on carcinogenic and other (e.g., mutagenic, teratogenic) effects and often involves value judgments about the acceptable projected rate of increase in cancer. In some jurisdictions, this is 1 in 1,000,000 but in other jurisdictions, the acceptable projected rate of increase is 1 in 100,000. A relatively small incremental health risk from a single project is not of much comfort if the area already has a relatively high health risk from other operations like incinerators or other emissions, or if other projects exist at the same time causing a greater cumulative risk or an unacceptably high total risk. An analogy often used by remediators is to compare the risk of the remediation on nearby residents to the risks of death through car accidents or tobacco smoking(Wikipedia, 2016). Remediation is generally subject to an array of regulatory requirements, and also can be based on assessments of human health and ecological risks where no legislated standards exist or where standards are advisory.

The development of new and innovative technologies and methods for treating environmental contaminants is a critical step in the effort to clean up the nation's hazardous waste sites. Field demonstration of these technologies is, in turn, a key step in their development. The continuing investment of public and private resources in demonstration projects represents a major commitment to promoting the technical and cost advantages offered by these technologies. The number of government-sponsored field demonstration projects of new waste cleanup technologies has grown to over 600. (The EPA Environmental Technology Verification Program (ETV) develops test protocols and verifies the performance of innovative technologies that have the potential to improve protection of human health and the environment. ETV was created in 1995 to help accelerate the entrance of new environmental technologies into domestic and international markets. For the past 18 years, ETV has operated as a public-private partnership through cooperative agreements between EPA and private non-profit testing and evaluation organizations. ETV will conclude operations at the end of 2013 (U.S EPA, 2013).

The EPA ETV program seeks to provide credible information about the performance of environmental technologies from disinterested third parties under the auspices of EPA. The Materials Management and Remediation Center (MMR), established in 2008, is operated in cooperation with Battelle. This center verifies the performance of materials management technologies, including for recycling, beneficial use of waste materials, recovery of useful components of waste, and treatment to minimize disposal requirements (e.g., containment, volume, cost); and technologies to remediate contaminated land and ground water, such as that found at Superfund sites and other properties where industrial or commercial activities have resulted in a legacy of hazardous constituents that limit future use of the property.

The Materials Management and Remediation Center operated in cooperation with Battelle ended in 2012.

This center was designed to verify the performance of materials management technologies, including:

- Recycling
- Beneficial use of waste materials
- Recovery of useful components of waste
- Treatment to minimize disposal requirements (e.g., containment, volume, cost)
- Remediation of contaminated land and groundwater, such as that found at Superfund sites and other properties where industrial or commercial activities have resulted in a legacy of hazardous constituents that limit future use of the property.

Battelle conducts research and development, designs and manufactures products, and delivers critical services for government and commercial customers.
Headquartered in Columbus, Ohio since its founding in 1929, Battelle serves the national security, health and life sciences, and energy and environmental industries (U.S EPA, 2105).

4. METARIAL and METHODS

Nowadays, hazardous substances that threaten the environment are increasing every day.To predict and assess their environmental fate of point sources which affect the diversity of the regional condition, is very difficult and complex because of uncertainties of the input data. (Arunraj and Maiti, 2008). Therefore, due to the fact that the results of environmental factors cannot be digitized they also cannot be assessed clearly because of defective and inaccessible information. The advantage of using of Multi Criteria Decision Analysis (MCDA) and Fuzzy Logic is specified in similar studies. Most of the methods used have been developed based on the theory of classical logic. In these studies, it is used in the method of analytic hierarchy process with fuzzy logic**.** In this method, the many sub factors' values convertedinto a single magnitude value. The methods and processes to be implemented are used to evaluate all possible effects that may arise from point source**.** There are many factors and sub-factors revealing the environmental impacts. An appropriate method should select for environmental impact by taking into account the complexity of environmental system.Analytical hierarchy process (AHP), which is one of Multi-criteria decision-making methods provides a systematic approach to the solution of complex problems that are generated by many factors. In this method, the magnitude of the environmental impacts that come from point sources offers an assessment by taking into account the impact factors. Therefore, it is intended to be used with fuzzy logic. Human thought can be modeled by a fuzzy logic theory base on linguistic analogy for a data group such as incomplete, inconsistent, ambiguous and questionable constituents. Therefore, fuzzy logic provides rational and well-considered results for complicated problems. (Musee et al, 2008).

Full understanding of the relationship between indicators and formulating the relationship correctly is difficult. These relationships are usually expressed as qualitative due to the nature of human thought and linguistic fuzzification.

In the analysis of complex systems and decisions, fuzzy logic can be seen as a tool that is used to digitize the qualitative human thoughts.

Table 4.1[2]**:** Summary of Search Terms.

Type of Model	Application Areas	Related Science
MCDA Keywords	Environmental Phrases	Subject Area
MCDA or multi-criteria decision analysis	contamin* or remedial	Environmental sciences
MCDA or multi-criteria decision making	ecosystem	Environmental studies
AHP or analytic hierarchy process	land	Engineering, environmental
Outranking	nano*	Social sciences,
MAUT or multi-attribute utility theory	site select*	mathematical science
MAVT or multi -attribute value theory	sustainab*	Operations research &
ELECTRE	waste	management sciences
ANP or analytic network process	water or coastal	
Swing weight*	natural resource*	
Expected utility	risk and environ*	
TOPSIS or Technique for Order Preference by Similarity to Ideal Solution	aquatic or terrestrial	
SMAA or stochastic multi-criteria acceptability analysis	energy	
PROMETHEE or Prefeference Ranking Organization Method for Enrichment Evaluation	emission or atmosph*	

[2]Note: Search terms are indicated here by subject areas.

* Indicates a wildcard, so all words including the letters prior to it were queried

Here qualitative-based thinking, 'IF-THEN' is converted to a real number with defuzzification rules (Liu ve Lai, 2008).
In this study, AHP which is one of the different applications of MCDA is selected. The application type of MCDA is shown Table 4.1.

MCDA method isclassified as percentage according to MCDA Keyword and application area. As it is shown in Table 4.2, AHP application which is one of the biggest ratio is 62% for EIA. Hence, AHP is preferred for applications which are Environmental Impact Assessment.(Linkov, I, Moberg E. 2012)

Table 4.2: Percent Distribution of MCDA Method by Application Area.

	AHP / ANP	MAUT/ MAVT	Outranking	Multiple	Review	Other	Total
Waste Management	50%	17%	13%	3%	3%	14%	100%
Water Quality / Management	19%	33%	14%	19%	0%	15%	100%
Air Quality / Emissions	0%	10%	60%	10%	10%	10%	100%
Energy	42%	9%	21%	6%	6%	16%	100%
Natural Resources	50%	7%	0%	7%	21%	15%	100%
Stakeholders	48%	15%	9%	9%	18%	1%	100%
Strategy	39%	21%	16%	5%	9%	10%	100%
Sustainable Manufacturing / Engineering	64%	7%	4%	7%	4%	14%	100%
Remediation / Restoration	27%	33%	20%	7%	7%	6%	100%
Spatial / GIS	80%	17%	0%	0%	3%	0%	100%
Environmental Impact Assessment	62%	12%	7%	5%	7%	7%	100%

4.1 Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP) is a basic approach to decision making.
It is designed to cope with both the rational and the intuitive to select the best from a number of alternatives evaluated with respect to several criteria. In this process, the decision maker carries out simple pair wise comparison judgments which are then used to develop overall priorities for ranking the alternatives. The AHP both allows for inconsistency in the judgments and provides a means to improve consistency.

The simplest form used to structure a decision problem is a hierarchy consisting of three levels:

- the goal of the decision at the top level,
- followed by a second level consisting of the criteria by which the alternatives,
- located in the third level,

will be evaluated. Hierarchical decomposition of complex systems appears to be a basic device used by the human mind to cope with diversity. One organizes the factors affecting the decision in gradual steps from the general, in the upper levels of the hierarchy, to the particular, in the lower levels.

The purpose of the structure is to make it possible to judge the importance of the elements in a given level with respect to some or all of the elements in the adjacent level above. Once the structuring is completed, the AHP is surprisingly simple to apply (Saaty, T.L , Vargas L.G, 2012)

4.2 How to Structure a Decision Problem

The most creative task in making a decision is deciding what factors to include in the hierarchic structure. When constructing hierarchies one must include enough relevant detail to represent the problem as thoroughly as possible, but not so thoroughly as to lose sensitivity to change in the elements.

Considering the environment surrounding the problem, identifying the issues or attributes that one feels should contribute to the solution, and who are the participants associated with the problem, are all important issues when constructing a hierarchy.

Arranging the goals, attributes, issues, and stakeholders in a hierarchy serves two purposes:

- It provides an overall view of the complex relationships inherent in the situation and in the judgment process, and

it also allows the decision maker to assess whether he or she is comparing issues of the same order of magnitude.(Saaty, T.L , Vargas L.G, 2012)

4.3 How to Structure a Hierarchy

Perhaps the most creative and influential part of decision making is the structuring of the decision as a hierarchy.

The basic principle to follow in creating this structure is always to see if one can answer the following question: ‘‘Can I compare the elements on a lower level in terms of some or all of the elements on the next higher level?’’

A useful way to proceed is to work down from the goal as far as one can and then work up from the alternatives until the levels of the two processes are linked in such a way as to make comparison possible.

Here are some suggestions for an elaborate design.

- Identify overall goal. What are you trying to accomplish? What is the main question?
- Identify sub goals of overall goal. If relevant, identify time horizons that affect the decision.
- Identify criteria that must be satisfied in order to fulfill the sub goals of the overall goal.
- Identify sub criteria under each criterion. Note that criteria or sub criteria may be specified in terms of ranges of values of parameters or in terms of verbal intensities such as high, medium, low.
- Identify actors involved.
- Identify actor goals.
- Identify actor policies.
- Identify options or outcomes.
- Take the most preferred outcome and compare the ratio of benefits to costs of making the decision with those of not making it. Do the same when there are several alternatives from which to choose.
- Do benefit/cost analysis using marginal values. Because we are dealing with dominance hierarchies, ask which alternative yields the greatest benefit; for costs, which alternative costs the most (Saaty, T.L , Vargas L.G, 2012).

4.4 Judgment and Comparison

A judgment is an expression of an opinion. A comparison is an expression of an opinion about the dominance (importance, preference or likelihood) of one thing over another. Dominance represents the intensity of strength. It is done every day through verbal expression that has some quantitative significance that we need to use to combine the many dominance judgments involved decision.

The set of all such judgments in making comparisons with respect to a single property or goal can be represented in a square matrix in which the set of elements is compared with itself.

Table 4.3: List of Degree Importance.

Degree of importance	Definition	Definition Explanation
1	Equal importance (no preference)	Two activities contribute equally to the objective
2	Intermediate between 1 and 3	
3	Moderately more important	Experience and judgment slightly favor one activity over another
4	Intermediate between 3 and 5	
5	Strongly more important	Experience and judgment strongly favor one activity over another
6	Intermediate between 5 and 7	
7	Very strongly important	An activity is favored very strongly over another; its dominance demonstrated in practice
8	Intermediate between 7 and 9	
9	Extremely strongly more important	The evidence favoring one activity over another is of the highest possible order of affirmation
1/2, 1/3, 1/4, 1/5, 1/6, 1/7, 1/8, 1/9	Reciprocals of 2, 3, 4, 5, 6, 7, 8, and 9	

It is a way of organizing all the judgments with respect to that property to be processed and synthesizing along with other matrices of comparison judgments involved in that decision. Each judgment represents the dominance of an element in the column on the left of the matrix over an element in the row on top. It reflects the answer to two questions: which of the two elements is more important with respect to a higher level criterion and how strongly (Saaty, T.L , Peniwati K 2012).

Paired comparison judgments in the AHP are applied to pairs of homogenous elements. The fundamental scale of values to represent the intensities of judgments is shown in Table 4.3 (R. Venkata Rao, 2012). This scale has been validated for effectiveness, not only in many applications by a number of people, but also through theoretical justification of what scale one must use in the comparison of homogeneous elements (Saaty, T.L , Vargas L.G, 2012).

4.5 The AHP Theory and Calculation

The mathematical basis of the AHP can be explained in fairly simple outline for the purposes of this book but you need to know what a matrix and a vector are and how to multiply a matrix by a vector. For a full treatment of the AHP the mathematically undaunted should refer to Saaty's book. We will cover the mathematics first and then explain the calculations. The AHP theory consider n elements to be compared, $C_1 \ldots C_n$ and denote the relative 'weight' (or priority or significance) of C_i with respect to C_j by aij and form a square matrix $A= (a_{ij})$ of order n with the constraints that $a_{ij} = 1/a_{ji}$, for $i \neq j$, and $a_{ii} = 1$, all i.

Such a matrix is said to be a reciprocal matrix.

The weights are consistent if they are transitive, that is $a_{ik} = a_{ij}a_{jk}$ for all i, j, and k. Such a matrix might exist if the aij are calculated from exactly measured data. Then find a vector ω of order n such that $A\omega = \lambda\omega$. For such a matrix, ω is said to be an eigenvector (of order n) and λ is an eigenvalue. For a consistent matrix, $\lambda = n$. For matrices involving human judgment, the condition $a_{ik} = a_{ij}a_{jk}$ does not hold as human judgments are inconsistent to a greater or lesser degree. In such a case the ω vector satisfies the equation $A\omega= \lambda max\omega$ and $\lambda max \geq n$. The difference, if any, between λmax and n is an indication of the inconsistency of the judgments. If $\lambda max = n$ then the judgments have turned out to be consistent. Finally, a Consistency Index can be calculated from $(\lambda max-n)/(n-1)$. That needs to be assessed against judgments made completely at random and Saaty has calculated large samples of random matrices of increasing order and the Consistency Indices of those matrices. A true Consistency

Ratio is calculated by dividing the Consistency Index for the set of judgments by the Index for the corresponding random matrix. Saaty suggests that if that ratio exceeds 0.1 the set of judgments may be too inconsistent to be reliable. In practice, CRs of more than 0.1 sometimes have to be accepted. A CR of 0 means that the judgments are perfectly consistent (Coyle, G, 2004).

4.6 Intuitive Justification of the Method

The quantified judgments on pairs of activities C_i, C_j are represented by an n-by-n matrix as A = (a_{ij}), ($i,j = 1,2,\ldots.,n$)

The entires aij are defined by the following entry rules.

Rule 1. If $a_{ij}= \alpha$, then $a_{ij} = 1/\alpha$. $\alpha \neq 0$

Rule 2. If C_i is judged to be of equal relative importance as C_j, then $a_{ij} = 1$, $a_{ji} = 1$; in particular, $a_{ii} = 1$ for all i.

Thus the matrix A has the form

$$A = a_{ij} = \begin{pmatrix} 1 & a_{12} \ldots\ldots & a_{1n} \\ \frac{1}{a_{12}} & 1.\ldots\ldots. & a_{2n} \\ \vdots & & \\ \frac{1}{a_{1n}} & \frac{1}{a_{2n}} & 1 \end{pmatrix}$$

Having recorded the quantified judgments on pair (C_i, C_j) as numerical entries aij in the matrix A, the problem now is to assign to the n contingencies C_1, C_2,....C_n a set of numerical weights w_1, w_2,...w_n that would “reflect the recorded judgments.”

These weights should reflect the group’s quantified judgments. This present the need to describe in precise, arithmetic terms, how the weights w_i should relate to the judgments a_{ij}; or, in other words, the problem of specifying the condition we wish to impose on the weights we seek in relation to the judgments obtained. The desired description is developed in *three steps*, proceeding from the simplest special case to the general one.

Step 1 Set of activity assumed C_1,C_2,.....C_n . C_1on a scale and its weight – say, w_1, for C_2, its weight– say, w_2 so on.

The ideal case of exact measurement, the relation between the weights w_i and the judgment a_{ij} are simply given by

$$a_{ij} = \frac{w_i}{w_j} \quad for \quad i, j = 1,2,\ldots\ldots,n \tag{4.1}$$

$$A= \begin{pmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} \ldots\ldots\ldots\ldots & \frac{w_1}{w_n} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} \ldots\ldots\ldots\ldots & \frac{w_2}{w_n} \\ \vdots & & \\ \frac{w_n}{w_1} & \frac{w_n}{w_2} \ldots\ldots\ldots\ldots & \frac{w_n}{w_n} \end{pmatrix}$$

Step 2 In order to see how to make allowance for deviations, consider the *i*th row in the matrix *A*. The entries in that row area_{i1}, a_{i2}, $a_{i3}\ldots$,a_{ij},…,a_{in}

In the ideal(exact) case these value are the same as the ratios

$$\frac{w_i}{w_1},\frac{w_i}{w_2},\ldots\ldots\ldots\ldots\ldots\ldots,\frac{w_i}{w_j}\ldots\ldots\ldots\ldots\ldots\ldots\ldots,\frac{w_i}{w_n}$$

Hence, in the ideal case, if we multiply the first entry in that row by w1, the second entry by w_2 and so on, we obtain

$$\frac{w_i}{w_1}w_1 = w_i,\ \frac{w_i}{w_2}w_2 = w_i\ , \ldots.. \ \frac{w_i}{w_j}w_j = w_i \ \ldots\ldots.,\frac{w_i}{w_n}w_n = w_i \tag{4.2}$$

The result is arrow of identical entriesw_i, w_i, w_i, ………w_i,

Due to ideal case relations

$$a_{ij} = a_{ij}w_j \qquad (i,j = 1,2,\ldots\ldots,n) \tag{4.3}$$

more realistic relation for the general case take the form (for each fixed *i*)

$$w_i = \textit{the average of } (a_{i1}w_1, a_{i2}w_2, \ldots.. a_{in}w_n) \tag{4.4}$$

More explicitly it has

$$w_i = \frac{1}{n}\sum_{j=1}^{n} a_{ij}\, w_j \qquad (i,j = 1,2,\ldots\ldots,n) \qquad (4.5)$$

Step 3 (4.5) formula is still not realistic enough that is that (4.5) which Works for the ideal case is still too stringent to secure the existence of a weight vector *w* that should satisfy (4.5).

For good estimates, a_{ij} tends to be close to $\frac{w_i}{w_j}$ and hence it is a small perturbation of this ratio.

As a_{ij} changes it return out that there would be a corresponding solution of 4.5 (i.e., w_i and w_j can change to accommodate this change in a_{ij} from ideal case), if *n* were also to change. It denotes this value of *n* by λ_{max}.

In this connection it has a solution that also turns out to be unique.

$$w_i = \frac{1}{\lambda_{max}}\sum_{j=1}^{n} a_{ij} w_j \qquad (i,j = 1,2,\ldots\ldots,n\ ) \qquad (4.6)$$

This is the well-known eigen value.

4.7 Computing of Eigenvector

One of the steps consists of the computation of a vector of priorities from the given matrix. In mathematical terms the principal eigenvector is computed and when normalized becomes the vector of priorities.

Vector can be obtained in the following four ways:

(1) *The crudest* Sum the elements in each row and normalize by dividing each sum by the total of all the sums, thus the results now add up to unity. The first entry of the resulting vector is the priority of the first activity; the second of second activity and so on.

(2) *Better* Take the sum of elements in each column and form the reciprocals of these sums. To normalize so that these numbers add to unity, divide each reciprocal by the sum of reciprocal.

(3) *Good* Divide the elements in each column by the sum of column (i.e., normalize the column) and then add the elements in each resulting

row and divide this sum by the number of elements in the row. This is a process of averaging over the normalized columns.

(4) *Good* Multiply the n elements in each row and take the nth root. Normalize the resulting number (Saaty,T.L, 1990).

4.8 Consistency Index (C.I)

The deviation from consistency may be represented by λ_{max} – n /(n-1) which we call the *consistency index* (C.I)

$$CI = \frac{\lambda_{max} - n}{n-1} \tag{4.7}$$

4.9 Random Index (R.I)

Random Index Study A historical study of several RIs used and a way of estimating this index can be seen in Alonso and Lamata.

The main idea is that the CR is a normalized value since it is divided by an arithmetic mean of random matrix consistency indexes (RI). Various authors have computed and obtained different RIs depending on the simulation method and the number of generated matrices involved in the process.

Saaty (at Wharton) and Uppuluri (at Oak Ridge) simulated the experiment with 500 and 100 runs2 , respectively. Lane and Verdini13 (1989), Golden and Wang 36(1990), and Noble37 (1990) carried out 2500, 1000, and 5000 simulation runs. Forman8 (1990) also provided values for matrices of size 3 through 7 using examples from 17672 to 77487 matrices.

Tumala and Wan38 (1994) subsequently performed the experiment with samples ranging from 4600 to 470000, and they obtained the values shown in Table 4.4.

It shall be called the consistency index of a randomly generated reciprocal matrix from the scale 1 to 9 with reciprocals forced the *random index* (R.I).

At Oak Ridge National Laboratory, colleagues generated an average R.I for matrices of order 1-15 using a sample size of 100 (Alonso, J.A, 2006).

Table 4.4: RI(n) values from various authors.

	Oak Ridge	Wharton	Golden Wang	Lane, Verdini	Forman	Noble	Tumala, Wan	Aguaron et al	Alonso, Lamata
	100	500	1000	2500		500		100000	100000
3	0,382	0,58	0,5799	0,52	0,5233	0,49	0,5	0,525	0,5245
4	0,946	0,9	0,8921	0,87	0,886	0,82	0,834	0,882	0,8815
5	1,22	1,12	1,1159	1,1	1,1098	1,03	1,046	1,115	1,1086
6	1,032	1,24	1,2358	1,25	1,2539	1,16	1,178	1,252	1,2479
7	1,468	1,32	1,3322	1,34	1,3451	1,25	1,267	1,341	1,3417
8	1,402	1,41	1,3952	1,4		1,31	1,326	1,404	1,4056
9	1,35	1,45	1,4537	1,45		1,36	1,369	1,452	1,4499
10	1,476	1,49	1,4882	1,49		1,39	1,406	1,484	1,4854
11	1,576	1,51	1,5117			1,42	1,433	1,513	1,5141
12	1,476		1,5356	1,54		1,44	1,456	1,535	1,5365
13	1,564		1,5571			1,46	1,474	1,555	1,5551
14	1,568		1,5714	1,57		1,48	1,491	1,57	1,5713
15	1,586		1,5831			1,49	1,501	1,583	1,5838

The order of matrix (first row) and the average R.I (second row) determined as described is shown in Table 4.5

Table 4.5: Acceptable RI(n) values for this study.

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI(n)	0	0	0.58	0.90	1,12	1,24	1,32	1,41	1,45	1,49	1,51	1,48	1,56	1,57	1,59

The ratio of C.I to the average R.I for the same order matrix is called *Consistency Ratio* (C.R). The consistency ratio of 0,10 or less is considered acceptable. In this study, it will be used Table 4.5 values as R.I.It is well known that small changes in aij imply small changes in λ_{max}, with the difference between this and n being a good measure of consistency. Saaty has shown that if the referee is completely consistent then,

$$a_{ij} \cdot a_{jk} = a_{ik} \ (\forall\ i,j,k), \tag{4.8}$$

$$\lambda_{max} = n \tag{4.9}$$

and

$$CI = 0 \tag{4.10}$$

In this exceptional case, the two different matrices of judgments (A) and weights (W) are equal. However, it would be unrealistic to require these relations to hold in the general case. For instance, it is known that the number of totally consistent different matrices (using the Saaty scale) for n=3 is 13 or only 4 depending on whether the indifference in the relation of preference is accepted or not, for n=4 these values are 13 and 1, respectively, for n=5 is 14 and none, and so on. Otherwise, if the referee is not absolutely consistent then $\lambda_{max}> n$, and we need to measure this level of inconsistency. For this purpose, Saaty defined the consistency ratio (CR) as

$$CR = \frac{CI}{RI} \qquad (4.11)$$

where RI is the average value of CI for random matrices using the Saaty scale obtained by Forman and Saaty only accepts a matrix as a consistent one iff CR < 0.1.

(Alonso, J.A, 2006). With another word, the consistency ratio of 0,10 or less is considered acceptable. **(**Saaty, T.L **,** 1990). In this study, it will be used Table 4.5 values as R.I.

4.10 Calculation of Factor Index

The priority weight of impact factor should be calculated. F_1, F_2 ,….,F_n represents the set of impact factor in any hierarchy matrix.aij is a crisp value that is obtained with comparison of Fi and Fj . F_i and $F_j$comparison, it is shown in given matrix equation (4.12).

$$A = a_{ij} = \begin{pmatrix} 1 & a_{12} \dots\dots & a_{1n} \\ \frac{1}{a_{12}} & 1.\dots\dots. & a_{2n} \\ \vdots & & \\ \frac{1}{a_{1n}} & \frac{1}{a_{2n}} & 1 \end{pmatrix} \quad (i,j = 1,2,\dots\dots,n \quad) \qquad (4.12)$$

$$a_{ij} = 1, a_{ij} = \frac{1}{a_{ij}} \qquad (4.13)$$

The priority weight of A matrix can be calculated with Equation (4.14) by using the arithmetic mean method.

$$w_i = \frac{1}{n}\sum_{j=1}^{n}\frac{a_{ij}}{\sum_{k=1}^{n} a_{kj}} \qquad (i,j = 1,2,\ldots\ldots,n) \qquad (4.14)$$

w_i is the weight in their part of the F factor. If Fi factor ranks as t units in a different part, $w^{(i)}_{section}$ shows the upper hierarchy priority weight.

w'_i shows weight in hierarchy of F_i and it may calculate with equation (4.15).

$$w_i' = w_i \; * \; \prod_{i=1}^{t} w_{section}^{i} \qquad (4.15)$$

(4.6) equation or (4)th sub title of 4.7 article can be used to weight to the partitions of FI Hierarch. After it was recovered with the impact factors for priority weights, P* can be calculated with (4.14) equation.

FI* is total fuzzy score which is found by equation (4.16)

$$FI^* = \sum_{i=1}^{n} P_i^* \, x \, w_i' \qquad (i= 1,2,\ldots\ldots\ldots n) \qquad (4.16)$$

4.11 Fuzzy Logic

Fuzzy set theory is developed for solving problems in which descriptions of activities and observations are imprecise, vague, and uncertain. The term "fuzzy" refers to the situation in which there are no well-defined boundaries of the set of activities or observations to which the descriptions apply (Chen,S.J, Hwang C.L, 1992).

This notion of fuzziness exists almost everywhere in our daily life, such as the "class of red flowers," the "class of good kickers," the "class of expensive cars," or "numbers close to 10," etc. These classes of objects cannot be well represented by classical set theory. In classical set theory, an object is either in a set or not in a set. An object cannot partially belong to a set.

To cope with this difficulty, Zadeh [Zl] proposed the fuzzy set theory in 1965. A fuzzy set is a class of objects with a continuum of membership grades. A membership function, which assigns to each object a grade of membership, is associated with each fuzzy set.

Usually, the membership grades are in [0,1]. When the grade of membership for an object in a set is one, this object is absolutely in that set; when the grade of membership is zero, the object is absolutely not in that set. Borderline cases are assigned numbers between zero and one. Precise membership grades do not convey any absolute significance. They are context-dependent and can be subjectively assessed.

4.12 Basic of Fuzzy Sets

In this section we will review the definition of a fuzzy set as well as some of its basic concepts as they apply to later chapters.

4.12.1 Definition of a fuzzy set

Let U be a classical (or ordinary) set of objects, called the universe, whose generic elements are denoted by x. That is,

$$U = \{x\} \tag{4.17}$$

A fuzzy set A in U is characterized by a membership function $\mu_A(x)$ which associates with each element in U a real number in the interval [0,1]. The fuzzy set, A, is usually denoted by the set of pairs A $\{(x, \mu_A(x)\}, x \in U\}$.

For an ordinary set, A,

$$\mu_A(x) = \begin{cases} 1, & \text{iff } x \in A, \\ 0, & \text{iff } x \notin A \end{cases} \tag{4.18}$$

When U is a finite set $\{X_l \ldots , X_n\}$, the fuzzy set on U may also be represented as (Zadeh [Z4], Dubois and Prade [026]):

$$A = \sum_{i=1}^{n} {x_i}/{\mu_{A(xi)}} \tag{4.19}$$

When U is an infinite set, the fuzzy set may be represented as:

$$A = \int_{x}^{\cdot} x / \mu_{A(xi)} \qquad (4.20)$$

(Chen S.J, Hwang C.L, 1992)

4.13 Membership Function

The membership function $\mu_A(x)$describe the membership of elements x of the base set X in the fuzz set a whereby for $\mu_A(x)$ a large class of functions can be taken.
Reasonable functions are often piecewise linear functions, such as triangular or trapezoidal functions.
The grade of membership $\mu_A(x_0)$ of a membership function of $\mu_A(x)$ describes for the special elements $x = x_0$, to which grade it belongs to the fuzzy set A. This value is in the unit interval [0,1]. Of course, x_0 can simultaneously belong to another fuzzy set B such that $\mu_B(x_0)$ characterizes the grade of membership of x_0 to B. This case is shown in Figure 4.1

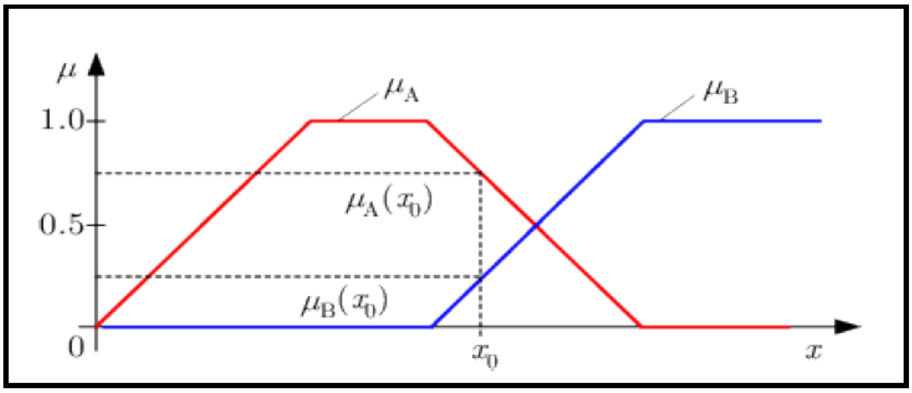


Figure 4.1: Membership grades of µA(x)and µB(x).

In the following, a set of important properties and characteristics of fuzzy sets will be described.

- Having two fuzzy sets A and B based on X, then both are equal if their membership functions are equal, ie.
  A-B $\longleftrightarrow \mu_A(x)$- $\mu_B(x)$, $x \in A$
- The universal set U is defined as $\mu_U(x)=1$, $x \in A$

- The hight of a fuzzy sets A is the largest membership grade obtained by any element in that set, i.e

- $$hgt(A)_{x \in X} = sup\mu_A(x) \quad (4.21)$$

- A fuzzy set *A* is called normal when $hgt(A) = 1$ and it is Sub normal when $hgt(A) < 1$
- The *support* of a fuzzy set *A* is the crisp set that contains all the elements of *X* that have nonzero membership grades in *A*,i,e

$$supp\ (A) = \{ x \in X \mid \mu_A(x) > 0 \} \quad (4.22)$$

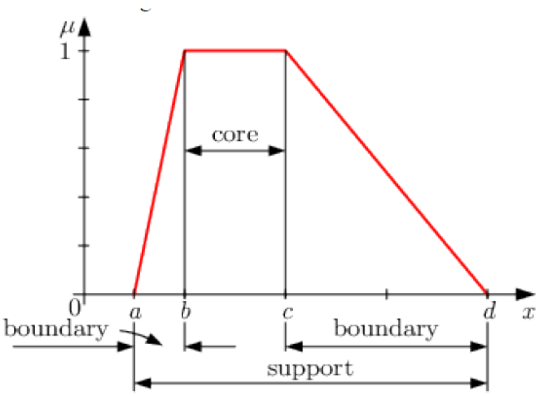


Figure 4.2: Some characteristic of membership function.

- The core of a normal fuzzy set *A* is the crisp set that contains all the elements of *X* that have the membership grades of one in *A*, i.e.
$$core\ (A) = \{ x \in X \mid \mu_A(x) = 1 \} \quad (4.23)$$
- The boundary is the crisp set that contains all the elements of X that have the membership grades of $0 < \mu_A(x) < 1$ in A, i.e.
$$bnd(A) = \{ x \in X \mid 0 < \mu_A(x) < 1 \} \quad (4.24)$$
- Having two fuzzy sets *A* and *B* based on *X*, then both are *similar* if $core(A) = core(B)$ $supp(A) = supp(B)$ and
- If the support of a normal fuzzy set consist of a single element x_0 of *X*, which has the property $supp\ (A) = core(A) = \{x_0\}$,
- This set is called a singleton

The type of representation of membership function depends on the base set. If this set consist of many values or is the base set a continuum, then *a parametric representation* is appropriate. For that function are used that can be adapted by changing the parameters. Piecewise linear membership function are preferred, because of their simplicity and efficiency with respect to computability. Mostly these are trapezoidal or triangular functions, which are defined by four and three parameters, respectively. Figure 4.2 shows a trapezoidal function formally described by

$$\mu_A(x, a, b, c, d) = \begin{cases} 0, & x < a, x > d \\ \frac{x-a}{b-a} & a \leq x \leq b \\ 1, & b < x < c \\ \frac{d-x}{d-c} & c \leq x \leq d \end{cases} \quad (4.25)$$

Which migrates for the case $b = c$ into a triangular membership function.

4.14 Elementary Operator for Fuzzy Sets

The basic connective operations in classical set theory are those of intersection, union and complement. These operations on characteristic functions can be generalized to fuzzy sets in more than one way. However, one particular generalization, which results in operations that are usually referred to us as standard fuzzy set operations, has a special significance in fuzzy set theory. In the following, only the Standard operations are introduced. The following operations can be defined:

- The fuzzy *intersection* operator ∩ (fuzzy AND connective) applied to two fuzzy sets A and B with the membership functions $\mu_A(x)$ and $\mu_B(x)$ is

$$\mu_{A \cap B}(x) = min\{\mu_A(x), \mu_B(x)\}, \ x \in \quad (4.26)$$

The *fuzzy union* operator U (fuzzy OR connective) applied to two fuzzy set and *B* with membership function

$$\mu_A U_B(x) = max \{\mu_A(x), \mu_B(x)\}, \ x \in X \tag{4.27}$$

- The *fuzzy complement* (fuzzy NOT operation) applied to the fuzzy set A with the membership function

$$\mu_A(x) is \ \overline{\mu A(x)} = 1 - \mu_A(x) \ x \in X \tag{4.28}$$

Whilst the operation according to Eqs. (4.26) and (4.27) are based on min/max operations; the complement is an algebraic one. Union and intersection can also be defined in an algebraic manner but giving different results as

- The *fuzzy intersection* operator ∩ (fuzzy AND connective) can be represented as the algebraic product of two fuzzy sets A and B, which is defined as the multiplication of their membership function: $\mu_A \cap_B(x) = \mu_A(x), \mu_B(x), \ x \in X$
- The *fuzzy union* operator U (fuzzy OR connective) can be represented as the algebraic sum of two fuzzy sets A and B, which is defined as:

$$\mu_A U_B(x) = \mu_A(x) + \mu_B(x) - \mu_A(x)\, \mu_B(x), \ x \in X \tag{4.29}$$

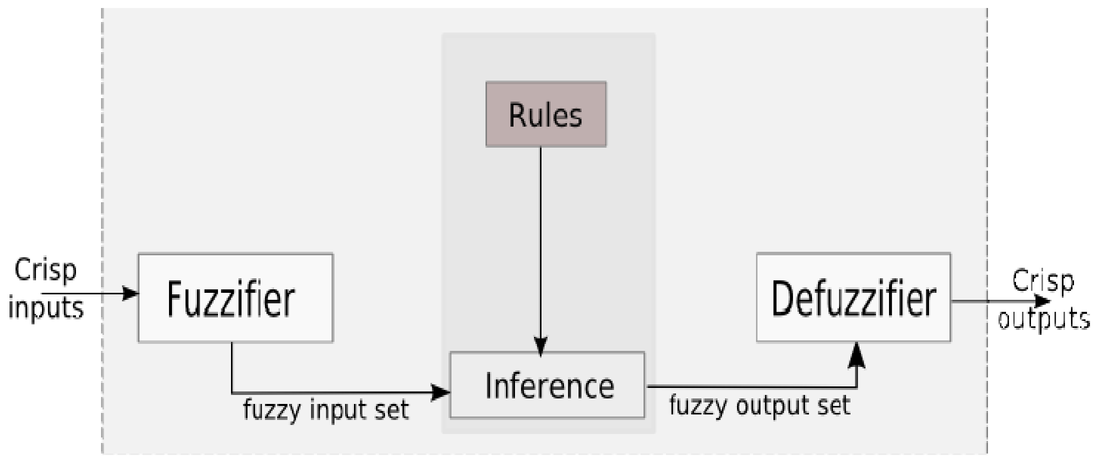


Figure 4.3: A Fuzzy Logic System

The process of fuzzy logic is explained in Algorithm 4.3: Firstly, a crisp set of input data are gathered and converted to a fuzzy set using fuzzy linguistic variables, fuzzy linguistic terms and membership functions.

This step is known as fuzzification. Afterwards, an inference is made based on a set of rules. Lastly, the resulting fuzzy output is mapped to a crisp output using the membership functions, in the defuzzification step (Mendel,J, 1995)

4.15 Defuzzification

Calculate the Standard trapezoidal fuzzified number (STFN) value

$$a_{ij} = \frac{(a_{ij} + b_{ij} + c_{ij} + d_{ij})}{4} \quad (4.30)$$

As explained equation (4.13), a_{ij} value can be states as $a_{ij} = 1$ and $a_{ij} = 1/a_{ij}$

As a result, all fuzzied score in the range of number between 0 and 9 is transformed into a final crisp score.

Below it is compared the following five defuzzification methods Centroid of area Z_{COG} Bisector of area Z_{BOA} Mean of maximum Z_{MOM} Smallest of maximum Z_{SOM} Largest of maximum Z_{LOM}

In this study, Centroid principle or Center of Gravity calculation is preferred.

4.16 Centroid principle or Center of Gravity

This method is also known as center of gravity or center of area defuzzification. This technique was developed by Sugeno in 1985. This is the most commonly used technique. The only disadvantage of this method is that it is computationally difficult for complex membership functions. The centroid defuzzification technique can be expressed as

$$Z_{COG} = \frac{\int_Z^{\cdot} \mu A\,(Z) x\ z\ x\ dz}{\int_Z^{\cdot} \mu A\,(Z)\ x\ dz} \quad (4.31)$$

Where z_{COG} is the crisp output, $\mu_A(z)$ is the aggregated membership function and z is the output variable.

4.17 Reduction of the Impact Magnitude

Z_{COG} value which obtained with 4.26 formulas is a calculated Impact value which comes from the membership of BoP and EEI which explained in chapter 5.

Acceptable IM value is projected to be equal value to 3 values or below a value of 3 values.

This assumption is selected to convergence to negligible level of IM values which is shown in Table 5.1

Therefore it is expected that IM_C value is reduced up to equal or below 3 values

By making analogy with the values of Table 5.1, criteria such as rejection, conditional acceptance or directly acceptance are obtained.

The acceptance criteria is scaled with the same logic as shown in Table 4.6

Table 4.6: Acceptance Scale of IMC.

Criteria of Acceptance of Project or activity of facility	Acceptable IM Value
Project and its IM_c acceptable	$IM \leq 3.0$
Project and its IM_c can be tolerated but precaution must be taken	$3.0 \leq IM \leq 5.0$
Project cannot be acceptable and its IM_c must be mitigated	$5.0 \leq IM \leq 6.0$
Project is rejected and its IM_c must be mitigated largely	$IM \geq 6.0$

$$Z_{COG} = IM_C \tag{4.32}$$

$$IM_A \leq 3.0 \tag{4.33}$$

IM_{EMS} is the total priority weights of selected factors of EEI the combination with ISO 9001, ISO 14001, OHSAS 18001 and Remediation.

The normalized IM_{EMS} scale is as 4.34 formulation.

The experiences have shown that the success of EMS systems' applications (such as ISO 9001, ISO 14001, OHSAS 18001 and Remadiation) may be anticipated about 70% in practice. Its details will be explained in section 5

In order to remain in confidence interval, the performance indicator is considered as 70% for local facilities in this study. It is shown 4.35 formulas

$$IM_{EMSN} = \frac{1}{n} \; x \; 10 \; x \sum_{i=1}^{n} w_{ij} \qquad (i = 1,2,\ldots\ldots\ldots\ldots,n) \qquad (4.34)$$

IM_{EMSN} = Normalized EMS values.

$IM_{EMS} = 0,7 * IM_{EMSN}$ That is;

$$IM_{EMSN} = 0,70 \; x \; \frac{1}{n} \; x \; 10 \; x \sum_{i=1}^{n} w_{ij} \qquad (i = 1,2,\ldots\ldots\ldots,n) \qquad (4.35)$$

IM_{EMS} values are shown on Figure 6.20.

IM_R (Residual IM) means that IM_A is a subtracted value from IM_C and it is a value which is closest value to IM_{EMS}

$$IM_R = IM_C - IM_A \qquad (4.36)$$

$$IM_A \leq IM_C - IM_{EMS} \qquad (4.37)$$

5. THE PROPOSED IMPACT ASSESSMENT APPROACH FOR THE FACILITY WHICH IS EFFECTED THE ENVIRONMENTAL VALUE

5.1 Description of Proposed Approach

The impact of human activities has been briefly mentioned in introduction of Chapter 1. During the research of Literature, it is decided to use Fuzzy Logic model, since plenty of factors and information missing, uncertain and/or vague. Therefore the Fuzzy Logic model is chosen as the most appropriate one for the sake of this study.

The evaluated data with Fuzzy Logic is converted to crisp value after running a pair wise comparison.

At the pair wise comparison which is made with AHP method, the primary effect of impact of Environmental Resources is found.

The execution of AHP method for environmental resources with the pair wise comparison is made with the primary effects of the presence of priority weights (vectors) or eigenvectors. These values have been assessed as a realistic "effect size".

EIA is represented by linguistic factors used in variable.

These factors have flexed beyond the limits of fuzzy membership functions.

In this way the crisp values are obtained safely.

At this stage, the experts have been estimated to the value of factors by using fuzzy numbers.

Thus, the environmental impact magnitude as the views of experts about complex environmental relations has been able to reflect on the outcome of the factors.

The complex structure of Environmental Impact Assessment, which is affected by multiple factors, is associated with qualitative impact magnitude of human mind.

A model to calculate the risk of delay at the construction projects is developed by Zeng et all (2007).

This Fuzzy AHP management based model, in terms of the implementation of the environmental risk assessment of the problem has been found appropriate for the reasons described in the preceding paragraph.

The model used in this study, is created an approach considering the effects (EIA) on the environment of the facility.

Thus, at the preparation step of the model, the effects on environment of point source which produced pollutions are assessed and formed an approach.

Besides the multiple expert opinions, it is preferred to reach a holistic and united assessment by forming the impact assessment group as a combination of different views of the different disciplines.

For an environmental impact assessment, different views of various disciplines from several factors are needed. Although having different opinions of experts, these factors may create difficulties in practice. Combining the opinions of experts from various disciplines may trigger each other and this may allows a more accurate assessment.

At the assessment of Factor Index, linguistic variables are considered to be more appropriate to use in the environmental impact assessment.

Environmental impact assessment studies of the effect size represents that factors that contribute to the index, it was stated in the environmental impact assessment section.

These components which were used for fuzzy numbers (triangular and trapezoidal fuzzy number standard (STFN), are also used in this study. Instructions on scoring factors index (FI) and environmental impact index (EI) has been adapted into consideration. The intention of using hierarchy at the index account is to create an environmental impact assessment.

5.2 Steps of the Proposed Approach

The Point source can also be viewed as any facility, with having benefits and going to produce an estimated damage to environment. The mentioned benefit and estimated damage to environment can evaluate with pair wise comparison by using both AHP and fuzzy logic model.

The assessments can be done by an evaluation group. The experts and experienced people from different disciplines related to issue should be included in this group. This expert team should compose of people who are able to recognize hazards of point source pollution that is a facility. In addition this, environmental characteristics should be evaluated by expert by considering the inputs and outputs of production.

Expert who may/should be in this specialist staff;

- Chemists and biologists who can consider the ecosystem properties
- Water scientists
- Agricultural engineers
- Meteorologists
- City scientists
- Engineers in the industry
- Environmental engineers
- Employees who worked in the industry for a long time
- The local groups that know the region very well.

Evaluation group reviews the relevant information and data, and the effects associated with them. They monitor the eligibility criteria relating to the environmental impact of their work. If necessary, they repeat the evaluation criteria for creating some new domains or revise it.

In this section, the matrix of any facility and environmental values that affect the facility considered as a point source that may pollute the environment will describe in detail. The flow chart of this case is shown in Figure 5.1(Zeng, J.,et al, 2007)

5.2.1 Preliminary step

When assessing the impact of environmental pollutants of point sources, environmental values and factors should consider.

As mentioned at the beginning of this chapter, in order to measure these factors and assess them in a systematic way, a hierarchy has established using the AHP technique.

To be able to evaluate the factors in this hierarchy and to have the impact magnitude (IM) within the recommended approach, it is required to have knowledge about the components of this system.

A point source, which may cause an environmental pollution considering the fact that a production process lived and thought that it was a system, the aim of this approach will be to determine the value of this systematic impact on the environment.

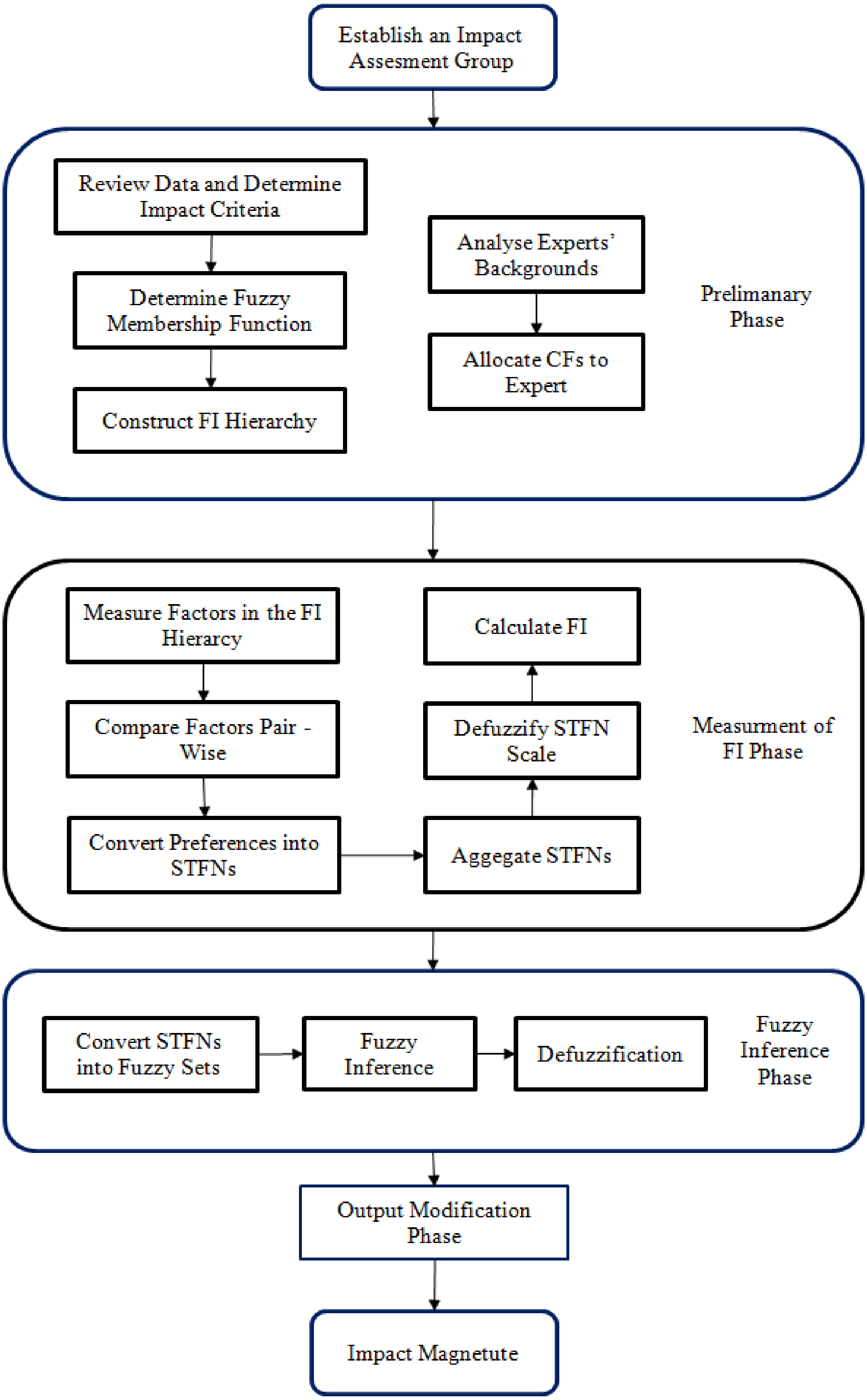


Figure 5.1: Flow chart of Fuzzy reasoning IM assessment model.

To find the environmental Impact Magnitude, one needs to determine the environmental characteristics of the point source and its producing process correctly. The model described in this study, can respond to various pollution characterization. It is possible to gather information and to obtain an observation about facility, which causes pollution and the eco system features of its environment. However, before scoring, analysis studies should be based on facility characteristics and features of existing eco-system. This is crucial for obtaining accurate results.

5.2.2 Creating FI and impact criteria

To find the value of Impact Magnitude (IM), the score of factor indices (FI) should be estimated and obtained for both facility and its environmental impact for project.

To express FI value, five linguistic constituent will be used. FI defined respectively Very high (VH), High (H), Medium (M), Low (L), and Very Low (VL) in terms of variables. IM divided into four classes;

Negligible (N), Minor (Mi), Major (Ma) and Critical(C) respectively

A description of each classification is shown in Table 5.1. FI, with triangular fuzzy numbers, Impact Magnitude (IM) is expressed with the trapezoid fuzzy numbers.

5.2.3 The measurement of the factors in the FI hierarchy

The purpose of creating the Factor Index is to determine the susceptibility or predisposition of a dangerous incident. Gentile et al., (2003). FI also clarifies the relationship between the susceptibility and predisposition of an event (Topuz,E, et al, 2010). For this purpose, it must be establisheda hierarchy of factors, which measure the impact predisposition by using the AHP method. The scored factors, which involve in this hierarchy, generate FI value. The purpose of preparing the FI hierarchy is to detail the impact factor sufficiently and evaluate FI 's effectively. Thus, a hierarchy is created within factors, which are determined by the FI analysis. The same issue is applicable also for sub-factors of hierarchy. An example of a model is shown in Figure 5.2 (Zeng et al., 2007). First Level shows the analysis result of FI. In the second Level, FI is divided into N sub-factors, which are effected levels. Then all the sub-factors are divided into sub-factors to identify all cases of possible adverse effects.

Table 5.1: Severity scale of FI and IM Component.

FI Catagories	Impact Degree	FI Fuzzy numbers	Explanation
Very High	VH	(7.5; 7.5;10.0)	Very high contribution to Environmental Impact
High	H	(5.0; 7.5;10.0)	Significant contribution to Environmental Impact
Medium	M	(2.5; 5.0; 7.5)	No critical contribution to Environmental Impact
Low	L	(0.0;2.5;5.0)	No contribution to Environmental Impact
Very Low	VL	(0.0;0.0;2.5)	Exactly no contribution to Environmental Impact
Impact Magnitude (IM)		IM numbers	
Negligible	VL	(0.0;0.0;1.0;3.0)	Impact can be acceptable
Unimportant	UI	(1.0;3.0;4.0;6.0)	Impact can betolarated but precaution must be taken
Important	I	(4.0;6.0;7.0;9.0)	Impact effect must be mitigated
Critical	C	(7.0;9.0;10.0;10.0)	Impact cannot be accepted.

FI analysis starting from 3rd and 4th level and later returning to the second level and FI analysis taken place at the first level which is also final level. Experts evaluate each factor on the last level of the FI hierarchy using a common scale. In order to determine the priorities of the weight of impact factor, a modified fuzzy AHP is used.

FI is found by combining priority weights, which consist of the impact factor, and given points.

Experts evaluate the impact factors in the lower levels of the hierarchy FI, according to knowledge and experience.

Experts may notify ideas with a certain score, a numerical range, the linguistic variables or fuzzy numbers.

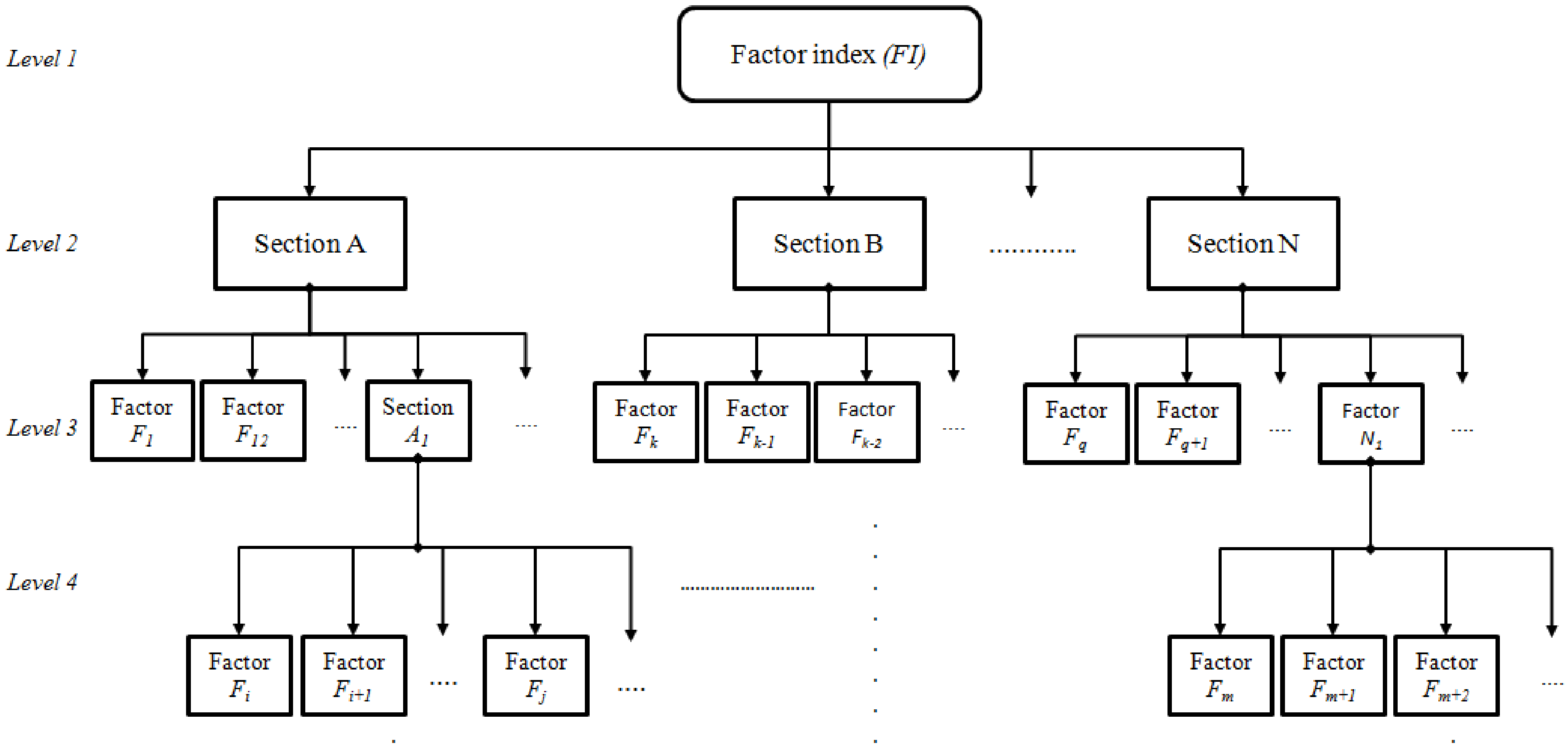


Figure 5.2: A General Structure of FI hierarchy.

If experts can reached sufficient knowledge about the impact factor and impact factors and can measure in numbers, they might often choose to give a certain point or a numerical range. If impact factor cannot be measured numerically or contains uncertainties, it may be evaluated with a variable or a linguistic or fuzzy numbers. Figure 5.3 represent a framework for the proposed model within multiple issues and various criteria simultaneously. When applying to the model to “the Environmental Impact Analysis for any Facilities” based on “the Benefit of Project”(as Benefit) and Estimating of Environmental Impact (as Cost) hierarchies, a decision maker assesses first the relative importance of issues under benefit and cost hierarchy. The analysis would be followed by a decision as to whether or not to the integrated system is needed for the facility (Saaty, T.L , Peniwati K 2012).

This is executed by comparing the two alternatives – to fully or partly integrated system or not to integrated system with each other under a criterion. The integrated system consists of ISO 9001, ISO 14001, OHSAS 18001 and in addition a treatment system which specified according to work content. The proposed approach, in this study is to find out a impacts magnitude which comes from hierarchical factors and to develop a methods reducing Impact Magnitude. General concept of model is shown in Figure 5.3 as a sketch. The second level of the hierarchy is composed of the Benefit of Project and Estimating of Environmental Impact, which is thought to affect EIA. The Impact characterizations of two factors on this level are referred to with their own names at this level. These are shown in Figure 5.4. At the model, BoP and EEI shall be considered as equal level and equiponderant. Hence the characterization of BoP and EEI shall be also considered as different and independent factors. The IM of EIA will be proposed the intersection components of BoP and EEI. It is shown in Figure 5.5.

The purpose of the proposed approach in this model, which is “any activity BoP and EEI”, was evaluated in the first level.

The second level of the BoP’s hierarchy is the main axis of the first level affecting work directly. This condition is characterized by benefit and cost in the context. These are shown in Figure 5.5.

In this section, it is pointed out that economic and environmental issues are two important but not absolute conditions for a sustainable development.

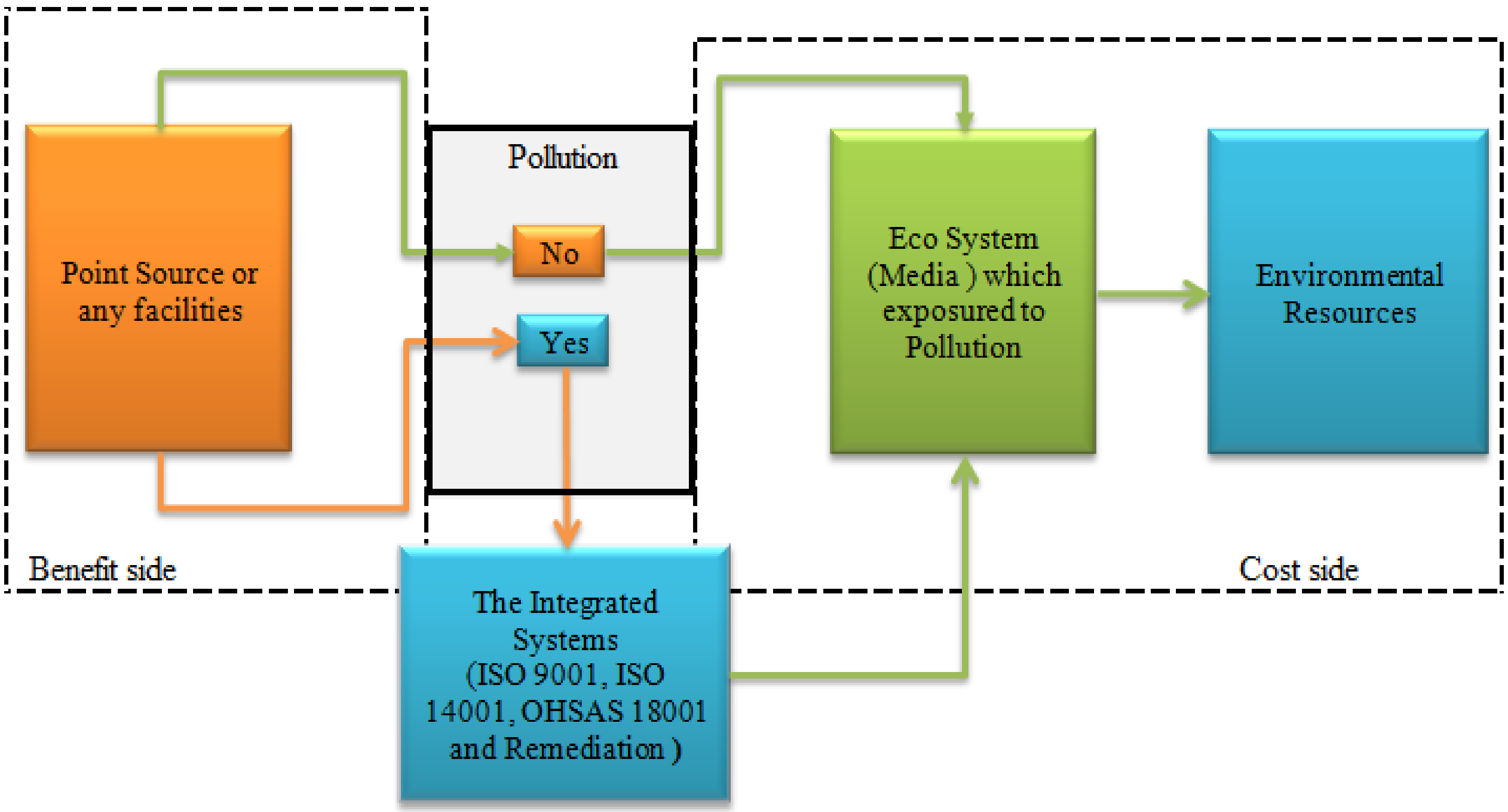


Figure 5.3: Flow chart of Model.

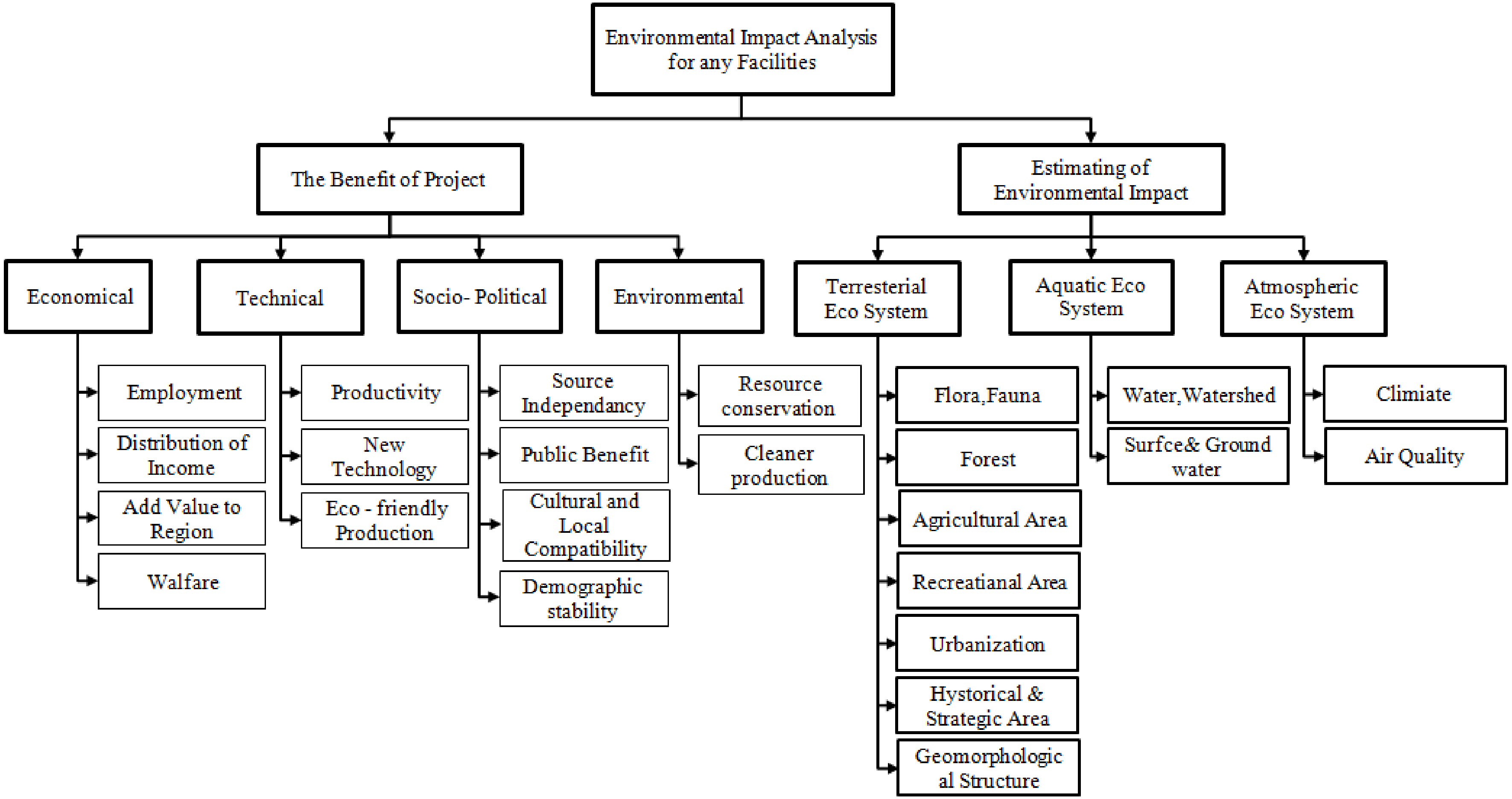
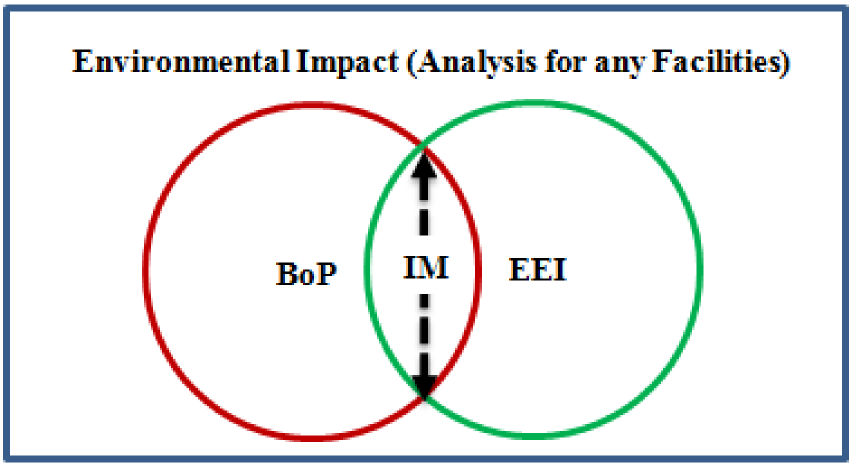


Figure 5.4: The hierarchical structure of Model.



The **Figure 5.5:** intersection of BoP and EEI.

Third important issue is Socio Politic issue because of it is constitutive. The social dimension has also to be considering because humans are integral parts of ecosystems.

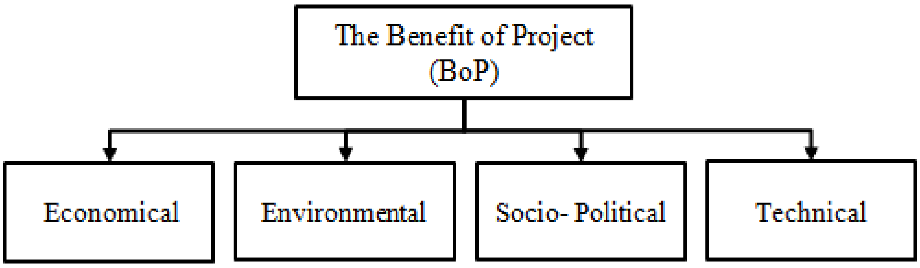


Figure 5.6:1st and 2nd levels level of BoP.

Humans and ecosphere are two important partners in ensuring a good quality of life. It follows that protecting natural resources, their composition, structure, and functions, is protecting humans and life on earth (U.S FAO).

Forth leg of BoP is a Technical factor. Technical factor mainly includes Technology. Technology may appear to be expensive at the implementation stage, but may save money in the long-term, particularly where a low-cost technological solution can be found to replace a high-cost, low-tech application.

Decision makers need to weigh the costs and savings associated with introducing technology. These include the initial costs of purchasing hardware and software, the hiring of consultants to set up the new system and ongoing maintenance and management costs etc.

The third level of the hierarchy, which is typical for this kind of study, is discussed within the frame of Economic, Technical, Socio-Politic and Environment. These sub-factors are likely to make a positive impact in any activity on the model and they are at the first level of the hierarchy of the Benefit of the Project. These are shown in Figure 5.6.

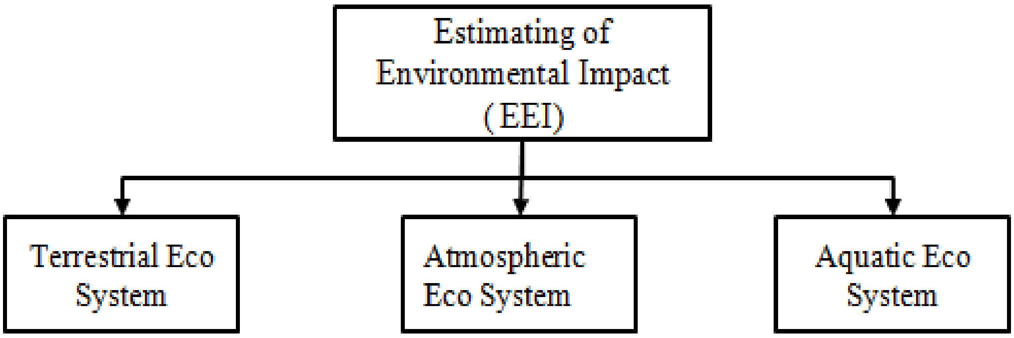


Figure 5.7: 1st and 2nd levels level of EEI.

Estimating of Environmental Impact has three factors for its second hierarchy level. It has been characterized by the factors of Terrestrial, Atmospheric and Aquatic Eco Systems. It is shown in Figure 5.7.

The regular activity or discrete emission or solid/liquid wastes of any facility (or point source) may have an affect the three factors.

This hypothesis (factors) also represents the cost side of the benefit-cost dilemma. At the same time, this also is the first level of the benefit factor of the hypothesis. It was shown in Figure 5.6.

Estimating of Environmental Impact Level and Benefit of Project Level is shown in the second level.

This situation makes sense in terms of suitability of stream that is discussed in the Model. Economical sub factor of BoP is second factor of BoP and it has four different factors base on benefit of model.

The relationship between economic growth, social progress such as distribution of income, employment welfare etc and regional wealth represents a key to development. In this context, Economical factor is divided into four main factors in this study.

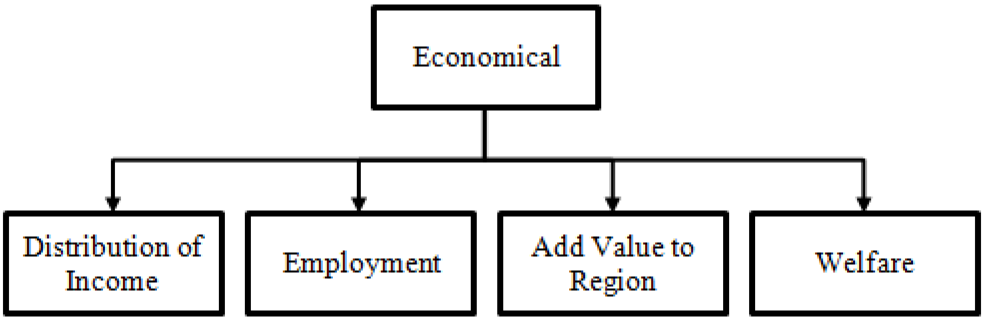


Figure 5.8: 2nd level of BoP and 3rd levels of Economic factor.

Economic factor is a positive value in the model, which is sub factor of the Benefit of the Project. The investment and income inequality are inversely related. The investment that addresses societal needs is a primary engine of growth. As known, Income equality, by fueling social content and belongingness, increases socio-politic stability. It is also valid for Employment, Add Value to Region and welfare. These are shown in Figure 5.8

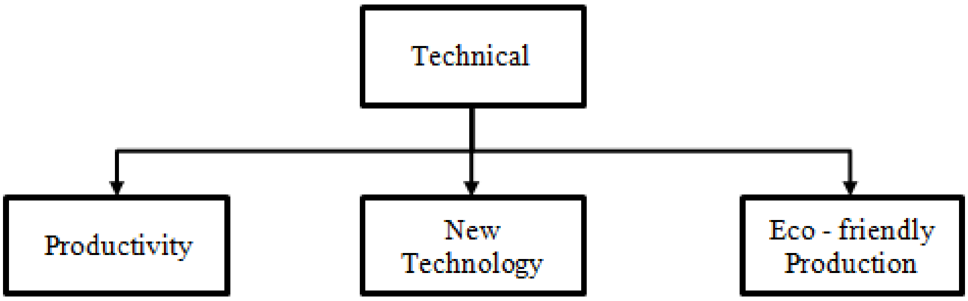


Figure 5.9: 2nd level of BoP and 3rd levels of Technical factor.

Productivity is one of the most important indicators of long-term economic prospects. Improving productivity is the key to making possible permanent increases in the standard of living. The increased concern about environmental factors already plays an important role when new technologies are considered. Thus, Progress in technology is the only source of permanent increases in productivity; on the other hand, a number of transient factors (such as ISO 9001-14001, OHSAS 18001 and treatment) can affect the productivity. Every new technology improve the new or existing system For this reason, new technologies have an important place in the technical hierarchy. Of course, enterpriser should do cost-benefit optimisation.

Another factor of Technical factor is Eco-friendly production. It can help preserve the environment through reduction of hazardous, harmful and destructive waste and energy efficiency.

Eco-friendly production mostly includes following:

- Energy efficiency
- Renewable energy
- Low impact manufacturing
- Reduction of polluting substance
- Reduction of greenhouse gas emissions
- Recycled, recyclable and biodegradable content
- Low impact to environment as product or by-product

A technical factor, which is sub factor of the Benefit of the Project, is one of the positive values in the model.

The sub factors of Technical factor are shown in Figure 5.9 as hierarchy graph.

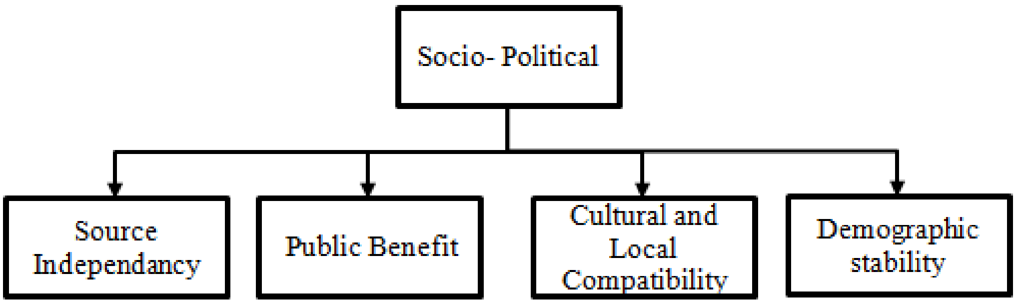


Figure 5.10: 2nd level of BoP and 3rd levels of Socio Political factor.

An ideal source supply has four components: reserve, predictability, generation and delivery.

Another important content on sources is cheapness, clean and minimum (as impact) damage upon the environment.

General public benefit is defined as a “material positive impact on society and the environment, taken as a whole, as assessed against a third-party. The Model Legislation explicitly states that “the creation of a general public benefit is in the best interests of the benefit corporation.” This serves to protect against the presumption that the financial interests of the corporation take precedence over the general public benefit purpose, which maximizes the benefit corporation's flexibility in corporate decision-making standard, from the business and operations of a benefit corporation."

A growing body of research shows that there are at least two distinct types of corporate cultures: individualistic and collectivistic.

Collectivistic companies encourage loyalty to the group and a willingness to make personal sacrifices to advance the greater good. Conversely, individualistic organizations tend to concentrate on costs and benefits, but highly value independent thinking. This statement of Human resources consulting is mainly valid for environmental approach on cultural and local compatibility that is a sub factor of socio politics.

The demographic instability is defined as pressures on the population such as disease and natural disasters that make it difficult for the government to protect its citizens or demonstrate lack of capacity or will. On the other hand, demographic stability may close to cleanness of the environment.

Socio-Politic factor is a positive value in the model that is a sub factor of the Benefit of the Project.

Socio-Politic factor which is 3rd level of hierarchy consists of the source Independency, Public Benefit, Cultural and Local Compatibility and Demographic stability.

The sub-factors of Socio-Political factor are shown in Figure 5.10 as a hierarchy graph.

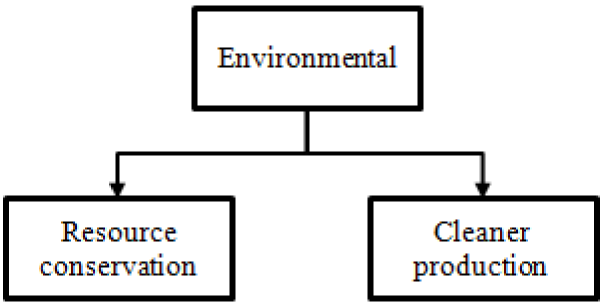


Figure 5.11: 2nd level of BoP and 3rd levels of Environmental factor.

Conservation of natural resources which is used by humanity may be through the wise use of the Earth's resources.

The term conservation came into use in the late 19th cent. and referred to the management, mainly for economic reasons, of such valuable natural resources as timber, fish, game, topsoil, pastureland, and minerals, and also to the preservation of forests (see forestry), wildlife (see wildlife refuge), parkland, wilderness, and watershed areas. In recent years the science of ecology has clarified the workings of the biosphere; i.e., the complex interrelationships among humans, other animals, plants, and the physical environment. At the same time burgeoning population and industry and the ensuing pollution have demonstrated how easily delicately balanced ecological relationships can be disrupted (see air pollution; water pollution; solid waste). The Resource Conservation and Recovery Act (RCRA) give EPA the authority to control hazardous waste from the "cradle-to-grave." This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous solid wastes. The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances (U.S EPA, 2015). The United Nations Environment Program developed in 1991 the following Cleaner Production (CP) definition that is still commonly used:

"CP is the continuous application of an integrated preventative environmental strategy to processes, products and services to increase efficiency and reduce risks to humans and the environment". Several complementary CP techniques or practices are possible, ranging from low or even no cost solutions to high investment, advanced clean technologies. A common distinction for CP implementation in developing countries is:

- Good Housekeeping: appropriate provisions to prevent leaks and spills and to achieve proper, standardized operation and maintenance procedures and practices;
- Input Material Change: replacement of hazardous or non-renewable inputs by less hazardous or renewable materials or by materials with a longer service life-time;
- Better Process Control: modification of the working procedures, machine instructions and process record keeping for operating the processes at higher efficiency and lower rates of waste and emission generation;

- Equipment Modification: modification of the production equipment so as to run the processes at higher efficiency and lower rates of waste and emission generation;
- Technology Change: replacement of the technology, processing sequence and/or synthesis pathway in order to minimize the rates of waste and emission generation during production;
- On-Site Recovery/Reuse: reuse of the wasted materials in the same process or for another useful application within the company;
- Production of Useful By-Products: transformation of previously discarded wastes into materials that can be reused or recycled for another application outside the company; and
- Product Modification: modification of product characteristics in order to minimize the environmental impacts of the product during or after its use (disposal) or to minimize the environmental impacts of its production (U.S UNIDO, 2016).

All those item, which indicated above, are in a very close relationship with the correct application of ISO 9001-14001 OHSAS 18001 and treatment in facility.

Environmental factor is a positive value in the model, which is a sub factor of the Benefit of the Project. Environmental factor which is on the 3rd level of hierarchy consists of the resource Conservation and Cleaner Production. The sub factors of Environmental factor are shown in Figure 5.11 as hierarchy graph. There are plenty of different ecosystems' classifications all over the world. In this study, terrestrial ecosystems are considered as shown Figure 5.12. By doing so, it is possible to gain an understanding of the living and non-living factors that composed of these dynamic ecosystems. An ecosystem is a collection of communities of both living and non-living things that are interrelated. While many ecosystems exist on land and in the waters of the world, terrestrial ecosystems are those that are found only on land. In order to understand easily of hierarchies in this study, we distinguished aquatic eco system from Terrestrial Eco System. Thus, on hierarchies, the evaluation of more independent elements is preferred. In this case, Atmospheric eco system hierarchy which have.climate and air quality factors are also valid.

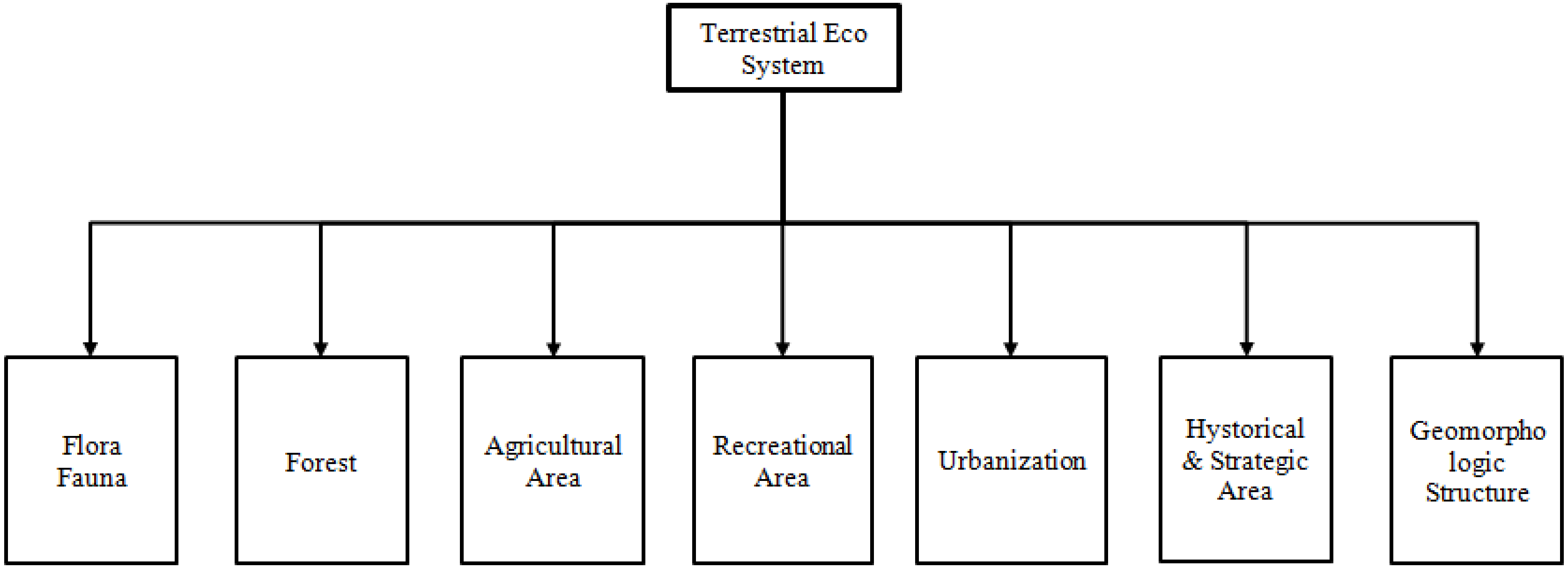


Figure 5.12: 2nd level of EEI and 3rd levels of Terrestrial Eco factor.

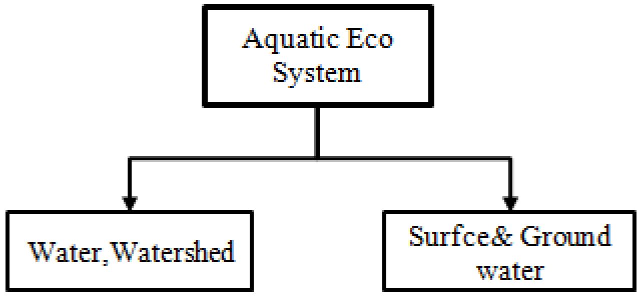


Figure 5.13: 2nd level of EEI and 3rd levels of Aquatic Eco factor.

The Aquatic Eco System consists of two distinct sub factors. It is shown in Figure 5.13. They are water, watershed and Surface Groundwater respectively. Aquatic Eco system factor is a very important concept for environmental decision making in meso level, serving as a policy objective and sustainability of water sources (Dimakis A.A, ,Arampatzis G., Assimacopoulos D, 2016).

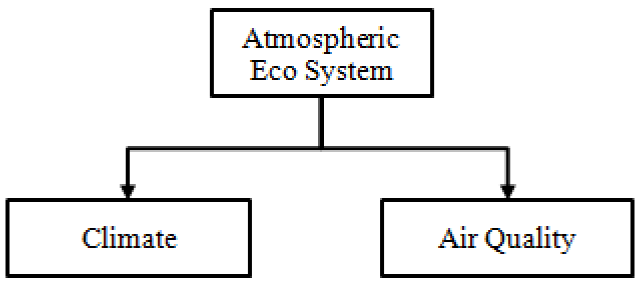


Figure 5.14: 2nd level of EEI and 3rd levels of Atmospheric Eco factor.

The factor of Atmospheric Eco system has two sub factors. It is shown in Figure 5.14. One of them is Climate and the others is Air Quality. The climate plays important roles in determining factor of air quality over multi variety scales in time and space, owing to the fact that emissions, transport, dilution, chemical transformation, and eventual deposition of air pollutants all can be influenced by meteorological variables such as temperature, humidity, wind speed and direction, and mixing height. In addition, other air contaminants of relevance to human health, including smoke from wildfires and airborne pollens and molds, may be influenced by climate change. In this model, the focus is on their effect of Impact to Atmospheric Eco System. The small but growing literature focusing on climate impacts on air quality (Patrick L. Kinney P.L,2008).

6. APPLICATION

In this study, the impact of human activities was briefly mentioned in introduction of Chapter 1 and the approach of Impact assessment was explained in Chapter 5 detail**.**

In this chapter, Benefit of Project (BoP) and Estimate Environmental Impact(EEI) of facility which already exists or which is in project stage will be compared to its possible potential benefit and harm to the environment.

In this comparison, applications of the combination are as following;

- The economic and social benefits of the project to the environment is large but less harmful to the environment to be represented as L-BoP / S-EEI)
- The economic and social benefits of the project to the environment is less but great damage to the environment to be represented as S-BoP / L-EEI)
- The economic and social benefits of the project to the environment is large and also great damage to the environment to be represented as L-BoP / L-EEI)
- The economic and social benefits of the project to the environment is little damage are less and negligible damage to the environment to be represented as S-BoP / S-EEI)

The fourth combination should be considered to be the most important and biggest potential impact that will be able to affect the environment. These are the positive and negative effects should be highly emphasized.

Depending on the evaluation of the above-mentioned combinations, "Impact Magnitude (IM)" is obtained. After obtaining IM with one of the combinations which is stated above, solutions are found to reduce to IM and to minimize the damage of facility to the environment.

This solution is able to achieve a reduction of the negative impact of IM score which is taken place by "Estimating of Environmental Impact" as described in Chapter 5. The primary purpose is to reduce IM values of the hierarchy of EEI. In order to achieve this, a matrix is composed with each factor of EEI Hierarchy and EMS system which are consist of ISO 9001, ISO 14001, OHSAS 18001and Remediation. The IM is reduced due to the combination of ISO 9001, ISO 14001, OHSAS 18001 and Remediation which has created positive impact. In this way, the decision-makers may be informed for positive impact score which comes from each combination of each one of ISO 9001, ISO 14001, OHSAS 18001 and Remediation. The results obtained with approaches are evaluated in order to assess how to give direction to the existing or new established facility within EMS.

6.1 FI Measurement Step

fter the preparation part, which was mentioned in chapter 5 as shown in Figure 5.2 with a flow diagram the FI measurement phase comes. All scores of FI (Factor Index) were obtained in the preliminary step. The phase corresponding to the linguistic variables used in FI measurement was shown in Table 5.1 and explained in 5.2.2 Creating Fi and Impact Criteria section. The measurement of the factors in the FI hierarchy was explained in section 5.2.3. The basis of this information, priority weights of the lower level of the factors of the hierarchical structure which are described in the relevant section will be presented separately. As stated in the hierarchical structure for the Benefit of the Project (BoP) and the Estimating Environmental Impact (EEI), the impact ofcharacteristics and sizeof FI values will be calculated separately due to their different values.

6.1.1 Evaluation of the benefit of project

All assessments in this section base on the related to the combination of the application “L-BoP / L-EEI” which is described in 6.Application
The remaining L-BoP / S-EEI and S-BoP / L-EEI applications are presented as an annex to this study.

First, this section starts with the assessment of sub-factors of the Benefit of Project hierarchy. The corresponding values are shown in Table 6.1.

Table 6.1: Sub Factors and Values of the Benefit of Project.

Key Factors	Score		STFN[3]			
Distribution of Income (DoI)	7	8	7	7	8	8
Employment (Emp)	8	9	8	8	9	9
Add Value to Region (AVtR)	7	8	7	7	8	8
Welfare (W)	7	8	7	7	8	8
Productivity (P)	7	8	7	7	8	8
New Technology (NT)	5	7	5	5	7	7
Eco Friendly Production (EFP)	7	9	7	7	9	9
Source Independency (SI)	7	9	7	7	9	9
Public Benefit (PB)	6	7	6	6	7	7
Cultural and Local Compatibility(C&LC)	5	6	5	5	6	6
Demographic Stability (DS)	4	6	4	4	6	6
Resource Conservation (RC)	7	9	7	7	9	9
Cleaner Production (CP)	7	9	7	7	9	9

The main factor scores of Table 6.1 are evaluated as indicated below.

Any facility which is established in any place for a good purpose is obvious to provide a positive contribution to the regional and local communities.

For this reason, experts has been taken following considerations into account in their assessment as shown in Table 6.1

The most obvious and short term change due to an establishment is that people living in the region can find a job easier.

For this reason, highest score has been given to this factor as 8-9.

Evaluated with the score 7-8 Distributions of Income, Add Value to Region, Welfare and Productivity are considered to have positive contributions to the area in the medium and long term. Evaluated with the score 7-9 factors, Eco Friendly Production, Source Independency, Resource Conservation and Cleaner Production, are the basic expectation from a well projected and accurately designed facility.

---

[3] *Standard Trapezoid Fuzzy Number (STFN)*

The upper and lower limit scores in the evaluation are therefore kept very high. All of the items of Distributions of Income, Add Value to Region, Welfare and Productivity is all considered as a positive affect that will affect the region in the mid and long term. Experts have evaluated the item of New Technology between 5 and 7 that a little above average scores with the cautious approaching.

Experts have estimated a value between 6-7 points for Public Benefit because each new Project will create debate and will be a subject to disagreements in the community. For this reason, experts were cautious about the given score. They rated the Cultural Compatibility and Local Factor with 5-6 points. Because of the fact that the assessed factor is rather vague and open- ended topic, they rated those with a score 5-6 which is very close to mean score. The new facility which is established in the region will make the region a center of attraction, and therefore the population of the region is taken into consideration as unstable. For this reason, experts rated this factor with 4-6 points which is below average.

The Benefit of Project	Eco	T	SC	Env	C_{IJ}	ΠC_{IJ}	$(\Pi C_{IJ})^{1/n}$	w_{ij}
Economical (Eco)	1	3	4	1	Cij	12	1,861	0,355
Technical (T)	0,333	1	2,000	0,1429		0,095	0,556	0,106
Socia Cultural (SC)	0,250	0,5	1	0,2		0,025	0,398	0,076
Environmental (E nv)	1,000	7,000	5,000	1		35,00	2,432	0,464
Σ	2,583	11,500	12,000	2,343		Σ	5,247	
	λ_{max}	4,130	$CI = (\lambda_{max} - n) / n$			0,043		
			$CR = CI / RI$			0,048		

Figure 6.1: Matrix of the Benefit of Project.

In pair wise comparison, Economical and Environmental factors are assumed as the same value.

The other factors such as Technical and Socio Cultural are evaluated as a secondary.

As shown on Figure 6.1, Determining the importance of each factor was set a numerical value in terms of pair wise comparison and it is found that its priority weight (eigenvector) of the Benefit of Project as (0.355, 0.106, 0.076, 0.464)

Economical	DoI						Emp						AVtR						W					
Key Factors	Score		STFN				Score		STFN				Score		STFN				Score		STFN			
Distribution of Income (DoI)	1	1	1	1	1	1	0,88	0,89	0,88	0,88	0,89	0,89	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Employment (Emp)	1,00	1,13	1,00	1,00	1,13	1,13	1	1	1	1	1	1	1,14	1,13	1,14	1,14	1,13	1,13	1,14	1,13	1,14	1,14	1,13	1,13
Add Value to Region (AVtR)	1,00	1,00	1,00	1,00	1,00	1,00	1,00	0,89	1,00	1,00	0,89	0,89	1	1	1	1	1	1	1,00	1,00	1,00	1,00	1,00	1,00
Welfare (W)	1,00	1,00	1,00	1,00	1,00	1,00	1,00	0,89	1,00	1,00	0,89	0,89	1,00	1,00	1,00	1,00	1,00	1,00	1	1	1	1	1	1

Figure 6.2: The fuzzufied matrix of Economical[4] factor.

[4]*Economic factors hierarchy made with fuzzy number matrix according to value of Table 6.1*

The value of fuzzy number of Economical matrix is evaluated on assigned value of Table 6.1. That is, given values to the key factors are compared with each other in terms of matrix which shown Figure 6.2. For instance, key factor of Distribution of Income (DoI) is assigned 7 as lower value and 8 as upper value and the key factor of Employment (Emp) is assigned 8 as lower value and 9 as upper value. The score of Distribution of Income (DoI) and Employment (Emp) is obtained in relation. They can be calculated with equation 6.1 and 6.1.

$$Score_{\ lower} = \frac{DoL}{Emp} = \frac{7}{8} = 0{,}875 \approx 0{,}88 \tag{6.1}$$

$$Score_{\ upper} = \frac{DoL}{Emp} = \frac{8}{9} = 0{,}888 \approx 0{,}89 \tag{6.2}$$

All other key values are evaluated in the same calculation. At end, a new matrix is obtained as shown in Figure 6.3. In order to obtain a new matrix with crisp value, all fuzzy numbers in matrix of Figure 6.2 are defuzzified with Formula (4.30) as described in chapter 4.15. Thus, a new matrix with crisp value is obtained as shown below;

$a_{12} = (0{,}88+0{,}88+0{,}89+0{,}89)/4$ from equation (4.30)

$a_{12} = 0{,}882$

1st index denote DoI

2nd index denote Emp

Economical	DoI	Emp	AVtR	W	ΠC_{ij}	$(\Pi cij)^{1/n}$	w_{ij}
Distribution of Income (*)(DoI)	1	0,882	1	1	0,882	0,969	0,242
Employeement (Emp)	1,134	1	1,134	1,134	1,458	1,099	0,274
Add Value to Region (AVtR)	1,000	0,882	1	1	0,882	0,969	0,242
Walfare (W)	1,000	0,882	1,000	1	0,882	0,969	0,242
Σ	4,134	3,646	4,134	4,134	Σ	4,006	
	λ_{max}	4,000	$CI = (\lambda_{max} - n) / n\text{-}1$			0,000	
			$CR = CI / RI$			0,000	

Figure 6.3: Comparison characteristics with respect to Economical.

The eigen vector of Economical factor is obtained as (0.24; 0.27; 0.24;0.24) . Its figure is shown in Figure 6.3. The other sub factor of Benefit of Project such as Technical, Socio Political and Environmental are progressed in the same manner and Eigen vectors of all others sub factors are obtained.

The pair wise judgment matrixes are shown below with their title;

Technical	P	NT	EFP	ΠC_{ij}	$(\Pi cij)^{1/n}$	w_{ij}
Productivity (P)	1	1,271	0,944	1,201	1,063	0,351
New Technology (NT)	0,787	1	0,746	0,587	0,837	0,277
Eco Friendly Production (EFP)	1,059	1,340	1	1,419	1,124	0,372
Σ	2,845	3,612	2,690	Σ	3,024	
λ_{max}	3,000	$CI = (\lambda_{max} - n) / i$		0,000		
		$CR = CI / RI$		0,000		

Figure 6.4: Comparison characteristics with respect to Technical.

The eigen vector of Technical factor is obtained as (0.35; 0.28; 0.37). W_{ij} values of technical factor are shown in Figure 6.4. For the objective of Model, the largest weight is given to Eco Friendly Production. This is followed by Productivity and New Technology respectively.

Socio Economical	SI	PB	C&LC	DS	ΠC_{ij}	$(\Pi cij)^{1/n}$	w_{ij}
Source Independency (SI)	1	1,226	1,450	1,625	2,889	1,304	0,320
Public Benefit (PB)	0,816	1	1,183	1,333	1,287	1,065	0,262
Cultural and Local Compatibility(C&LC)	0,690	0,845	1	1,125	0,656	0,900	0,221
Demographic Stability (DS)	0,615	0,750	0,889	1	0,410	0,800	0,197
Σ	3,121	3,821	4,522	5,083	Σ	4,069	
λ_{max}	4,000	$CI = (\lambda_{max} - n) / n-1$			0,000		
		$CR = CI / RI$			0,000		

Figure 6.5: Comparison characteristics with respect to Socio Economical.

The eigen vector of Socio Economical factor is obtained as (0.32; 0.26; 0.22;0.20) and is shown in Figure 6.5. To one of the components of socio-economic matrix, Source Independency the largest value was given.This is followed by Public Benefit, Cultural and Local Compatibility and Demographic Stability respectively.

Environmental	P	NT	ΠC_{ij}	$(\Pi cij)^{1/n}$	w_{ij}
Resource Conservation (RC)	1	1	1,000	1,000	0,500
Cleaner Production (CP)	1,000	1	1,000	1,000	0,500
Σ	2,000	2,000	Σ	2,000	
λ_{max}	2,000	$CI = (\lambda_{max} - n) / n$		0,000	
		$CR = CI / RI$		0,000	

Figure 6.6: Comparison characteristics with respect to Environmental.

The components of Environmental matrix are given equal weight. Both are important and sensitive for the environment properties. Priority weights of Environmental factor are shown in Figure 6.6.

6.1.2 The Comparison of factor index of BoP

The weight of each matrix is donated w_{ij} at step of pair wise comparison. The applied calculation method in this study was already described in Article 4.7 (4).
For calculating the weight of factor hierarchy 4.6 equation in the article 4.6 or 4.14 equation in the article 4.10 may be used. To calculate the weight of a hierarchy of scores by the weight calculated in the hierarchy is multiplied by its own above hierarchy score (shown in Table 6.2). For example, to calculate the score of DoI (Distribution of Income) factor with hierarchy the weight calculated in the hierarchy is multiplied by its own above. hierarchy score, (which is Economical factor) That is; the score of Distribution of Income (DoI) is multiplied by score of Economical factor. As a result, it is yielded the score of w'_{DoI} as 0,086. It is calculated with equation 6.3. After calculating the weight of the lowest factors that makes scoring in the hierarchy, FI* is calculated by using the equation (4.15).

Table 6.2: The priority weight of sub factor of BoP.

Key Factors	w	w'
Economical	0,355	
Distribution of Income (DoI)	0,242	0,086
Employment (Emp)	0,274	0,097
Add Value to Region (AVtR)	0,242	0,086
Walfare (W)	0,242	0,086
Technical	0,106	
Productivity (P)	0,351	0,037
New Technology (NT)	0,277	0,029
Eco Friendly Production (EFP)	0,372	0,039
Socio-Economical	0,076	
Source Independency (SI)	0,320	0,024
Public Benefit (PB)	0,262	0,020
Cultural and Local Compatibility(C&LC)	0,221	0,017
Demographic Stability (DS)	0,197	0,015
Environmental	0,464	
Resource Conservation (RC)	0,500	0,232
Cleaner Production (CP)	0,500	0,232

.

Table 6.3: FI* Calculation of Benefit of the Project.

Key Factors	Score		STFN(*)				w'	FI*			
			A	B	C	D	E	A* E	B* E	C* E	D* E
Distribution of Income (DoI)	7	8	7	7	8	8	0,086	0,601	0,601	0,687	0,687
Employment (Emp)	8	9	8	8	9	9	0,097	0,778	0,778	0,876	0,876
Add Value to Region (AVtR)	7	8	7	7	8	8	0,086	0,601	0,601	0,686	0,686
Walfare (W)	7	8	7	7	8	8	0,086	0,601	0,601	0,686	0,686
Productivity (P)	7	8	7	7	8	8	0,037	0,261	0,261	0,298	0,298
New Technology (NT)	5	7	5	5	7	7	0,029	0,147	0,147	0,205	0,205
Eco Friendly Production (EFP)	7	9	7	7	9	9	0,039	0,275	0,275	0,354	0,354
Source Independency (SI)	7	9	7	7	9	9	0,024	0,170	0,170	0,219	0,219
Public Benefit (PB)	6	7	6	6	7	7	0,020	0,119	0,119	0,139	0,139
Cultural and Local Compatibility(C&LC)	5	6	5	5	6	6	0,017	0,084	0,084	0,101	0,101
Demographic Stability (DS)	4	6	4	4	6	6	0,015	0,060	0,060	0,089	0,089
Resource Conservation (RC)	7	9	7	7	9	9	0,232	1,623	1,623	2,086	2,086
Cleaner Production (CP)	7	9	7	7	9	9	0,232	1,623	1,623	2,086	2,086
							Σ	6,941	6,941	8,512	8,512

$$w'_{DoI} = w_{DoI} * w_{Economical} \tag{6.3}$$

$$w'_{DoI} = 0,242 * 0,355$$

$$w'_{DoI} = 0,08591 \approx 0,086$$

Thus, the weight score in hierarchy with the lowest factors of the Benefit of Project hierarchy is obtained by multiplying first, then by collecting, FI*. The calculations to obtain FI* score are shown in Table 6.3. The calculations with values in Table 6.3 are in order to obtain the total FI* values. The obtained FI*values need to be translated into a fuzzy set of points. The fuzzy membership function of the impact value which is shown in Table 5.1 will be plotted on a graph. Then the class and membership of functions will be determined through FI* values. The obtained value corresponds to the step of impact estimation of impact characterization. In order to determine class and membership of FI* values regarding Environmental Impact of BoP, Figure 6.1 in which membership function can be seen, is drawn. The scores of bottom level Impact factors of BoP gave base on experts opinions according to Table 5.1. In order to calculate FI values on those scores that given by experts were obtained Table 6.3. STFN values corresponding to the priority value and FI values in hierarchy are shown in Table 6.3

6.1.3. The Convert STFN to fuzzy set of BoP

On Figure 6.7, the intersection of FI* score and its membership ratios are determined. Those intersection ratio points are indicated in the Table 6.4

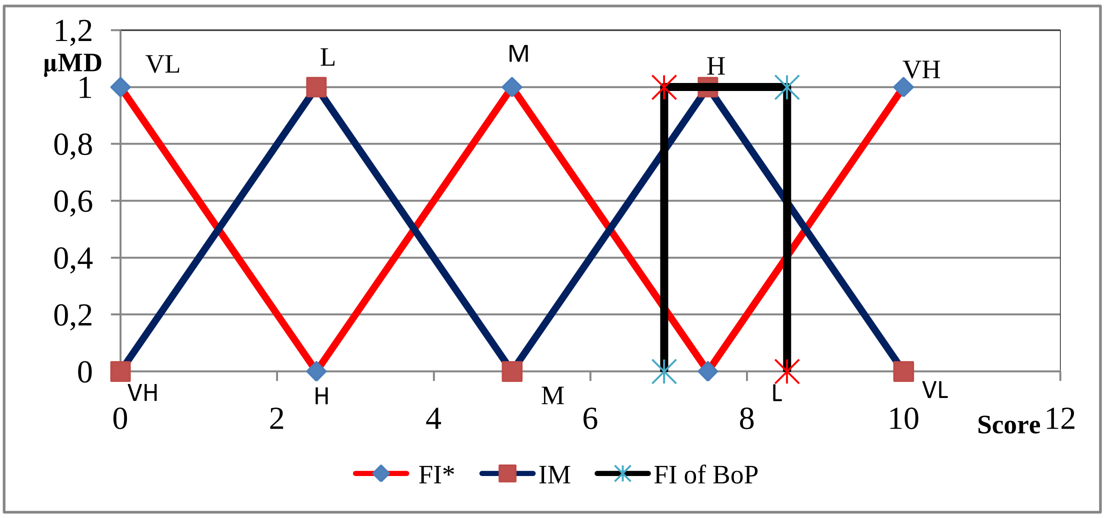


Figure 6.7: Determination of the membership value and FI* Class for BoP.

In Figure 6.7, where the points cut the function of the FI* and the resulting class of membership and degrees, are shown in Table 6.4

Table 6.4: The Membership value of BoP.

FI^*_{BoP}	μ_{IMc}
M	0,22
H	0,78
VH	0,40

The resulting values of class and membership which belong to BoP are some of the pillar of the environmental impact value.The second member of intersection pillar is the Estimating Environmental Impact (EEI).By using associated with found fuzzy class, the fuzzy rule base will be prepared.Two FI parameters with “and” operator which lead to getting truncated fuzzy IM results are combined in order to provide fuzzy intersection (as minimum) operation.Therefore, fuzzy union (maximum) operation will be used for getting a single fuzzy membership function**.**

6.1.4 Estimating environmental impact

All given values in this section will be carried out like the Benefit of the Project as described and will run on those related to LL, like the combination of hierarchy explained in 6^{th} applications. All evaluation in this section, the combination of EEI hierarchy as described section 6 for BoP, the applications will be progressed over the alternative of L Bop- L EEI**.** The LBoP-SEEI and SBoP-LEEI applications will be presented as an annex to this work. In this section, first the Estimating Environmental Impact’s sub-factors is going to be evaluated. Its corresponding values are shown in the Table 6:11. The basis of the values given in Table 6.5 are evaluated on the basis of the following factors.A facility which is built a place for any purpose may be considered as a local or regional threat in the framework of environmental criteria**.** The scores given in the Table 6.5 are the magnitude of the negative impact of a facility' to its environment and environmental value.Experts took most of the facilities available today and pollution created by them into account at the scoring evaluation.

Table 6.5: Sub Factors and Fuzzy Values of the EEI.

Key Factors	Score			STFN(*)		
Flaro, Fauna (FF)	9	10	9	9	10	10
Forest(F)	8	9	8	8	9	9
Water & Watershed (W-WS)	8	9	8	8	9	9
Surface & Groundwater S&GW)	8	8	8	8	8	8
Agriculture (A)	9	10	9	9	10	10
Recreational area (RA)	7	8	7	7	8	8
Urbanization (U)	6	7	6	6	7	7
Climate (C)	6	7	6	6	7	7
Air Quality	7	8	7	7	8	8
Historical & Turistic Area (H&TA)	6	7	6	6	7	7
Geomorphological Structure (GS)	6	7	6	6	7	7

For this reason, it is accepted that the facilities such as chemical industry, mining, food industry cosmetic etc..are most environmentally damaging sources. In this connection, experts have proposed that the terrestrial pollution is larger than other key elements such as Air, Water etc. and they anticipated that the mentioned pollution will affect Agriculture areas, Flora Fauna at first. In this section, given score is between 9 and 10. The valid reason for Agriculture and Flora - Fauna are also valid for Forest, Water and Watershed which are scored between 8 and 9. The points given by experts according to the degree of influence of others factors are as follows on the Table 6.5. Surface & Ground has 8-8 points that is very close score to Water & watershed water.Recreational area has points between 7 and 8 which are above average. Urbanization, Climate, Touristic and Historic Area and Geomorphologic Structure evaluation scores are between 6 and 7 points which are close to average value. Scoring may be revised considering the production of a facility and resulting pollution by that.For instance;Land pollution, in other words, means degradation or destruction of earth's surface and soil, directly or indirectly as a result of human activities. Anthropogenic activities are conducted citing development, and the same affects the land drastically, we witness land pollution; by drastic we are referring to any activity that lessens the quality and/or productivity of the land as an ideal place for agriculture, forestation, construction etc.

The degradation of land that could be used constructively in other words is land pollution (U.S EF Conserve Energy, 2016**).**

Estimting Environmental Impact	TES	AqES	AtES	C_{IJ}	$\pi\ C_{iJ}$	$(\pi\ C_{iJ})^{1/n}$	w_{ij}
Terresterial Eco System (TES)	1	1	0,417	cij	0,41667	0,75	0,23
Aquatic Eco System (AqES)	1	1	0,417		0,41667	0,75	0,23
Atmospheric Eco Systme (AtES)	2,4	2,4	1		5,76	1,79	0,55
Σ	4,4	4,4	1,833		Σ	3,29	
λ_{max}		3,00	$CI = (\lambda_{max} - n)/n\text{-}1$				0,00
			$CR = CI/RI$				0,00

Figure 6.8: Matrix of the Estimating of Environmental Impact.

In pair wise comparison, the value of Atmospheric Eco System's factorisevaluated as the most important factor.Aquatic Eco System and Terrestrial Eco System are considered regarded as the secondary and tertiary respectively.As shown on Figure 6.8, determining the importance of each factor is to set a numerical value in terms of

Terresterial Eco System	FF				F				A				RA				U				H&TA				GS			
Flaro, Fauna (FF)	1	1	1	1	1,1	1,1	1,0	1,0	1,0	1,0	1,0	1,0	1,3	1,3	1,3	1,3	1,5	1,5	1,4	1,4	1,5	1,5	1,4	1,4	1,5	1,5	1,4	1,4
Forest(F)	0,9	0,9	1,0	1,0	1	1	1	1	0,9	0,9	0,9	0,9	1,1	1,1	1,1	1,1	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3
Agriculture (A)	1,0	1,0	1,0	1,0	1,1	1,1	1,1	1,1	1	1	1	1	1,3	1,3	1,3	1,3	1,5	1,5	1,4	1,4	1,5	1,5	1,4	1,4	1,5	1,5	1,4	1,4
Recreational area (RA)	0,8	0,8	0,8	0,8	0,9	0,9	0,9	0,9	0,8	0,8	0,8	0,8	1	1	1	1	1,2	1,2	1,1	1,1	1,2	1,2	1,1	1,1	1,2	1,2	1,1	1,1
Urbanization (U)	0,7	0,7	0,7	0,7	0,8	0,8	0,8	0,8	0,7	0,7	0,7	0,7	0,9	0,9	0,9	0,9	1	1	1	1	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0
Historical & Turistic Area (H&TA)	0,7	0,7	0,7	0,7	0,8	0,8	0,8	0,8	0,7	0,7	0,7	0,7	0,9	0,9	0,9	0,9	1,0	1,0	1,0	1,0	1	1	1	1	1,0	1,0	1,0	1,0
Geomorphological Structure (GS)	0,7	0,7	0,7	0,7	0,8	0,8	0,8	0,8	0,7	0,7	0,7	0,7	0,9	0,9	0,9	0,9	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1	1	1	1

Figure 6.9: The Fuzzified Matrix of Terrestrial Eco System Factors[5].

[5]*Terrestrial Eco System factors hierarchy made with fuzzy number matrix according to value of Table 6.5*

pair wise comparison and its priority weight (eigenvector) of the Estimating of Environmental Impact is found as (0.23, 0.23, 0.55).

To obtain the matrix of Figure 6.10 from the matrix of Figure 6.9, similar calculation is done as described in the Economical Hierarchy in 6.1.1 section. As seen in Figure 6.10, Agriculture and Flora, Fauna reach highest values among the priority weights in the matrix of Terrestrial Eco System. As mentioned before, the experts had made the same high estimation.

Terresterial Eco System	FF	F	A	RA	U	H&TA	GS		Π C_{IJ}	$(\Pi cij)^{1/n}$	w_{ij}
Flaro, Fauna (FF)	1	1,06	1,00	1,27	1,46	1,46	1,46	C_{ij}	4,22	1,23	0,17
Forest(F)	0,94	1	0,89	1,13	1,31	1,31	1,31		2,15	1,12	0,16
Agriculture (A)	1,00	1,12	1	1,27	1,46	1,46	1,46		4,45	1,24	0,17
Recreational area (RA)	0,79	0,88	0,79	1	1,15	1,15	1,15		0,84	0,98	0,14
Urbanization (U)	0,68	0,76	0,68	0,87	1	1,00	1,00		0,31	0,85	0,12
Historical & Turistic Area (H&TA)	0,68	0,76	0,68	0,87	1,00	1	1,00		0,31	0,85	0,12
Geomorphological Structure (GS)	0,68	0,76	0,68	0,87	1,00	1,00	1		0,31	0,85	0,12
Σ	5,782	6,350	5,732	7,268	8,393	8,393	8,393	Σ		7,094	
λ_{max}	7,00	$CI = (\lambda_{max} - n) / n\text{-}1$					0,00	$CR = CI / RI$		0,000	

Figure 6.10: Comparison characteristics with respect to Terrestrial Eco System.

The other sub factor of Estimating Environmental Impactsuch as Aquatic and Atmospheric Eco System are progressed in the same manner and thus, Eigen vectors of all others sub factors are obtained. The pair wise judgment matrixes are shown below with their title; The components of Aquatic matrix are given almost equal weight as shown in Figure 6.11. Both are important and sensitive for the environment properties.

Aquatic Eco System	W-WS	S&GW		Π C_{IJ}	$(\Pi cij)^{1/n}$	w_{ij}
Water & Watershed (W-WS)	1	1,06	Cij	1,06	1,03	0,52
Surface & Groundwater S&GW)	0,94	1		0,94	0,97	0,48
Σ	1,9412	2,063	Σ		2,00	
λ_{max}	2,00		$CI = (\lambda_{max} - n) / n\text{-}1$			0,00
			$CR = CI / RI$			0,00

Figure 6.11: Matrix of Aquatic Eco System.

According to estimation of experts, the air quality is found to be slightly more important than climate as shown in Figure 6.12.

Atmospheric Eco Systme	W-WS	S&GW		Π C_{IJ}	$(\Pi cij)^{1/n}$	w_{ij}
Climate	1	0,87	Cij	0,866	0,93	0,46
Air Quality	1,15	1		1,155	1,07	0,54
Σ	2,15	1,87		Σ	2,01	
	λ_{max}	2,00	$CI = (\lambda max - n) / n$			0,00
			$CR = CI / RI$			0,00

e

Figure 6.12: Matrix of Atmospheric Eco System.

6.1.5 The Comparison of factor index of the EEI

The weight of each matrix is stated w_{ij} at step of pair wise comparison. The calculation method was applied in this study was described in Article 4.7 (4). The calculation of the weight of factor of hierarchy of Estimating Impact is progressed in a similar way as the weight calculation of the Benefit of Project.The estimated values of EEI are shown Table 6.6.

Table 6.6: The priority weight of sub factor of EEI.

Key Factors	w	w'
Terresterial Eco System	0,227	
Flaro, Fauna (FF)	0,173	0,039
Forest(F)	0,157	0,036
Agriculture (A)	0,174	0,040
Recreational area (RA)	0,138	0,031
Urbanization (U)	0,119	0,027
Historical & Turistic Area (H&TA)	0,119	0,027
Geomorphological Structure (GS)	0,119	0,027
Aquatic Eco System	0,227	
Water & Watershed (W-WS)	0,515	0,117
Surface & Groundwater S&GW)	0,485	0,110
Atmospheric Eco Systme	0,545	
Climate (C)	0,464	0,253
Air Quality	0,536	0,292

6.1.6. The Fuzzy inference for EEI

On Figure 6.13, the intersection of FI* score and its membership ratios are determined. Those intersection ratio points are indicated in the Table 6.8. This calculated class and membership degree belongs to Estimated Environmental Impact (EEI) pillar of Environmental Impact. In other words, these values represent the

Table 6.7: FI* Calculation of EEI.

Key Factors	STFN				W'	FI*			
	A	B	C	D	E	A* E	B* E	C* E	D* E
Flaro, Fauna (FF)	9	9	10	10	0,039	0,354	0,35	0,393	0,393
Forest(F)	8	8	9	9	0,036	0,286	0,29	0,322	0,322
Water & Watershed (W-WS)	8	8	9	9	0,117	0,937	0,94	1,054	1,054
Surface & Groundwater S&GW)	8	8	8	8	0,110	0,882	0,88	0,882	0,882
Agriculture (A)	9	9	10	10	0,040	0,357	0,36	0,397	0,397
Recreational area (RA)	7	7	8	8	0,031	0,219	0,22	0,250	0,250
Urbanization (U)	6	6	7	7	0,027	0,162	0,16	0,190	0,190
Climate (C)	6	6	7	7	0,253	1,519	1,52	1,772	1,772
Air Quality(AQ)	7	7	8	8	0,292	2,046	2,05	2,338	2,338
Historical & Turistic Area (H&TA)	6	6	7	7	0,027	0,162	0,16	0,190	0,190
Geomorphological Structure (GS)	6	6	7	7	0,027	0,162	0,16	0,190	0,190
					Σ	7,087	7,087	7,976	7,976

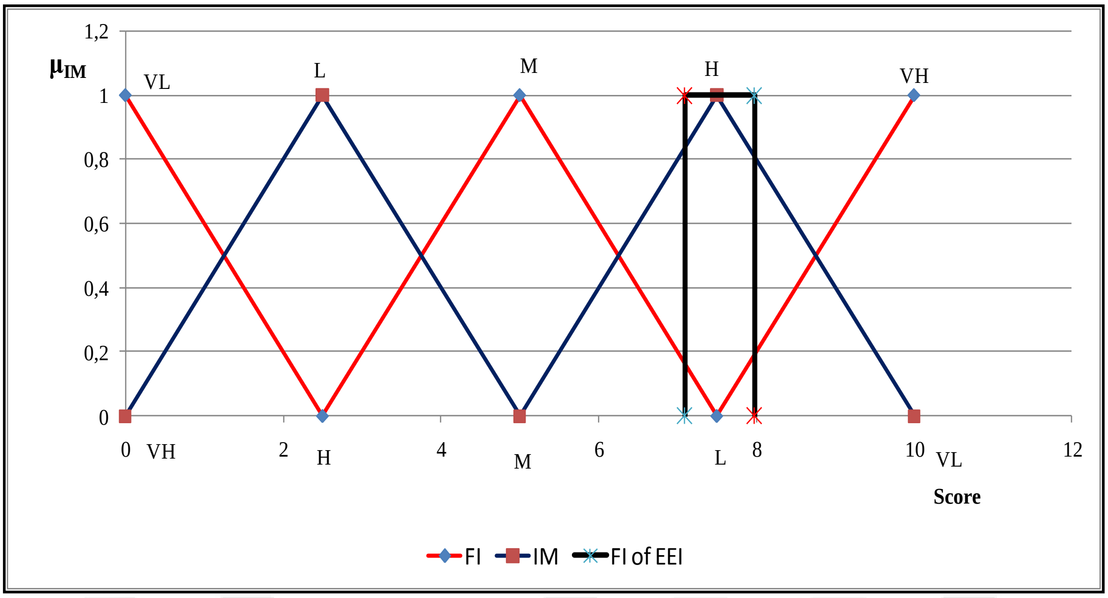


Figure 6.13: Determination of the membership value and FI* Class for EEI.

second pillar for necessary inference of IM. The scores of bottom level Impact factors of EEI gave base on expertsopinions according to Table 5.1. In order to calculate FI values on those scores that given by experts were obtained Table 6.7. STFN values corresponding to the priority value and FI values in hierarchy are shown in Table 6.7.

Table 6.8: The Membership value of EEI.

MD_{EEI}	μ_{IMc}
VH	0,20
H	0,85
M	0,18

6.1.7 Impact magnitude and intersection of BoP & EEI

The basis of fuzzy rule is prepared by using the calculated classes and membership degrees of BoP and EEI.By connecting with "and" operatorwhich is the intersection of BoP and EEI factors are obtained an IMc (Impact Magnitude). Figure 6.14 shows the fuzzy inference table.As seen in Figure 6.14, Fuzzy rule base is prepared by using fuzzy classes of factors with all of the combination of them. For instance, For FI memberships of FI_{BoP} assume M(0.22) , the intersection points of FI_{EEI} with FI_{BoP} are

Medium (0.18), High (0.22) and Very High (0.20) because intersection of FI_{BoP} and FI_{EEI} value were composed by using "and" operator to achieve Impact Magnitude.

In this case a Membership degree of that major Impact Magnitude is High (0.20). It is follows that for FI membership of FI_{BoP} considered as High (0.78), intersection values with FI_{EEI} are Medium (0.18), High (0.78) and Very High (0.20) respectively

The Impact Magnitude of this intersection combination is High (0.78).For FI membership of FI_{BoP} andFI_{EEI} are Medium (0.18), High (0.40) and Very High (0.20) respectively. The Impact Magnitude of this last intersection combination is High (0,40). Membership degree of IM is inferred by using fuzzy union (max) operator and shown in bold type in Figure 6.14. The maximum membership degree for major value in the rule base is 0.78, so membership degree of major Impact Magnitude is also 0,78. As it is shown on Equation 6.5, IM_C is an IM of intersection of BoP & EEI.

6.1.8 Defuzzification and obtaining impact magnitude

After obtaining membership of the calculated Impact Magnitude (IM_C) , they are defuzzified as shown in Equation 6.4.

$$IM_C = \frac{Negligible*2+Minor*4 + Major*7+Critical*10}{Negligible+Minor + Major+Critical} \quad (6.4)$$

$$IM_C = \frac{0*2+0,2*4 + 0,78*7+0,4*10}{0+0,20+0,78+0,20} = 7.435$$

The ratio of membership of functions and IM_c value are determined by the intersection of BoP and EEI as shown in Formula 6.5. Defuzzified Impact Magnitude, (7.435) is drawn on fuzzy membership function of IM_c in order to find out actual class and membership degree of IM_c. As shown in Figure 6.15 IM_c intersects IM_c membership function on the point of 0.8 for Major and 0.2 for critical class which means established any facility Impact to Environment obtained the major class with degree 0.8.

$$IM_C = IM_{BoP} \cap IM_{EEI} \quad (6.5)$$

		FI_{EEI}*														
		VL		0	L		0	M		0,18	H		0,85	VH		0,2
$FI*_{BoP}$					X											
VL	0	X	VL	0	X	VL	0		VL	0		VL	0		VL	0
L	0	X	L	0	X	L	0		L	0		L	0		L	0
M	0,22	X	M	0	X	M	0	Negligible Impact acceptable	M	0,18	(Unimportant) Impact can be accepted	M	0,22	Major Impact ;Impact can be tolarated but precaution must be taken	*M*	*0,2*
H	0,78	X	H	0	X	H	0	(Unimportant) Impact can be accepted	H	0,18	Major Impact ;Impact cannot be accepted	*H*	*0,78*	Major Impact ;Impact can be tolarated but precaution must be taken	H	0,2
VH	0,4	X	VH	0	X	VH	0	(Unimportant) Impact can be accepted	VH	0,18	Major Impact ;Impact can be tolarated but precaution must be taken	*VH*	*0,4*	Major Impact ;Impact can be tolarated but precaution must be taken	VH	0,2

Figure 6.14: Fuzzy Inference of IM for BoP & EEI.

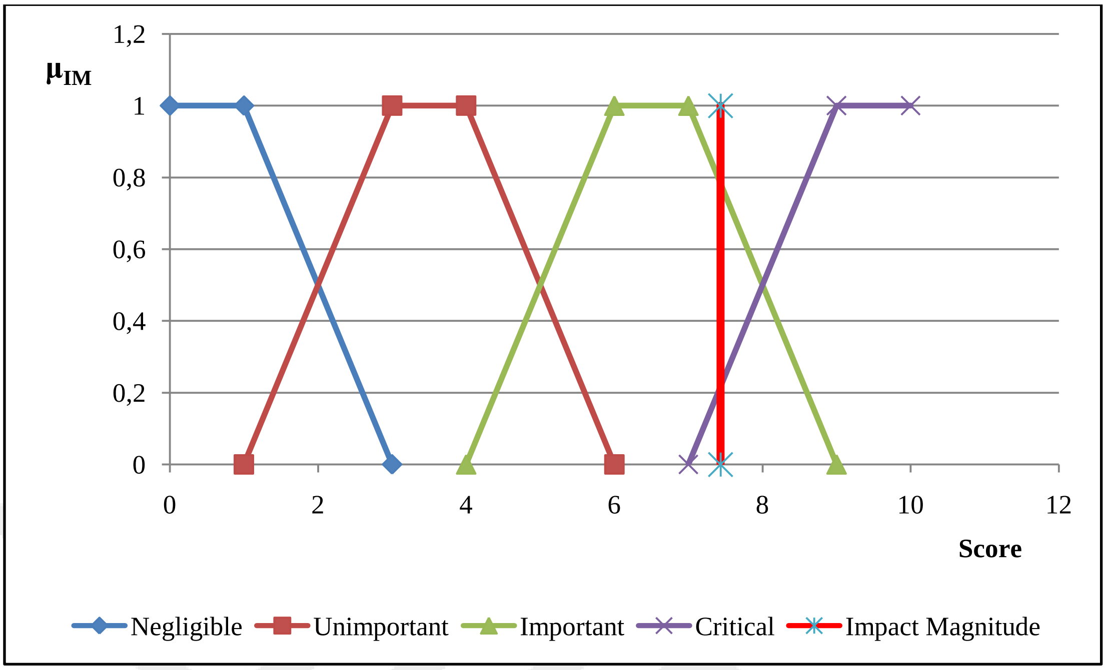


Figure 6.15: Class and Membership degree of IMC for BoP and EEI.

The results which are described and obtained on sections 6.1 and 6.2 were run based on given large values of BoP and EEI through expert opinion. Figure 6.15 is shown the calculated IM of BoP & EEI. Its membership and μ_{IMc} values are shown in Table 6.9.

Table 6.9: The Membership value of IMc.

IM_c	μ_{IMc}
Critical	0,2
Important	0,8

To achieve various combinations of BoP and EEI, the experts did the scoring on small value to each hierarchy as indicated in Table 6.10 and Table 6.11.

It is obvious that there is the possibility of obtaining various combinations of hierarchies depend on expert oponions.

Therefore, in order to get correct results , the estimates making by expert should be suitable for the purpose. Who are expert are given in Section 5.2.

Table 6.10: Small value of Benefit of Project.

Key Factors	Score		STFN(*)			
Distribution of Income (DoI)	2	4	2	2	4	4
Employment (Emp)	3	5	3	3	5	5
Add Value to Region (AVtR)	1	3	1	1	3	3
Welfare (W)	3	5	3	3	5	5
Productivity (P)	3	5	3	3	5	5
New Technology (NT)	1	2	1	1	2	2
Eco Friendly Production (EFP)	3	5	3	3	5	5
Source Independency (SI)	1	3	1	1	3	3
Public Benefit (PB)	1	3	1	1	3	3
Cultural and Local Compatibility(C&LC)	1	3	1	1	3	3
Demographic Stability (DS)	1	3	1	1	3	3
Resource Conservation (RC)	2	4	2	2	4	4
Cleaner Production (CP)	1	2	1	1	2	2

Table 6.11: Small Estimation of Environmental Impact.

Key Factors	Score		STFN(*)			
Flora, Fauna (FF)	3	4	3	3	4	4
Forest(F)	3	4	3	3	4	4
Water & Watershed (W-WS)	3	4	3	3	4	4
Surface & Groundwater S&GW)	2	3	2	2	3	3
Agriculture (A)	3	4	3	3	4	4
Recreational area (RA)	2	3	2	2	3	3
Urbanization (U)	2	3	2	2	3	3
Climate (C)	3	4	3	3	4	4
Air Quality	3	4	3	3	4	4
Historical & Touristic Area (H&TA)	1	2	1	1	2	2
Geomorphologic Structure (GS)	1	2	1	1	2	2

Accordingly, all possible combinations values of Impact Magnitude belonging to four properties are given in Table 6.12. Figure 6.16 shows the comparison graph of the combination of BoP & EEI base on IM. Large BoP means that the facility, which is represented by BoP may produce dangerous or hazardous products for environment. Small BoP meansthat the products or sub products of facility do not create any concern for environment spoilage. These possible problems can prevent with a little effort or preventive action. Both Large and Small EEI appear passive (secondary) in this evaluation and it is observed that is not dominant.

The acceptance criteria of the value of IM_c of Facility is shown in Table 4.6

Table 6.12: The comparison of combination of BoP & EEI base on IM.

Type of Combination of two Hierarchy	The Large value of BoP & Large value of EEI	The Large value of BoP & Small value of EEI	The Small value of BoP & Large value of EEI	The Small value of BoP & Small value of EEI
Impact Magnitude	7,435	7,386	4,806	4,733
Interperation	Althoug this combination created largest IMc, it is very close IMc value of the" combination of The Large value of BoP & Small value of EEI".It also show that BoP is dominanted the model base on the IMc effect	This combination may be valid for large BoP which producing mostly dangerous or hazardous product for environment but surround of facilities may be less effected to biota or having poor flora fauna etc. Or facility may reside in very poor area base on environmental value.	IMc value of this combination is very close value to the combination of " The Small value of BoP & Small value of EEI". It means that BoP seems the dominate effect of combination of model	The environmental impact of the BoP may be small, but its environmental impact has a greater impact than the acceptable level.

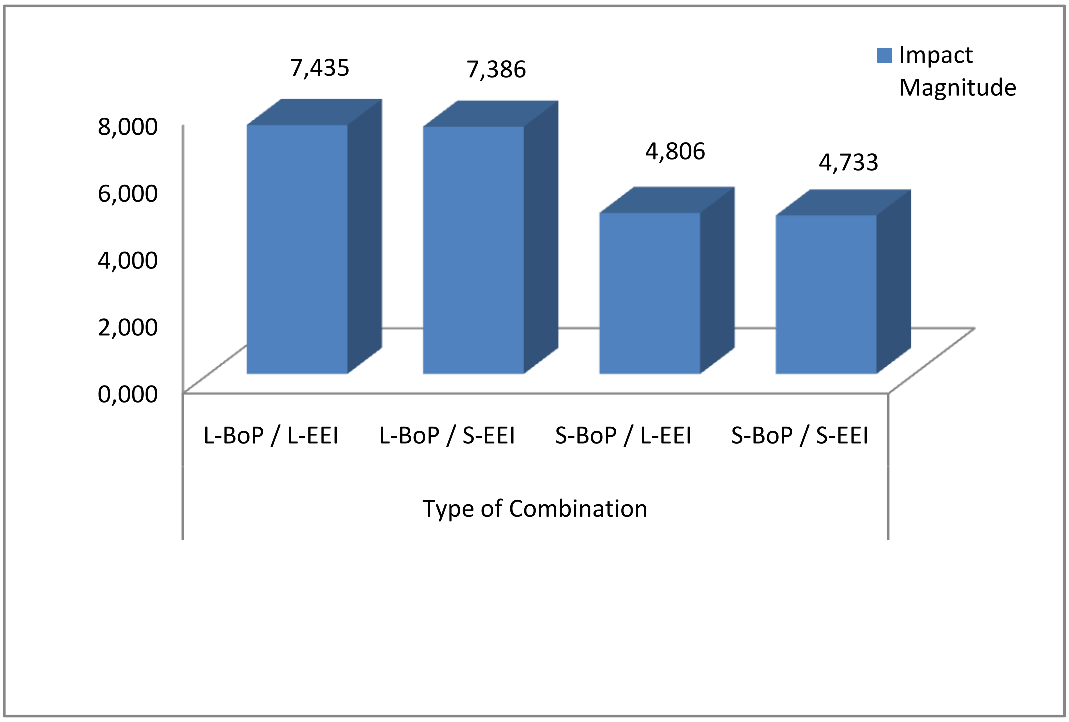


Figure 6.16: The graph of three different IM Characteristics.

6.2 Residual of Impact Magnitude

6.2.1- Reduction of the impact magnitude

The priority weights of BoP and EEI factors and their sub-factors install with FAHP were obtained, explained, evaluated in section 6.1.1 and 6.1.2 respectively**.** In the 6.1.8 section, IMc value and membership values were obtained through 6.5 equations as a intersection of those two hierarchies. With this membership value and Impact Magnitude, a score was found out for evaluation of EIA. EEI hierarchy was taken from the existing factors in force directives and regulations of EIA. The obtained score of IM, was the value on basis of the value that indicated in Table 5.1. According to definition of IM such as Critical, Important or unimportant, if score is close 6.0 or larger than 6.0, the project may result in denial or returned for revision of the project. Therefore due to the high impact IM score, depending on the project is rejected or returned for revision to be made, it may be necessary to reduce IM score and some improvement through correction and preventiveactions may be assured. The purpose of this model is to scale down IM value to acceptable level. In this connection, the improvement works have to be carried out over sub-factors of the EEA hierarchy, covering environmental values is recommended. The improvement effort of each one of sub factors of EEI hierarchy will be made pair wise comparison at the basis of ISO 9001, ISO 14001, OHSAS 18001 and Remediation. Table 5.1 was made out of 10 scoring value of IM.

In Table 5.1, based on the given IM value, a matrix is obtained by using EEI's each sub-factor and IMS's constituents which are ISO 9001, ISO 14001, OHSAS 18001 and Treatment**.** Each key factor distribution is made over10 points in frame of IMS's constituents and Remediation.

The purpose of this section is to reduce the high IM value by using ISO 9001, ISO 14001, OHSAS 18001 and Remediation.In Table 6.13. Flora Fauna should be considered as one of the hierarchies of matrixand it ise generated with ISO 9001, ISO 14001, OHSAS 18001 and Remediation. By this way, it is possible to obtain the priority weight of matrix.It may be repeated for all items of Table 6.13 as realized for Flora & Fauna.As shown below in Figure 6.17 a matrix has been created for the hierarchy of Flora- Fauna.

Table 6.13: Evaluation of Key Factors within EMS constituents.

Key Factors	19001	14001	18001	Remed.
Flora, Fauna (FF)	1	7	1	1
Forest(F)	1	5	2	2
Water & Watershed (W-WS)	2	5	2	1
Surface & Groundwater S&GW)	2	5	2	1
Agriculture (A)	3	4	2	1
Recreational area (RA)	3	3	3	1
Urbanization (U)	2	4	3	1
Climate (C)	2	3	3	1
Air Quality	2	5	3	1
Historical & Touristic Area (H&TA)	4	2	3	1
Geomorphologic Structure (GS)	1	3	3	3

Flora Fauna	ISO 9001	ISO 14001	OHSAS 18001	Remediation	w_{ij}
ISO 9001	1,000	7,000	1,000	1,000	0,318
ISO 14001	0,143	1,000	0,143	0,143	0,045
OHSAS 18001	1,000	7,000	1,000	1,000	0,318
Remediation	1,000	7,000	1,000	1,000	0,318
Σ	3,143	22,000	3,143	3,143	
λ_{max}	4,00	$CI = (\lambda_{max} - n) / n-1$		0,00	
		$CR = CI / RI$		0,00	

Figure 6.17: Matrix for Flora Fauna evaluating with EMS constituents.

Its priority weight value (eigenvector) is (0.318, 0.045, 0.318, 0.318). It is shown in Figure 6.17.

All priority weight of all objectives of EEI which are shown in Table 6.14 is as follows;

As indicated in Table 6.14 the total priority weights are 2.506 of ISO 9001, 3.233 of ISO 14001, 2.796 of OHSAS 18001, and 2.496 of Remediation respectively.

Due to eleven sub factors, total priority weight appeared eleven. On the other hand, the evaluations of membership of factors are made on 10 score because as indicated with the IM value of Table 5.1. Therefore, it should be converted to the Table 6.15 based on 10 score.

Table 6.14: Priority weight of the objectives of EEI.

Key Factors	19001	14001	18001	Remed.
Flora, Fauna (FF)	0,318	0,045	0,318	0,318
Forest(F)	0,480	0,088	0,202	0,230
Water & Watershed (W-WS)	0,186	0,532	0,186	0,097
Surface & Groundwater S&GW)	0,186	0,532	0,186	0,097
Agriculture (A)	0,327	0,205	0,242	0,226
Recreational area (RA)	0,167	0,167	0,167	0,500
Urbanization (U)	0,209	0,180	0,194	0,416
Climate (C)	0,184	0,432	0,287	0,097
Air Quality	0,158	0,482	0,272	0,088
Historical & Touristic Area (H&TA)	0,193	0,269	0,417	0,121
Geomorphologic Structure (GS)	0,100	0,300	0,300	0,300
Σw_{ij}	2,506	3,233	2,769	2,492

ISO 9001	ISO 14001	OHSAS 18001	Remediation	Σw_{ij}
2,506	3,233	2,769	2,492	11,000
2,506	3,233	2,769		8,508
2,506	3,233		2,492	8,231
2,506		2,769	2,492	7,767
	3,233	2,769	2,492	8,494
2,506	3,233			5,739
2,506		2,769		5,275
2,506			2,492	4,998
	3,233	2,769		6,002
	3,233		2,492	5,725
		2,769	2,492	5,261
2,506				2,506
	3,233			3,233
		2,769		2,769
			2,492	2,492

Figure 6.18: The combination of priority weight values of EIM.

As equation 4.34 is stated, the priority weights with score of 11.00 may be converged into the priority weight with 10.00 score for normalization of Figure 6.18. This normalization can be done with 4.34 formulas as it is seen in Figure 6.19. Figure 6.19 may be stated in a new and normalized scale as well.

[6]The scores of every combination of Figure 6.19 are ideal values in any application of any facility. But in practice, it may have some deviation from ideal conditions at the any applications. Based on the core issues of EMS effectiveness some empirical study confirms its multi-dimensional structure and determines the contribution of EMS effectiveness to specific performance dimensions of most of the facilities. (Psomas E.L, et al,2013**)**

ISO 9001	ISO 14001	OHSAS 18001	Remediation	IM_{EMS} [6]
2,278	2,939	2,517	2,266	10,000
2,278	2,939	2,517		7,734
	2,939	2,517	2,266	7,722
2,278	2,939		2,266	7,483
2,278		2,517	2,266	7,061
	2,939	2,517		5,456
2,278	2,939			5,217
	2,939		2,266	5,205
2,278		2,517		4,795
		2,517	2,266	4,783
2,278			2,266	4,544
	2,939			2,939
		2,517		2,517
2,278				2,278
			2,266	2,266

Figure 6.19: The converted table of Figure 6.18 base on 10 score.

For instance; the exploratory factor analysis of the indicator of performance dimension is roughly calculated as 75.63% in the impact of ISO 9001 effectiveness. The experiences have shown that the success of EMS systems' applications (such as ISO 9001, ISO 14001, OHSAS 18001 and Remediation) in any facility may be anticipated about 70%.

In order to remain in confidence interval, the performance indicator is considered as 70% for local facilities in this study.

Therefore, it may be created more reasonable and convenient table for using in practical. Approximately 70% reduced state table is shown in Figure 6.20

[6] IM_{EMS} Normalized IM

If IMc has a larger value, the decision maker may use to mitigate IMc by using Figure 6.20 base on criteria of Table 4.6 and equation with 4.35.

$$IM_R = IM_C - IM_A \quad (6.6)$$

In other words, IM_R statement that expressed as 6.6 equation is named as residual Impact Magnitude

In order to make an analogy to the acceptable Impact Magnitude (IM_A) base on Table 5.1 , IM_A is proposed as equal or below 3 value.

Colour Scale	IM_{EMS} [7]	ISO 9001	ISO 14001	OHSAS 18001	Remediation
	7,000	✓	✓	✓	✓
	5,414	✓	✓	✓	
	5,405		✓	✓	✓
	5,238	✓	✓		✓
	4,943	✓		✓	✓
	3,819		✓	✓	
	3,652	✓	✓		
	3,643		✓		✓
	3,357	✓		✓	
	3,348			✓	✓
	3,181	✓			✓
	2,057		✓		✓
	1,762			✓	
	1,595	✓			
	1,586				✓

Figure 6.20: The 70% reduced teoretical value.

It is shown in section 4.17 with formula 4.32. The acceptance condition of IM of any project or facility activity is assumed as $IM_A \leq 3.0$ that is shown in equation 4.33

For instance; in Table 6.12 the score of IM for the Large value of BoP & Large value of EEI was 7.435. It means that this value is IM of the intersection of BoP & EEI values.

As explained in the previous sections, "Large BoP" means that the facility effects seriously to environment and it may produce dangerous or hazardous product in a

[7] 70% reduced score of IM_{EMS}

considerable amount and "Large EEI" means that the member of environment elements such as of air, water, terrestrial may effected largely from facility.

It means that the facility or project with the score of 7.435 would be rejected because of its major impact which cannot be accepted.

In order to mitigate IMc score from 7.435 to around 3 score which is in acceptable limits Figure 6.20 can be used. It is provide also the opportunity to decision maker to choose the suitable EMS combination for their facility.

In order to reach the score 3 of IMc, it may be calculated as follows;

IM_C (Calculated IM) is 7.435. IM_A (Acceptable IM) is maximum 3.00 score according to Table 4.6. IM_R (Residual IM) means that IM_A is a subtracted value from IM_C and it is a value which is closest value to $IM_{EMS.}$ Hence; IM_R must be equal or less than $IM_{EMS.}$ It is donated as follows;

$IM_R \leq IM_{EMS}$

In order to achieve the score 3 or less than 3 score which is on the acceptable level as it is shown in Table 5.1, the necessary IM_R amount is (7.435 – 3.000 =) 4.435.

Actually IM_R score basis which is the closest value to the IM_{EMS} value to be found in Figure 6.20. That is, the closet value to 4.435 score in Figure 6.20 should be chosen.

It means that the score of 4.943 should be selected for 4.435 from Figure 6.20

In this case, selecting 4.943 from Figure 6.20 is the optimal solution.

As it is seen on Figure 6.20- 6.21, the provision of application of ISO 9001, OHSAS 18001 and Remediation is 4.943.

In order to reduce the IM's value up to the score 4.943, it should be some improvement and correction/preventive action at the facility through ISO 9001, OHSAS 18001 and Remediation.

Colour Scale	IM_{EMS}	ISO 9001	ISO 14001	OHSAS 18001	Remediation
	4,943	✓		✓	✓

Figure 6.21: Optimistic EMS tool.

By nature, decision maker select larger scores which correspond to other possibilities of tools of EIM to remain in more safe space. As seen Figure 6.21, if decision maker would choose all tools of EMS (ISO 9001, OHSAS 18001 and Remediation), IM_R will be mitigate up to 0.435 score. It may be assumed that the facility will not affect the environment negatively by making these extra precautions. It is valid for one of 5.414, 5.404 and 5.238 Impact values that cover the triple combination of EMS tools and they will reduce the impact scores up to 2.02, 2.03 and 2.19 respectively.

Colour Scale	IM_{EMS}^{7}	ISO 9001	ISO 14001	OHSAS 18001	Remediation
	7,000	✓	✓	✓	✓
	5,414	✓	✓	✓	
	5,405		✓	✓	✓
	5,238	✓	✓		✓
	4,943	✓		✓	✓

Figure 6.22: Assuring more safe EMS tools.

As stated before optimum and calculated solution is for the score 4.943 but it can create a more risky situation for environment if compared previous combinations' values.

On the other hand, to select each one of the other combinations being less than 4.943, it will not reduce the IM_R values equal and less than 3 score.

For this reason, the facility will be able to create a major threat to the environment. Figure 6.22 shows the reduced IM values with EMS tools for L-BoP/L-EEI. All combination of reduced IM values are shown in Table 6.15 as well.

Table 6.15: The Table of reduced IM values with EMS tools for L-BoP/L-EEI.

Type of IMS Combination	Impact Magnitude
IM_C of L-BoP / L-EEI	7,435
IM_R with ISO 9001- OHSAS 18001 -Remedition	2,492
IM_R with ISO 9001-ISO 14001-Remedition	2,197
IM_R with ISO 14001-OHSAS 18001 -Remedition	2,030
IM_R with ISO 9001-ISO 14001-OHSAS 18001	2,021
IM_R with ISO 9001-ISO -14001 OHSAS 18001 - Remedition	0,435

As it is shown in Figure 6.23, the reduced IM values with IMS tools for L-BoP/L-EEI. Essentially, Figure 6.23 contains the values of Table 6.15.Figure 6.23 have been made to provide a visual convenience to decision makers. As you would see from the figure, it is observed that the impact values can be downloaded from 2,43 to

0,435. As previously stated, combinations to be selected in the cost-benefit balance should be taken into consideration.

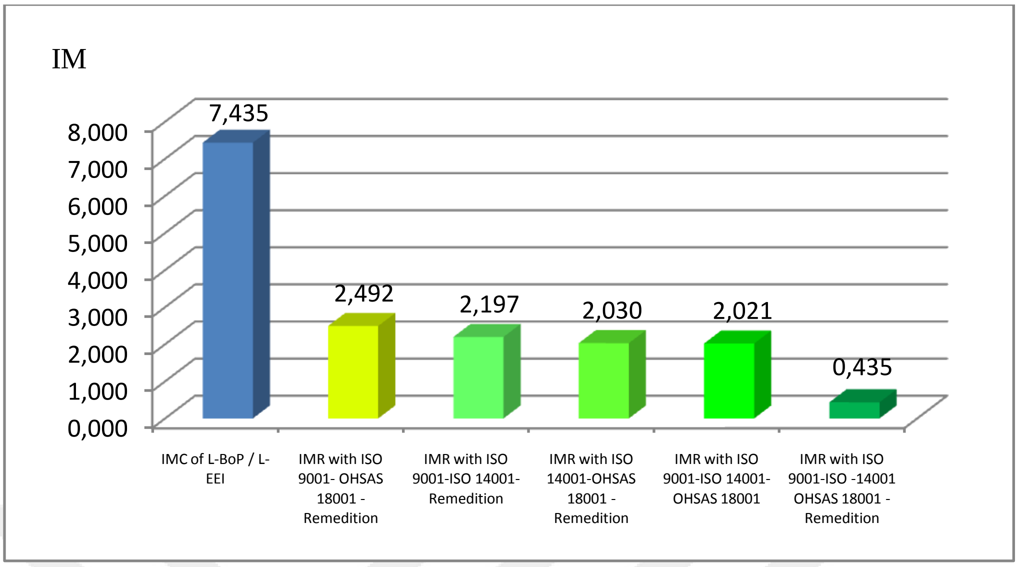


Figure 6.23: The graph of different IMS application of L-BoP / L-EEI scenario.

7. CONCLUSION

Products manufactured by any facility may have a distinct characterization. These can negatively affect the environment.

These effects may be associated many factors. Therefore, in order to clarify the complexity of factors in assessments, AHP method is recommended.

At AHP applications, obtaining products in facility and their ecological characterizations are of great importance.

In the hierarchy, product inputs and outputs of any facilities that affect the ecological values, is well identified.

The environmental impact factors that is caused by facility should be examined under two main groups. They are the Benefits of Project (BoP) (as a positive impact) and the Estimated Environmental Impact (EEI) (as a negative impact).

In fuzzy logic, impact value and impact degree is determined with help of contributing factor that are benefit and harm of facility to environment.

Impact Magnitude can be done with impact judgment which reveals the impact degree and degree of membership.

In application, the impacts of facility and its damages to the environment is considered as big and small.

Depending on the combination of application, the impact severity and membership degree of impact magnitude determined by intersection of BoP and EEI, is prominent for all entire system.

For example, the impact magnitude that obtained the combination of BoP which is its sub factor values large, it is not make much change in impact magnitude value of entire system even if combination of sub factor values of EEI are large or small.

The dominant impact size of the entire system comes from size caused by BOP factors.

That is, the impact magnitude and membership degree is determined by sub factors of hierarchy of BoP. Therefore they will be performance indicator because of primary effect of facility and this will create a prediction of environmental impact assessment (EIA) application

The proposed IMS systems in facility, to remedy the impact magnitude taken as the basis for an environmental management system can be done with the underlying to PDCA cycle.

This model is considered in four examples scenarios and it is described in the previous chapter.

In example described, the characterization of the interaction of environmental benefits and loss of the design scenarios is examined.

Both factors and their sub - factors are made in their hierarchy and on the basis of pair wise comparison.

As a result of pair wise comparisons, IMc value which is the intersection of hierarchies of BoP and EEI, is obtained.

This IMc value is considered as a reference or an indicative magnitude of pollution or potential harm of any facility for the environment.

In practice, the value of impact magnitude to bring an acceptable level, it is used the constituents of IMS which is forming by ISO 9001, ISO 14001, OHSAS 18001 and Remediation.

By making analogy with the values of Table 5.1, criteria such as rejection, conditional acceptance or directly acceptance are obtained.

In case of any rejection or conditional acceptance of the unsound projects, the solution opportunities are given to the decision maker in order to reduce negative effect of facilities by helping combination of EMS constituents.

In problematic cases where IM's have large value,

Figure 6.20 is prepared for providing convenience to decision makers and to choose the most appropriate combination of EMS constituents.

Since this table has numerical values, it also provides a choice flexibility to the decision-makers to reduce the impact magnitude which is problematic.

The most appropriate impact magnitude value for project acceptance may be designated through Figure 6.20 which consists of EMS constituents with different combination.

IM_C					
10,00 – 9,00	**EXTREMLY HIGH IMPACT**	Sensetive areas or very rich biological diversity. No tolerance using any Hazardous materials or wastes	The establishment of a new facility to this area is disapproved and Project is rejected.In the EIA reports, it is recommended to pay attention to the values that range. Extensive Emergency Planning on Environmental Protection	It is recommended to use all togather EMS constituents.	ISO 9001- ISO 1400-OHSAS 18001 and Remediation
8,90 – 7,00	**LARGE IMPACT**	Rich environmental resources, Living, Agricultural, Recreational ,Historical or Tourism areas. Exposure time to hazardous materials or wastes should be taken under control	The establishment of a new facility to this area is disapproved and Project is rejected.In the EIA reports, it is advisable to pay attention to the values that range. Extensive Emergency Planning on Environmental Protection	It is recommended to use togather all or three combinations of the EMS measures related to IMc.	ISO 9001- ISO 1400-OHSAS 18001 and Remediation
6,90 – 5,50	**ACCEPTABLE IMPACT WITH PREVENTIVE ACTIONS**	Area is not so rich as environmental resources.But impact can create some environmental problems in short and medium term. It should be taken preventive and corrective actions	The construction of a new facility to any region may be allowed after all protective and corrective measures have been taken. Necessary contingency plan must be made and kept current.	It is recommended to use two combinations of the EMS measures due to IMc.	
5,40 – 4,00	**ACCEPTABLE IMPACT WITH MINOR REVISIONS**	The environmental resources of the region, rich or not, but the impact (IMc) values can be tolerated with appropriate corrective actions	The establishment of a new facility to this area may be is approved by decision makers. But facility should always be kept under control. Project acceptable.	It is recommended to use one or two combinations of the EMS measures due to IMc.	
3,90 – 3,00	**ACCEPTABLE IMPACT**	The environmental resources of the region, rich or not. There is no big impact (IMc) values of facility. IMc can be tolerated.	Project is acceptable.	If neccessary it is proposed to use one combinations of the EMS measures due to IMc.	
2,90 – 0,00	**NO IMPACT**	Nı any preventive action	Poor area, There is no enviromental resources or biological diversity or no eclogical value.	No need to use any EMS constituent	

Figure 7.1: Impact Magnitude Scale.

The main axis of the model, impact magnitude which is measured through a systematic is to reduce with combination of EMS constituent which are ISO 9001, ISO 14001, OHSAS 18001 and Remediation. The main aim of the mentioned systems in this study is to avoid degrade or reduce any pollution which is produced by facility.

Each of the four elements of the above mentioned IMS gives an opportunity to decision maker to reduce the negative effect which came from facility as danger and treat characteristic of products.

The purpose of this model is to assess the correlative impact of hazardous substances and ecosystem properties with the help of a scale. This evaluation model is used to estimate the fate of EIA as a quantitative support. This scale is shown in Figure 7.1 (Talınlı İ, Öngen A, 1999).

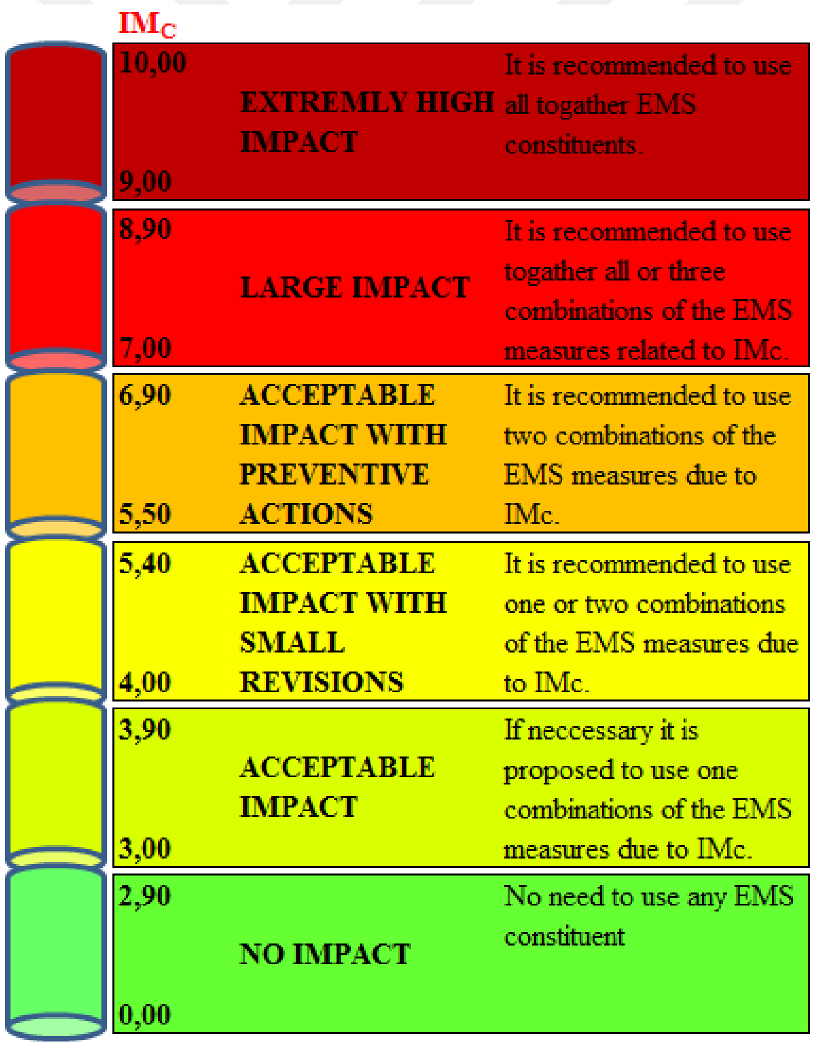


Figure 7.2: Rank of combination of IMS.

Figure 7.2 is shown which the IMS combination will be chosen according to IMc value. Depending on the any impact value that will be used with EMS combinations, scale values are given in Figure 7.2.

In order to provide environmental protection, the possible affects must be considered by enterprise owners and/or industrialists before activity of the construction.

For this, the assessment process should be done before starting the relevant activity.

In addition that it also requires the preparation of emergency action plan.

EIA report should be assessed based on environmental characteristics and project evaluations. For the fate of the project, decision-makers should give decisions as positive /negative based on mentioned assessment before the installation of construction.

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