

**"Sustainable Strategic Management of Sangan Iron Ore Mines
in Iran"**

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TABLE OF CONTENTS

Contents	Page number
Preface	vi
Introduction	1
Chapter 1: Overview about Mining in Iran and Sangan Iron Ore Mines (SIOM)	11
1 Overview about mining in Iran and Sangan Iron Ore Mines (SIOM)	12
1.1 Introduction	12
1.2 Islamic Republic of Iran -General outlook	13
1.3 History of mining in Iran	14
1.4 Current situation of Iran's mining and mineral industries	17
1.5 Main minerals in Iran	23
1.5.1 Copper	23
1.5.2 Iron Ore	23
1.5.3 Aluminum	24
1.5.4 Gold	24
1.5.5 Coal	25
1.5.6 Zinc	25
1.6 IMIDRO	26
1.7 Sangan Iron Ore Mines (SIOM)	29
1.7.1 General description of SIOM	29
1.7.2 A brief history of SIOM	30
1.7.3 Summery of exploration results	32
1.7.4 Structure of the main companies and development projects in SIOM	33
1.7.5 Brief geology description of SIOM	36
1.7.6 SIOM climate data	36
1.7.7 Site setting and topography	37
1.7.8 Hydrology	37
1.7.9 Mining and milling	38
Chapter 2: General Aspects of Sustainable Development in Mining	40
2 General aspects of sustainable development in mining	41
2.1 Sustainable Development	41
2.1.1 Definition	41
2.1.2 Sustainable development and international necessity	44
2.1.3 Difficulties in implementing sustainable development	46
2.1.4 Sustainable development governance at the international, regional and national levels	50
2.1.4.1 Strengthening sustainable development governance at the international level	50
2.1.4.2 Strengthening sustainable development governance at the regional level	51

2.1.4.3 Strengthening sustainable development governance at the national level	51
2.2 Sustainable development indicators (SDIs)	52
2.2.1 Purpose and quality of indicators.....	52
2.2.2 Criteria for sustainable development indicators.....	54
2.3 Sustainable mining	58
2.3.1 General aspects of sustainable mining	58
2.3.2 Outlining the sustainable development agenda for mines.....	63
2.3.3 Sustainable mining practices – a holistic model.....	65
2.3.4 Main principles of sustainable development in mining and mineral industries	74
2.4 Sustainable development issues for mine closure	79
2.4.1 Environmental issues	83
2.4.2 Socio-economic issues	83
2.4.3 Business case.....	84
Chapter 3: Status of Sustainable Development in Sagan Iron Ore Mines (SIOM).....	86
3 Status of sustainable development in Sangan Iron Ore Mines (SIOM).....	87
3.1 Sustainable development in SIOM	87
3.1.1 Social aspects	87
3.1.1.1 Building high school for girls.....	87
3.1.1.2 Construction of a new technical school.....	90
3.1.1.3 SIMP and IEIOC employees’ charity	92
3.1.1.4 Construction of three residential homes.....	93
3.1.1.5 Assistances to different organizations of Khaf County	94
3.1.1.6 Employment	96
3.1.1.7 Decreasing criminal activities.....	97
3.1.1.8 Measures to improve occupational safety and health	97
3.1.2 Environmental aspects.....	114
3.1.3 Economic aspects	120
3.1.3.1 IMIDRO`s economic strategy	122
3.1.3.2 Economic achievements	123
3.1.3.3 Economic effects of mining on development degree of Khaf County.....	131
Chapter 4: Sustainable Strategic Management in Iranian Mining Sector...133	
4 Sustainable strategic management in Iranian mining sector	134
4.1 Introduction into strategic management and strategic planning.....	134
4.1.1 Definition	134
4.1.2 The strategic management process.....	135
4.1.2.1 Strategic analysis and planning.....	136
4.1.2.2 Strategy formulation and strategic decision- making	137
4.1.2.3 Strategy choice	137
4.1.2.4 Strategy implementation	137
4.1.3 The strategic analysis and planning tools	138
4.1.3.1 PESTLE analysis	138
4.1.3.2 Porter’s five forces	139

4.1.3.3	The balanced scorecard.....	140
4.1.3.4	SWOT analysis.....	141
4.2	Sustainable development in strategic management	143
4.2.1	Terminology and theoretical considerations	143
4.2.2	Sustainability principles	144
4.2.3	Framework for strategic sustainable development.....	145
4.3	Framework for sustainable strategic management in Iran	147
4.3.1	Sustainable development in Iran according to international scale	147
4.3.1.1	International standards.....	149
4.3.1.2	The extent of environmental problem	152
4.3.1.3	Policy and legislative context	153
4.3.2	Sustainable development in Iran according to religious concerns	154
4.3.2.1	Islam and the environment	154
4.3.2.2	A glance at basics	155
4.3.2.3	A general introduction to Islam's attitude towards the conception of the universe, nature, natural resources and the relation between man and nature.....	156
4.3.2.4	Protection and conservation of all basic natural resources	158
4.3.2.5	Islamic principles and institutions governing the protection and conservation of the environment.....	161
4.3.2.6	General rules for protecting the environment from harm	162
4.3.2.7	General rules for not wasting the earth's resources.....	163
4.3.2.8	Conclusion	165
4.3.3	Sustainable development according to national agreements and regulations in Iranian mining sector	166
4.3.3.1	The general policies of the Islamic Republic of Iran.....	166
4.3.3.2	Constitution of the Islamic Republic of Iran.....	169
4.3.3.3	Rules, regulations, special laws and statutes relating to mining	170
4.3.3.4	Environmental protection and improvement law	173
4.3.3.5	Rules and regulations of the first to fifth five-year development plans of the Islamic Republic of Iran.....	174
4.4	Basic documents for strategic development in Iranian mining sector.....	177
4.4.1	Iranian mine sector strategic document.....	177
4.4.1.1	Directed pillars and strategic elements.....	179
4.4.1.2	Macro strategies in the main activities of the country mine sector	181
4.4.1.3	Operational strategies in the main activities of country mine sector	181
4.4.2	IMIDRO's strategy documents.....	181
4.4.2.1	IMIDRO's first strategic plan	181
4.4.2.2	IMIDRO's second strategic plan.....	183
4.4.2.3	IMIDRO's third strategic plan.....	184
4.5	Stakeholder model for SIOM	187
4.5.1	Literature review (definitions and concepts).....	187
4.5.2	Stakeholders theoretical approaches.....	188
4.5.3	Stakeholders identification and classification	189
4.5.4	Key stakeholders determination	190

4.5.5 SIOM key stakeholders	190
4.5.6 The main expectations of key stakeholders of mining sector in relation to the sustainable development.....	194
4.6 Strategy formulation for SIOM	196
4.6.1 Initiating stage	196
4.6.2 Input stage	198
4.6.2.1 External factors.....	198
4.6.2.2 Internal factors	203
4.6.3 Matching stage	207
4.6.3.1 SWOT analysis.....	207
4.6.3.2 Internal-external analysis	210
4.6.4 Decision making stage.....	211

Chapter 5: Stakeholder Surveys about SIOM, Results and Consequence...215

5 Stakeholder surveys about SIOM, results and consequences	215
5.1 Measures and results.....	215
5.1.1 Statistical analysis of population growth rate and literacy rate in Khaf County in comparison to Khorasan-e-Razavi Province and Iran.	215
5.1.1.1 Population growth rate	215
5.1.1.2 Literacy rate	218
5.1.2 Results of questionnaire NO. 1 (QN1).....	220
5.1.2.1 General questions	221
5.1.2.2 Social responsibility questions.....	222
5.1.2.3 Main conclusions from QN1	224
5.1.3 Results of questionnaire NO. 2 (QN2).....	225
5.1.3.1 Marital status and gender	225
5.1.3.2 Degree of education	226
5.1.3.2 Population variety.....	227
5.1.3.3 Literacy	229
5.1.3.4 Girls' high school and boys' technical school	230
5.1.3.6 Employment	231
5.1.3.7 Health.....	235
5.1.3.8 Transportation	236
5.1.3.9 Air pollution	236
5.1.3.10 Water and soil conditions.....	237
5.1.3.11 Social security	237
5.1.3.12 SIOM projects acceptance	238
5.1.4 Comparison and analysis of questionnaires NO. 1 and NO. 2.....	238
5.2 Selecting sustainable development indicators for SIOM.....	239
5.2.1 Sustainable development indicators of SIOM.....	240
5.2.2 Selection of indicators using Fuzzy Delphi Method.....	242
5.2.3 Results	246
5.3 Calculation of selected SD indicators for SIOM.....	248
5.3.1 Social indicators	248
5.3.1.1 Life expectancy	248
5.3.1.2 Net enrolment rate in primary education.....	249
5.3.1.3 Nutrition status of residents.....	252
5.3.1.4 Access to primary sanitary facilities	254

5.3.1.5 Access to electricity and other energy sources	256
5.3.2 Economic indicators.....	258
5.3.2.1 Length of railway	258
5.3.2.2 Ratio of annual electricity consumption in mining sector to total energy consumption in Khaf County	260
5.3.2.3 Increase in family's income (per capita).....	262
5.3.2.4 Length of roads	267
5.3.2.5 Employment-population ratio	270
5.3.3 Environmental indicators.....	273
5.3.3.1 Water consumption in Sangan mining complex	273
5.3.3.2 Area of land assigned to mining activities	275
5.3.3.3 Ratio of sanitary disposed solid waste to total solid waste produced	278
5.3.3.4 Solid waste production	280
5.3.3.5 Wastewater production.....	283
5.4 Strategic measures according to the SDIs' calculation.....	286
Chapter 6: Conclusion, Outlook and Suggestions.....	288
6 Conclusion, outlook and suggestions	289
6.1 Conclusion: strategic challenges and solutions.....	289
6.1.1 Water shortage	289
6.1.2 Lack of transportation capacity	289
6.1.3 Waste and tailings	290
6.1.4 Religious conflicts.....	291
6.1.5 Resource nationalism.....	292
6.1.6 Post mining management	293
6.2 Outlook: SIOM as a role model for sustainable mining in Iran	295
6.3 Suggestions for similar mining countries	297
6.4 Suggestions for mining in Islamic countries	298
6.4.1 Islam and the environment	298
6.4.2 A general introduction to Islam's attitude towards the conception of the universe, nature, natural resources and the relation between man and nature.....	299
6.4.3 Protection and conservation of all basic natural resources	300
6.4.4 Islamic principals and institutions governing the protection and conservation of the environment	300
6.4.5 Water as a scarce resource.....	301
Appendixes.....	viii
References	lii
Abstract.....	lxxv

PREFACE

Being involved directly as executive director of Sangan Iron Mine Project in Iran, I decided to continue my study at PhD level in a country with brilliant background in mining industry. So I selected RWTH Aachen University, Germany as my destination for completing my studying. During the period of my dissertation, I gained many new and useful experiences and learned a lot about subjects related to my thesis. They opened a new horizon to me and changed my attitudes in the case of sustainable strategic management. Because of this:

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This research is dedicated to the memory of my father, who has always been alive to me and I still feel his spiritual presence.

INTRODUCTION

This PhD project, as an academic research, aims at formulating sustainable strategies for managing a very rich iron ore resource in the eastern part of Iran named Sangan, near the boundary of Afghanistan.

The government of Islamic Republic of Iran along with private institutions' cooperation intends to implement several different phases in this region to produce steel industries feeds for developing this area sustainably. Besides, there are specific situations in this region which clarify the reason of selecting Sangan Iron Ore Mines (SIOM) as research's case study: arid weather condition, critical water shortage, region's geopolitical condition, religious conflicts, limited development in infrastructures, and prevalence of criminal activities.

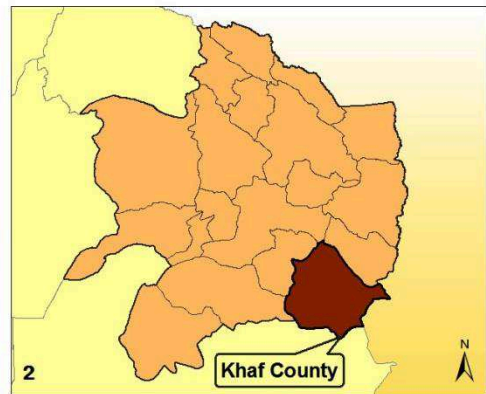
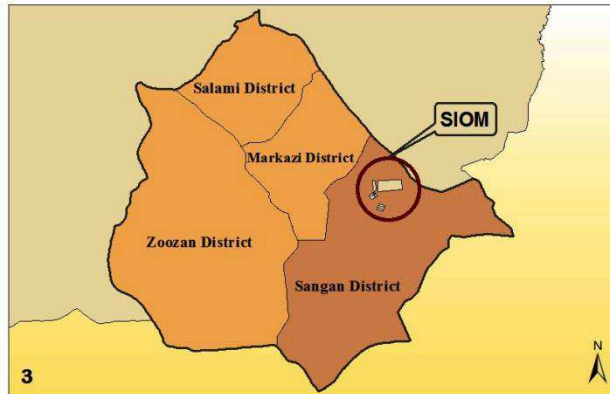
This PhD project was supported by Iranian Mines and Mining Industries Development and Renovation Organization (IMIDRO), the owner of SIOM.

General description of SIOM

The SIOM which belongs to IMIDRO is divided into three major districts (Western, Central and Eastern Anomalies) that contain a total geological resource of 1.2 billion tons, most of which is magnetite with a Fe grade ranging from 27 – 61%. The ore deposits are located mainly in Western and Central Anomalies and detailed exploration in Eastern Anomalies is still ongoing. The Sangan iron ore deposit is located at latitude N 34°24', longitude E 60°16' in the Khorasan-e-Razavi Province, North-Eastern Iran about 300 Km. far from Southeast of Mashhad.

The iron ore deposit is about 20 km Northeast of Sangan town at about 1650 meters above sea level. The plain starts at the foot of the hills at elevation around 1200 m.

- 1- Location of Khorasan-e-Razavi Province in Iran (I.R.O.)
- 2- Location of Khaf County in Khorasan-e-Razavi Province
- 3- Location of Sangan District and Sangan Iron Ore Mines in Khaf County



SIOM Geographical Location

Sustainable development; international and national necessity

Sustainable Development (SD) isn't just about the environment. It also provides steps for action that will create a better future for those of us who live on this planet aside from environmental issues. It is generally accepted that sustainable development calls for a convergence between the three pillars of economic development, social equity, and environmental protection on international and national levels.

The principal requirements for strengthening sustainable development governance at the international level are to strengthen monitoring, coordination and implementation of sustainable development including reinforcing links and collaboration between the policy and operational levels. The international system should commit to a development agenda that meets the goals of sustainable development and in this context applies balanced and integrated consideration of economic, social and environmental factors in policy development and implementation.

Countries should continue to promote coherent and coordinated approaches to sustainable development governance at the national level as this, in part, provides an important element for achieving coherence and consistency at regional and international levels.

According to the above explanations, reaching to sustainable development in mining and minerals industry in all over the world is an international and national necessity. Thus, nations specially developing ones need to examine how mining industry is affecting their social, environmental and economic conditions, if it is in a sustainable manner and what strategies can be set to ensure ongoing sustainable growth of these aspects within the nation.

Sustainable development in SIOM

SIOM is an example of a large scale mining area which is located on a special geographical and remote area. During the development of the mining complex, favorable economic, environmental and social relevant activities have been realized in the Sangan area which is mentioned below. In general, these activities have contributed positively to the development of the region¹. Main SD achievements in social pillar include:

- Construction of the first high school for girls
- Construction of a new technical school
- Establishing a charity fund
- Sponsoring local organizations financially
- Job creation and employment
- Improving occupational safety and health
- Reduction in criminal activities in the region

Main SD achievements in environmental pillar include:

- Preparation of environmental impact assessment (EIA) report
- Preparation of environmental management plan (EMP) report
- Frequent monitoring and auditing program

¹ J. Kretschmann and R. Amiri (2015), *How To Select The Most Appropriate Indicators For Sustainable Mining – A Case Study Of Sangan Iron Ore Mines (SIOM) In Iran*, Sustainable development in Mining Industry (SDIMI) Conference, 12-15 July Vancouver, Canada

Main SD achievements in economic pillar include:

- Improvement in infrastructures and other facilities
- Growth of industry section
- Development of road construction
- Development of railways

Research necessity

According to the Iranian government's strategies for increasing the minerals exploitation and export and the goal of self-dependency in this sector, new capacities have been defined for exploitation of iron ore especially in Khorasan-e-Razavi Province. Since damaging the surrounding environment of mines is inevitable, measures are required to insure the technical and optimum exploration and exploitation with the least unfavorable impacts. Considering the diversity of stakeholders and legislative constraints, it is necessary to have a conceptual model for formulating sustainable managerial strategies for mines and minerals industry. *Sustainable Strategic Management* is a new concept in Iran and this research will be the first one in this kind.

Bringing such a concept into action for the first time in Iranian mining sector will facilitate future planning and management not only for SIOM – as the case study – but also for other Iranian mines' management boards. Since Islamic laws and regulations were reviewed as part of this study, the outputs can be applied by other Islamic countries in which mining has a share in their GDP. The results of the research, as a role model, can be used and generalized to other developing mining countries like Iran, too.

Motivation for studying

Iran is a rich country in culture and natural resources. According to international rankings, Iran has the world's largest zinc reserves, in addition to 2nd largest reserves of copper, ninth largest reserves of iron and eleventh largest reserves of lead². As stated by US Geological Survey in 2009, Iran has the 8th rank in producing world's Iron ore. No wonder that Iran as a developing country aims at exploiting these

² http://en.wikipedia.org/wiki/International_rankings_of_Iran

resources to accelerate its economic blooming. Hence, equipping and developing mines and mineral industry has had the top priority when defining country's development plans.

Mining activities from exploration, exploitation to extraction and transportation have adverse effects on surrounding environment of the mining site which in long- run can lead to irreversible damages to the nature. Besides, communities inhabiting in vicinity of mining sites depend heavily on natural resources for life. Therefore, any impact threatening the resources endangers the livelihood of settlers. Based on national laws and regulations, it is obligatory to conduct Environmental Impact Assessment (EIA) studies on mining complexes to anticipate and prevent, and mitigate adverse impacts. However, according to research on status quo of mining sites and their surrounding environments, the situation doesn't comply with standards which mean environmental quality is mostly ignored in process of development. According to Environmental Performance Index (EPI) published in 2010 by Yale University, Iran was the 78th country among 153. This proves that sustainability should be engaged more in business sector which requires formulation of realistic strategies according to status quo of the country.

Sustainable strategic management is almost a new concept in Iran and is discussed only theoretically in academia. There was a necessity to adopt new approaches toward managing natural resources, and I - as former executive manager of Sangan Iron Ore Complex – decided to apply this approach to SIOM to formulate strategies which include economy, society, and environment.

Research purposes

The main purposes of this research are:

1. Introduction of mining in Iran and SIOM as one of the largest and richest iron ore deposits in Iran and also in Middle East (Chapter 1)
2. Reviewing what sustainability in mining and mineral industry means (Chapter 2)
3. Determining what aspects of SD should be improved in SIOM (Chapter 3)
4. Applying strategic management to achieve sustainable development goals in SIOM (Chapter 4)

5. Selecting appropriate sustainable development indicators and calculating them to measure the realization of sustainability in the region (Chapter 5)

Research objectives

1. Reviewing approaches to sustainable development in mining and minerals industries and its importance on international and national level (Chapter 2)
2. Examining the status of SD in Sangan Iron Ore Mines from social, economic and environmental aspects (Chapter 3)
3. Identifying the position of sustainable development in Iranian laws and regulations (Chapter 4)
4. Identifying the position of sustainable development in Islamic thoughts and jurisprudence (Chapter 4)
5. Determining the stakeholders in SIOM and considering their expectations in strategies (Chapter 4)
6. Formulating strategies for SIOM sustainable strategic management and presenting a role model for other Iranian mines and other Islamic countries (Chapter 4)
7. Interviewing local stakeholders and learning their perspectives and priorities regarding SIOM (Chapter 5)
8. Determining the main future challenges in SIOM and recommending solutions to facilitate the implementation of sustainable strategic management (Chapter 6)

Scope of the research

Defining sustainable strategies for a mining complex such as SIOM which has national importance needed comprehensive studies. To prevent distractions during research process, the main focus of the dissertation was put on:

- Status quo of SIOM concerning sustainability
- Selecting sustainable development indicators applicable to SIOM and their calculation

- Reviewing Iranian rules and regulations and Islamic thoughts to define realistic strategies with support of law and religion
- Identification of stakeholders in SIOM to include their interest in strategies
- Presenting a role model for sustainable strategic management in Iranian mining sector

Main contents

Following issues are covered in the dissertation:

- Sustainable mining, requirements and approaches
- Progress of sustainable development in SIOM
- Sustainable development in Iranian regulations and in Islam
- SWOT analysis of SIOM and identification of stakeholders
- Calculation of selected sustainable development indicators for SIOM, and
- Formulation of strategies for sustainable management of SIOM

New concept of the dissertation

- The term “sustainable development” has been introduced since 1987, but its envisioned goals have not achieved fully yet. One reason is qualitative essence of this term. Therefore, indicators were suggested to have quantitative tools to assess sustainability. On this research, SD indicators were selected through a multi-hierarchy process, to evaluate the progress of the region and SIOM in achieving SD.
- Internal and external stakeholders were identified to increase the social acceptance of the resultant strategies.
- SWOT analysis was conducted to have realistic idea of the situation of case study.
- Presenting a conceptual model of sustainable strategic management of SIOM and introducing it as a role model to other nations, specially Islamic and developing ones which are dependent on natural resources for growth.

Structure of the dissertation

The dissertation is written in 6 chapters, with supplementary parts such as the preface, appendices and references. In addition to reasons for study, purposes and objectives of the research, the theoretical and practical concepts of the research and study methods are given in the introduction.

Chapter 1: Overview about mining in Iran and Sangan Iron Ore Mines

This chapter reviewed the history of mining in Iran, status of mining and minerals in Iran and its international ranking, introduction of SIOM and its development projects and future plans.

Chapter 2: General Aspects of Sustainable Development in Mining

This chapter covers fundamentals of sustainable development and approaches toward sustainability in mining section. Sustainable development indicators and post-closure strategies were also presented. The output of this chapter helped to assess the different aspects of sustainability in SIOM.

Chapter 3: Status of Sustainable Development in Sangan Iron Ore Mines (SIOM)

SD in SIOM as the case study was comprehensively studied in this chapter. Economic, social and environmental aspects of sustainability in SIOM were pinpointed to present a better view of what the complex has achieved so far. It could be concluded as the result of this chapter that the mining activities of SIOM in the region has not only helped neighbor villages and cities to grow, but also had favorable impact on Khorasan-e-Razavi Province in general.

Chapter 4: Sustainable Strategic Management in Iranian Mining Sector

In this chapter, fundamentals of strategic management and its methods were presented. As this kind of managing is in direct relevance with each country's national and religious considerations, Iranian national laws and regulations were examined thoroughly. Moreover, Islamic thoughts and the Holy Quran verses were studied to define the importance of environment, nature conservation and sustainable development from religious point of view. And finally managerial strategy of SIOM was defined by using SWOT analysis.

Chapter 5: Stakeholder Surveys about SIOM, Results and Consequences

Local stakeholders were surveyed twice during the study period. The results were presented in this chapter. Moreover, the most suitable indicators

applicable to SIOM were selected by using Fuzzy Delphi Method (FDM). Calculation, interpretation and recommendation were followed after selection part.

Chapter 6: Conclusion and Outlook

According to the results of each chapter, main challenges that SIOM faces in future were listed in this chapter and solution(s) were suggested for each. Besides, it was discussed how this study can be a role model for other Iranian mining companies and also for other countries – especially Islamic ones - where mining is a driving force for economic development.

Research methods

- I. The main step in conducting the research was studying scientific literature on sustainable development, SD indicators (SDIs), strategic management, stakeholders' analysis, national regulations and Islamic jurisprudence by a ***systematic method***.
- II. ***Surveys and field research*** were conducted to get local stakeholders' opinions about SIOM in the region.
- III. ***Statistical methods*** were used to analyse the output of surveys.
- IV. ***Multi-criteria decision making method*** and ***experts' consultation*** was applied to get experts' opinions about suitable SDIs for SIOM.

Contributions of the dissertation

The results of this dissertation enable decision-makers and managers to get familiar with:

- The concept of sustainability and sustainable development in mining and mineral industry,
- Application of multi-hierarchy methods to facilitate selection process,
- Sustainable development indicators and their practice in strategy formulation and development planning,
- Iranian rules and regulations which support sustainability
- Islamic thoughts which emphasize the importance of natural resources and their conservation,

- Necessity of identifying stakeholders of a project to improve social acceptance,
- SWOT as one of strategic planning methods and how to apply it for managerial purposes, and
- Sustainable strategic management as a new approach to plan for natural and human resources.

Chapter 1

Overview about Mining in Iran and Sangan Iron Ore Mines (SIOM)

1 Overview about mining in Iran and Sangan Iron Ore Mines (SIOM)

1.1 Introduction

Mining and the minerals industry are important sectors in many developed, developing and poor countries. However, the mining industry in comparison with many other industries is known to be risky and its successfulness depends on and is sensitive to, economic, environmental, social, political and other circumstances³.

Exceptional in terms of its mineral diversity, Iran produces 68 minerals, and is ranked among the world's 15 most mineral-rich countries. In accordance with the statistics published by Statistical Center of Iran (SCI), there were 5316 active mines and 84922 employees in whole of country in 2012-13⁴ and in accordance with the statistics published by Central Bank of Iran (CBI) in the years 2013/14 and 2014/15, the share of this sector in the GNP⁵ of the country were 1.0 per cent⁶.

According to a report from the former Ministry of Industries and Mines, total mineral resources (at 'shallow depth') are estimated at 55,000 Mt of which 37,300 Mt are in the measured and indicated categories⁷.

Sangan Iron Ore Mines (SIOM) is one of the largest mineral areas in Iran, and also considered to be one of the Middle East's richest deposits which are located in a rectangular area with 26km length and 8km width. These iron ore deposits contain a total geological resource of 1.2 billion tons of mostly magnetite with a Fe grade ranging from 27 to 61%⁸. Based on the importance of this mining area, a strategic management program will be very important for SIOM and finally helpful for Iran's mineral industries and GDP.

The main aim of this research is presenting a strategic plan for realization of sustainable development in SIOM based on the current situation of this special mining area near the border of Afghanistan.

³ F. Rashidinejad and K. Karim (2011), *Iran Mining Industry Based on the 20-Year Perspective 2025*, second international future mining conference, Sydney, NSW, November 2011, p. 235-244

⁴ Statistical Centre of Iran (SCI) (2013), *Iran's active mine survey report* (Persian)

⁵ Gross National Product

⁶ Central Bank of Iran (CBI) (2015), *Annual Review 1393(2014/15)*, Access at: http://cbi.ir/SimpleList/AnnualReview_en.aspx

⁷ F. Rashidinejad (2008), *Iran Offers Diversity*, Mining Journal, London, March 2008

⁸ Danieli Co. (2008), *Feasibility Study for Sangan Iron Mine Project*, prepared by AMEC America Ltd.

1.2 Islamic Republic of Iran-General outlook

Islamic Republic of Iran covers 1,648,195 square kilometers of land in northern hemisphere and in south western parts of Asia in Middle East, located between 25°3' to 39°47' of latitude and 44°5' to 63°18' of longitude. It borders Afghanistan and Pakistan on its east, Iraq and Turkey to its west, Armenia, Azerbaijan & Turkmenistan along the Caspian Sea to its north and the Persian Gulf and the Gulf of Oman to its south. Besides Tehran (over 12 Million population), other major cities are Esfahan, Mashhad, Shiraz, Tabriz, Ahwaz and Bandar Abbas⁹.

Territories of Iran are located over a folded belt, known as Tethys, stretching from Mediterranean Sea to Himalaya and then to Indonesia. This belt has formed about 1.4 billion years ago. Though, Alpine foldings in about 800 million years ago has triggered transformation of the belt to its current form. The length of Iranian northern seacoast in south of the Caspian Sea is 664 kilometers and the length of southern seacoast at the top of Persian Gulf and Gulf of Oman is 1952 kilometres¹⁰.

Iran's population of about 75.5 Million, around 53.6 Million (two-thirds) live in urban areas. Iran has a predominantly young population with 60% of the population under 30 years of age. According to the statistics published by the SCI in 2011, the population of women was 49.1 percent and urbanized population was 70.99 percent¹¹.

Iranians now hold one percent of the world's population, ranking 10th in Asia and third in the Middle East. Some 46 people live in one square kilometer area in Iran, while in densely-populated countries, 360 people live in the same area. Out of the total population of Iran, 30 percent live in villages and 70 percent in cities¹².

With 8% arable land (main crops are wheat, rice and cotton) and 11% forest cover, Iran's main natural wealth is its oil & gas. Iran in 2011 was the fourth largest oil

⁹ Center for Techno-Economic Mineral Policy Options (C-TEMPO) (a registered society under ministry of mines, govt. of India) (2011), *Country Dossier on Mining & Minerals Iran*, p. 2, Access at: www.c-tempo.org

¹⁰ M. Pezeshkan, A. Jazayeri and B. Damghani (2005), *Mines and Mining in Iran*, IMIDRO publication, Tehran, Iran, p. 15

¹¹ Statistical Centre of Iran (SCI) (2011), *Population clock*, Access at: <http://www.amar.org.ir/Default.aspx?tabid=1603>

¹² M. Nezami Ardashir (2015), *Population of Iranians hits 80 Million*, Iran International magazine, No. 73, March 2015, p. 98, Access at: http://www.iraninternationalmagazine.com/issue_73/II73.pdf

producer (in this year Iran’s oil production was 205,800,000 tons about 5.35% of the whole production in the world), and was 4th largest gas producer (151,800 Mm3 about 4.45% of the world) ¹³. Iran in 2013 was OPEC’s 2nd largest oil producer with around 3.6 Million bpd¹⁴. Vast majority of Iran’s oil reserves are located in onshore fields in Khuzestan region bordering Iraq and in the Persian Gulf. The Iran’s political map is illustrated in Figure 1.1.



Figure 1.1 Iran’s political map¹⁵

1.3 History of mining in Iran

Iran has had an active mining sector for some 7000 years¹⁶ and the Achaemenid dynasty was considered to be the most important period for mining (contributing, for

¹³ C. Reichl , M. Schatz and G. Zsak (2013), *World mining data*, International organization committee for the world mining congresses, Vol. 28/2013, Vienna- Austria

¹⁴ Organization of the petroleum exporting countries (2014), *OPEC Annual Statistical Bulletin*

¹⁵ <http://maps.google.com/?ll=32.990236,53.789063&spn=16.806176,43.110352&t=m&z=5>

¹⁶ F. Rashidinejad and K. Karim (2011), *Iran Mining Industry Based on the 20-Year Perspective 2025*, second international future mining conference, Sydney, NSW, November 2011, p. 235-244

example, the stones at Persepolis)¹⁷. Discovering of ancient metal-mining sites in Iran indicates the existence of rich grades of precious and base metals. Iranian was the world's first industrial nation and the first metal tools were made out of copper, the sickle was used to harvest the crops¹⁸. The 12th century ushered in new metallurgical techniques and the invention of new alloy, brass¹⁹.

Archaeological surveys indicate that Persia (The name *Persia* was the official name of Iran²⁰ in the Western world before 1935)²¹ was among the leading nations in mining activity in ancient times²². Its ancient civilizations, richness of natural resources, and records of ancient mining and metalworking are testimonies to such a claim²³.

The history of mining in Iran can be divided into two periods. The first, the ancient and pre-modern period, is evidenced by abandoned mines where modern Western techniques and equipment, such as earthmoving machinery and explosives, were not deployed²⁴. Such mines can be grouped into three categories based on the materials extracted: (1) mines of metallic ores: iron, copper, gold, lead, zinc, and silver; (2) non-metallic mines and quarries of china clay (used in ceramic and tile making), Bentonite used as soap in ancient Iran, serpentine (used in clay ware); (3) mines of precious and semi-precious stones, such as Turquoise, Emerald, Quartz, Amethyst, Spinel ruby, Jadeite, Ruby and Corundum²⁵.

¹⁷ M. Pezeshkan, A. Jazayeri and B. Damghani (2005), *Mines and Mining in Iran*, IMIDRO publication, Tehran, Iran, p.1

¹⁸ I. Ramtin (2008), *Summary of 10,000 years of Iran's history (pre-Islamic)*, ISBN: 978-964-392-562-8, First publication (Persian)

¹⁹ F. Rezaeian (2009), *IRAN: Seven Faces of a Civilization*, Published by Tolu Ebtekarat Tasviri, Third edition, ISBN: 978-964-04-0569-7 (Persian)

²⁰ On 21 March 1935, the ruler of the country, Reza Shah Pahlavi, issued a decree asking foreign delegates to use the term "Iran" in formal correspondence.

²¹ http://en.wikipedia.org/wiki/Middle_Persian

²² K. A. Alipur (1993), *History of Geology and Mining in Iran*, Published by geological survey of Iran, Tehran, Iran (Persian)

²³ M. Zavosh (1997), *Mineralogy in ancient Iran*, Published by research center of humanities and cultural studies, Iran, August 1997 (Persian)

²⁴ M. Ghorbani (2002), *An introduction to economic geology of Iran*, Geological Survey of Iran, Tehran (Persian)

²⁵ http://en.wikipedia.org/wiki/Middle_Persian



Figure 1.2 Golden Rhyton, Excavated at Ecbatana, Achaemenes Era, 500 BC²⁶

The second, the modern mining period, is marked by utilization of Western techniques. These activities began at the time of Fath-Ali Shah (second ruler of the Qajar dynasty, r. 1797-1834)²⁷, through the efforts of Abbās Mirzā (d. 1833)²⁸, the crown prince.

During the Qajari dynasty, two military envoys of English and French specialists entered Iran during the war between Iran and Russia. There was a mineralogist, in the English envoy, his name was Captain Monteith. He was ordered in 1815 to research the copper and iron mines of Qarajedaq in Azarbayjan. After full research he concluded that there were rich ore bodies in the region. Later, in 1836, a group of experienced engineers and miners, heading by Lindsay, another English man, arrived to Qarajedaq, bringing with them a steam engine. Although they spent a lot of time and money in the mine location, they did not obtain any success²⁹.

Mining activity fell more or less dormant until Rezā Shah's (r. 1925-41) time. In 1925, Reza Shah deposed Ahmad Shah Qajar, the last Shah of the Qajar dynasty, and founded the Pahlavi dynasty³⁰. Then, with the onset of modernization of the country

²⁶ <http://www.livius.org/ia-in/influence/influence03.html>

²⁷ <http://www.iranicaonline.org/articles/fath-ali-shah-qajar-2>

²⁸ <http://www.iranicaonline.org/articles/abbas-mirza-qajar>

²⁹ M. Zavosh (1997), *Mineralogy in ancient Iran*, Published by research center of humanities and cultural studies, Iran, August 1997 (Persian)

³⁰ http://www.en.wikipedia.org/wiki/Rezā_Shāh

based on Western principles and the establishment of various metal industries, modern mining activities were initiated to supply an increased demand for raw materials. These efforts have continued to the present; as a result, more than 4,000 ore deposits and indications are known to exist in the country³¹.

In early years after arrival of Islam to Iran, about one fifth of the income of local rulers was gained from mining and buried treasures, which give us a clue: extraction of mines has continued over the history in Iran. Documentations from 7th century AC, confirm that mines such as Gold, Silver, Turquoise, Marble in Khorasan and Iron, Lead, Sulfur, Oil and Copper in Fars and Gold, Iron and Copper in Kerman and Gold, Silver and Mercury in west of Isfahan had existed³².

1.4 Current situation of Iran's mining and mineral industries

Islamic Republic of Iran holds 68 types of minerals, including Salt, Sand and Gravel, Gypsum, Chrome, Lead, Zinc, Copper, Coal, Gold, Iron and etc. with 37 billion tons of proven reserves and more than 57 billion tons of potential reservoirs, ranked among 15 major mineral rich countries³³. It owns the world's largest zinc reserves, in addition to the 2nd largest reserves of copper, the ninth largest reserves of iron and the eleventh largest reserves of lead³⁴ and with roughly 1% of the world's population possesses more than 7% of the world's mineral reserves³⁵.

Iran was the 10th largest producer country (without construction mineral, in Million metric ton) and the 8th largest producer country (without construction mineral, in Billion US dollar) in 2011³⁶. Iran's total mineral production in 2011 is shown in table 1.1.

³¹ M. Ghorbani (2002), *An introduction to economic geology of Iran*, Geological Survey of Iran, Tehran (Persian)

³² M. Pezeshkan, A. Jazayeri and B. Damghani (2005), *Mines and Mining in Iran*, IMIDRO publication, Tehran, Iran

³³ F. Rashidinejad and K. Karim (2011), *Iran Mining Industry Based on the 20-Year Perspective 2025*, second international future mining conference, Sydney, NSW, November 2011, p. 235-244

³⁴ Center for Techno-Economic Mineral Policy Options (C-TEMPO) (2011), *Country Dossier on Mining & Minerals Iran*

³⁵ http://en.wikipedia.org/wiki/International_rankings_of_Iran/Industry_and_mining, last access 09/2012

³⁶ (26) C. Reichl, M. Schatz and G. Zsak (2013), *World mining data*, International organization committee for the world mining congresses, Vol. 28/2013, Vienna- Austria

Total (include Bauxite)	Iron, Steel-alloys	Non-Ferrous Metals	Precious Metals	Industrial Minerals	Mineral- Fuels
381,178,800	25,700,700	743,500	40	25,620,560	328,414,000

Table 1.1 Iran's total minerals production in 2011 (ton)³⁷

In table 1.2 the production of mineral raw materials in Iran during recent years are shown. It can be seen in this table shows that Iran's total production of mineral raw materials in 2011 was 381,178,800 ton which has considerably increased about 40,895,249 (about 12 percent) in comparison to 2007³⁸.

Table 1.3 below shows the rank (2010 and 2011), production (2011) and the share of world mineral production (2011) by Iran in five groups of production.

³⁷ C. Reichl, M. Schatz and G. Zsak (2013), *World mining data*, International organization committee for the world mining congresses, Vol. 28/2013, Vienna- Austria, p. 41

³⁸ C. Reichl, M. Schatz and G. Zsak (2013), *World mining data*, International organization committee for the world mining congresses, Vol. 28/2013, Vienna- Austria, p. 207

Minerals	2007	2008	2009	2010	2011	Change 2007/2011 (%)	Change 2010/2011 (%)
Iron (ton)	16,640,000	15,091,200	16,956,300	18,841,000	25,511,100	53.31	35.40
Chromium (ton)	59,770	115,670	109,705	91,064	140,000	134.23	53.74
Manganese (ton)	35,020	41,293	42,500	44,540	45,900	31.07	3.05
Molybdenum (ton)	2,500	3,600	3,800	6,683	3,700	48.00	-44.64
Aluminum (ton)	203,600	241,300	281,300	303,000	321,900	58.10	6.24
Antimony (ton)	0	0	0	600	600	---	0.00
Arsenic (ton)	100	100	100	100	100	0.00	0.00
Bauxite (ton)	500,000	520,000	322,800	714,801	700,000	40.00	-2.07
Copper (ton)	244,200	248,100	262,599	210,000	259,100	6.10	23.38
Lead (ton)	31,864	26,905	27,000	25,000	30,000	-5.85	20.00
Mercury (ton)	0	0	0	1 800	1,800	---	0.00
Zinc (ton)	75,000	86,000	115,000	200,000	130,000	73.33	-35.00
Gold (kg)	850	850	850	850	400	-52.94	-52.94
Silver (kg)	40,000	40,000	40,000	40,000	40,000	0.00	0.00
Barite (ton)	280,300	343,750	200,000	269,134	270,000	-3.67	0.32
Bentonite (ton)	180,000	356,989	376,000	542,935	545,000	202.78	0.38
Boron (ton)	1,603	1,150	1,000	1,060	1,000	-37.62	-5.66
Diatomite (ton)	1,500	9,600	2 000	3,000	3,000	100.00	0.00
Feldspar (ton)	512,261	501,821	502,000	533,117	540,000	5.42	1.29
Fluorspar (ton)	68,192	61,592	62,000	59,831	60,000	-12.01	0.28
Graphite (ton)	0	0	0	360	360	---	0.00
Gypsum (ton)	16,000,000	17,691,242	17,700,000	18,313,023	18,300,000	14.38	-0.07
Kaolin (ton)	700,000	945,758	907,487	761,530	762,000	8.86	0.06
Magnesite (ton)	112,229	115,087	130,575	173,530	170,000	51.48	-2.03
Perlite (ton)	30,000	40,307	47,000	19,168	20,000	-33.33	4.34
Phosphates (ton)	40,500	76,143	75,000	108,730	110,000	171.60	1.17
Salt (ton)	2,534,871	2,447,428	2,200,000	2,997,441	3,200,000	26.24	6.76
Sulfur (ton)	1,456,000	1,570,000	1,570,000	1,780,000	1,575,000	8.17	-11.52
Talc (ton)	91,000	90 000	66 383	62 672	63,000	-30.77	0.52
Vermiculite (ton)	0	0	0	1 200	1,200	----	0.00
Steam Coal (ton)	324,000	324 000	104 000	99 000	113,000	-65.12	14.14
Coking Coal (ton)	1,039,000	1,266,000	1,048,000	926,000	1,061,000	2.12	14.58
Nat. Gas (Mio m ³)	111,900	116,300	131,200	146,200	151,800	35.66	3.83
Petroleum (ton)	209,600,000	213,000,000	204,000,000	207,100,000	205,800,000	-1.81	-0.63
Total (t)	340,283,551	348,255,076	352,072,590	371,150,360	381,178,800	12.02	2.70

Table 1.2 Production of mineral raw materials of Iran³⁹

³⁹ C. Reichl, M. Schatz and G. Zsak (2013), *World mining data*, International organization committee for the world mining congresses, Vol. 28/2013, Vienna-Austria, p. 207

Group of production	Type of production	Rank	Rank	Production in 2011 (ton)	Share (%)
		2011	2010		
Iron and Ferro-Alloy Metals	Iron	9	13	25,511,100	1.81
	Chromium	11	12	140,000	1.21
	Magnesite	15	17	45,900	0.24
	Molybdenum	8	7	3,700	1.44
Non-Ferrous Metals	Aluminum	23	23	321,900	0.72
	Antimony	10	11	600	0.4
	Arsenic	7	10	100	0.21
	Bauxite	16	16	700,000	0.34
	Copper	14	16	259,100	1.61
	Lead	16	19	30,000	0.64
	Mercury	1	1	1,800	46.31
	Zinc	14	15	130,000	1.02
Precious Metals	Gold	78	68	400	0.02
	Silver	28	28	40,000	0.17
Industrial Mineral	Barite	6	5	270,000	2.92
	Bentonite	7	6	545,000	3.45
	Boron	8	9	1,000	0.02
	Diatomite	16	15	3,000	0.15
	Feldspar	13	9	540,000	2.22
	Fluorspar	12	10	60,000	0.86
	Graphite	16	16	360	0.03
	Gypsum and Anhydrite	2	2	18,300,000	13.16
	Kaolin	11	9	762,000	2.36
	Magnesite	11	11	170,000	0.68
	Perlite	12	11	20,000	0.86
	Phosphate	25	24	110,000	0.18
	Salt	17	18	3,200,000	1.13
	Sulfur	11	10	1,575,000	2.57
	Talc	16	17	63,000	0.84
Vermiculite	13	11	1,200	0.23	
Mineral Fuels	Steam Coal	44	35	113,000	0
	Coking Coal	17	18	1,061,000	0.11
	Natural Gas (Mio m ³)	4	4	151,800	4.45

Table 1.3 Rank and share of the world mineral production by Iran⁴⁰

A list of some of Iran's mining and mining industries international rankings are summarized in the table 1.4, too.

⁴⁰ C. Reichl, M. Schatz and G. Zsak (2013), *World mining data*, International organization committee for the world mining congresses, Vol. 28/2013, Vienna- Austria

Name	Rank	Source	Notes	Year
Reserves of Zinc	1	British Geological Survey ⁴¹	Iran has the world's largest zinc reserves, in addition to 2nd largest reserves of copper, ninth largest reserves of iron and eleventh largest reserves of lead.	2010
World's largest mining companies	23	World Bank ⁴²	Iran's national mining corporation (IMIDRO) is the world's 23rd largest mining company with 0.6% of the world's total mining production.	2007
Steel production	14	World Steel Association/US Geological Survey ⁴³	More than 10.9 Million tons/year in 2009 and 16.3 Million tons/year in 2014; Iran plans to increase its steel production to more than 55 Million tons/year by 2025.	2014
Iron ore production	12	World Steel Association/US Geological Survey ⁴⁴	Annual production of 38 Million tons	2013
Copper production	14	World Mining Data ⁴⁵	Annual production of 259,100 tons	2011
Gypsum production	2	World Mining Data ⁴⁶	Iran with 18.3 mtpy is the world's 2nd largest producer after China.	2011
Cement production	5	List of countries by cement production / Pie Chart of World's Production ⁴⁷	2009: Annual production of 45 Million tons or ~1.6% of the world's total output	2010
Aluminum production	14	List of countries by aluminum production ⁴⁸	Annual production of 460,000 tons	2011

Table 1.4 Iran's mining and mining industries international rankings

⁴¹ http://en.wikipedia.org/wiki/International_rankings_of_Iran

⁴² http://en.wikipedia.org/wiki/International_rankings_of_Iran

⁴³ World steel committee on economic studies (2014), *Steel Statistical Yearbook 2014*, Brussels, Belgium

⁴⁴ World steel committee on economic studies (2014), *Steel Statistical Yearbook 2014*, Brussels, Belgium

⁴⁵ C. Reichl, M. Schatz and G. Zsak (2013), *World mining data*, International organization committee for the world mining congresses, Vol. 28/2013, Vienna- Austria, p. 207

⁴⁶ C. Reichl, M. Schatz and G. Zsak (2013), *World mining data*, International organization committee for the world mining congresses, Vol. 28/2013, Vienna- Austria, p. 207

⁴⁷ http://en.wikipedia.org/wiki/International_rankings_of_Iran

⁴⁸ <http://www.whichcountry.co/which-country-produces-the-most-aluminium/>

Figures 1.3 and 1.4 illustrate changes in number of employees in the country's mining sector, number of mines, and total value of minerals production, added value and investment value in the country's mining sector between 2002 and 2013⁴⁹.



Figure 1.3 Number of employees in Iran's mining sector and number of Iran's active mines from 2002 to 2013

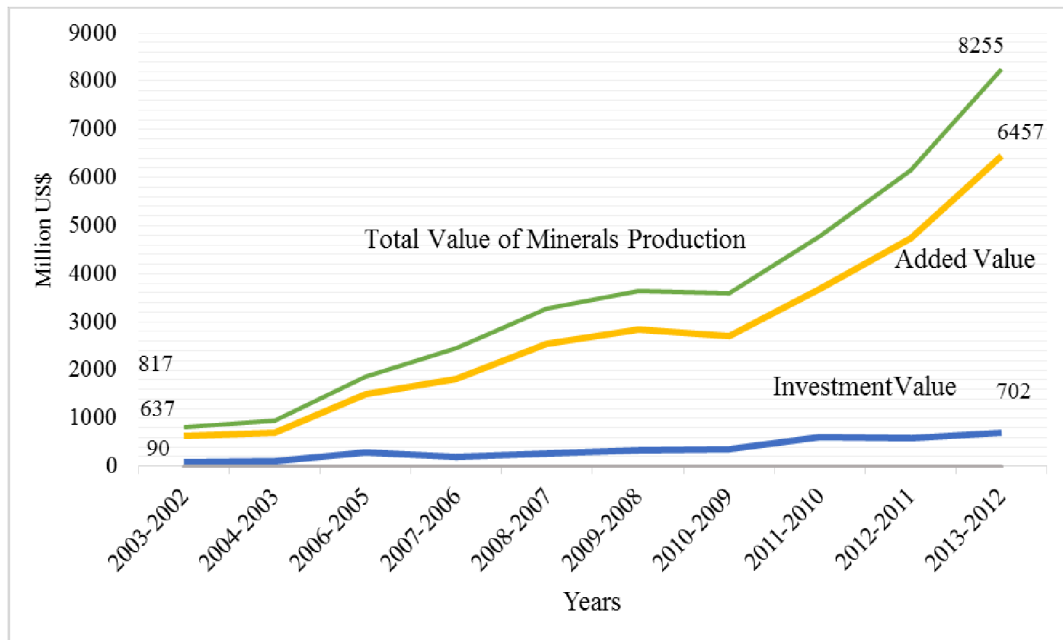


Figure 1.4 total values of Iran's minerals production, added value and investment value in the Iran's mining sector from 2002 to 2013

⁴⁹ Statistical Centre of Iran (SCI) (2013), *Iran's active mine survey report* (Persian)

1.5 Main minerals in Iran

1.5.1 Copper

Iran is located on the global copper strips and has 5% of world copper resources. There are 19 active copper mines in Iran with 15 Million tons of annual extraction. The biggest copper mines are: Sarcheshmeh (in Kerman), Meydook (in Kerman), and Songoon (in Ahar). The amount of copper resources in Iran is 3.2 billion tons. In 2011, Iran produced 259,100 tons copper bullion which showed 6.1% increase from 2007 to 2011⁵⁰.

1.5.2 Iron Ore

The most important iron ores in Iran are located in Kerman, Yazd, Khorasan, Hamadan, and Central provinces (Figure 1.5). The mineral resource of Iran's iron ore is estimated to be 4405 Mt (Table 1.5), but it should be considered as minimum, because further explorations are underway in whole of the country. There are 61 active iron ore mines in Iran of which three mines employed more than 500 persons, one mine employed 300 - 499 persons, five mines employed 100 - 299, five mines employed 50 - 99 persons, seven mines 20 - 49, 11 mines 10 - 19 and 29 mines have under ten employees⁵¹. In the year 2013 the annual extraction of iron ore exceeded 38 Million tons and its export was about 22.5 Million tons. Steel production and export was 15.4 Million tons and 368,000 tons at the end of 2013, respectively⁵².

No.	Mine	Mineral resources (Million tons)		
		Total	Measured	Indicated
1	Gol-e-Gohar	1140	886	254
2	Sangan	1200	375	825
3	Chadormalu	377	330	47
4	Choghart	138	121	17
5	Iran Central Iron Ore Mines	1250	376	874
6	Others	300	100	200
Total		4405	2188	2217

Table 1.5 The most important Iron Mines of Iran⁵³

⁵⁰ C. Reichl, M. Schatz and G. Zsak (2013), *World mining data*, International organization committee for the world mining congresses, Vol. 28/2013, Vienna- Austria

⁵¹ Statistical Centre of Iran (SCI) (2004), *Iran's active mine survey report* (Persian)

⁵² World steel committee on economic studies (2014), *Steel Statistical Yearbook 2014*, Brussels, Belgium

⁵³ F. Rashidinejad and K. Karim (2011), *Iran Mining Industry Based on the 20-Year Perspective 2025*, second international future mining conference, Sydney, NSW, November 2011, p. 235-244



Figure 1.5 Geographical location of the SIOM and some other world class Iranian mines⁵⁴

1.5.3 Aluminum

The 147,000 t/y capacity Hormozgan aluminum complex (Hormozal) was commissioned in January 2009. The plant is located adjacent to the Almahdi Aluminum Corp's smelter at Bandar Abbas, which was working on a 23,000 t/y capacity expansion. In December 2009, Almahdi and Hormozal signed a merger agreement. Other aluminum projects included a new 276,000 t/y capacity smelter under construction at Lamerd for South Aluminum Co. and an 110,000 t/y capacity expansion at Iran Aluminum Company⁵⁵.

1.5.4 Gold

Iran has some gold mine production units and projects as well. One of the most important gold mine project, Zarshouran, including mine development, mineral processing, smelting, tailing dams and required utilities is located in west of Iran. Exploration activities in Zarshouran area were fragmented and limited before 1996,

⁵⁴ F. Rashidinejad and S. Naraghi (2011), *Tailings disposal options study for Sangan Iron Mine Project*, Iran, Proceedings Tailings and Mine Waste, Vancouver, BC, November 2011

⁵⁵ Aluminum International Today (2009), *A summary of existing and new-build smelters in the Middle East*, Quartz Business Media Ltd., 21(1)/ 2009, p. 19-24

carried out by participation of international companies. New round of surveys in Zarshouran area was began in 1995 by Mineral Sport Co, South African company Minorco, a subsidiary of Anglo American and Lumar Consulting. The results of surveys conducted by Minorco showed that the main deposit zone has 800 meters length and true thickness slightly over 20 meters. These surveys confirmed existence of four types of ore. The continuation of exploration was given to Anglo-explorish which evaluated ore reserves at 11.5 million tons with an average grade of 7.9 ppm and as a result existence of 88 tons of pure gold in the mine⁵⁶. The proposed gold facility was expected to have a production capacity of 3,000 kilograms per year (kg/y) of gold, 1,000 kg/y of silver, and 800 kg/y of mercury⁵⁷. According to World Mining Data there was about 53% decrease in gold production from 850 kg to 400 kg during between 2010 and 2011 in Iran⁵⁸.

1.5.5 Coal

Iran's coal resources in four main coal mining area including central and eastern Alborz, Tabas and Kerman is more than 1.5 billion tons. Iran has 130 coal active mines at 2010, from relatively small underground mines in the Kerman Coalfield and from even smaller operations in the Alborz coalfields. Most production in the country is from underground, from relatively thin, locally steeply-dipping seams, and is destined for the steel industry⁵⁹.

In 2010/11, total extraction and export amount of the country were 1.9 Million tons and 43000 tons respectively⁶⁰.

1.5.6 Zinc

As it mentioned in table 1.4, according to British Geological Survey, Iran has the world's largest zinc reserves. The Angouran Zn-Pb deposit, consisting of both carbonate "oxide" and sulfide ores, is located in the Zanjan province of north-west Iran, about 450 km from Teheran. It is the largest Zn deposit of Iran and represents a

⁵⁶ <http://www.iraninternationalmagazine.com/text/zarshouran.htm>, Access on May 2015

⁵⁷ Mining & Development (2010), *Zarshouran gold plant to set up in 2010*, Iranian Mines and Mining Industries Development and Renovation Organization (IMIDRO), 4(38)/ 2010, p. 8 (Persian)

⁵⁸ C. Reichl, M. Schatz and G. Zsak (2013), *World mining data*, International organization committee for the world mining congresses, Vol. 28/2013, Vienna- Austria

⁵⁹ <http://www.mbeni.com/indy/ming/coal/as/ia/p0005.htm>, Access on May 2015

⁶⁰ Central Bank of the Islamic Republic of Iran (2010/11), *Economic trends and Balance Sheet*, Third quarter 1389 (2010/11), No. 62, May 2011, p. 21

world-class ore concentration in terms of Zn reserves and grades. The resources in 1999 were estimated at about 13.5 Mt of non-sulfide ore at 26.4% Zn and 4.5% Pb, 2.0 Mt at 31.2% Zn and 4.1% Pb as mixed “oxide”-sulfide, and 3.2 Mt at 37.0% Zn and 2.32% Pb as sulfide ores⁶¹.

Mahdi Abad mine is a world famous mine for its reservoirs of lead and zinc, known as the richest of its kind with 200 million tons minerals. On 23rd Jan. 2016, the management of Mahdi Abad Complex on behalf of IMIDRO published the call for the international auction for identification and pre-evaluation of the potential investors. This call includes: mining preparation and extraction, construction of process plant with annual capacity of producing 800,000 tons zinc concentrate and 80000 tons of lead-silver concentrate grading 60% as by product, and provision of necessary infrastructures⁶².

1.6 IMIDRO

For determining the overall strategies and policies, executing the projects relating to the construction and the renovation of metal related industries, extraction and processing of mineral products as well as executing exploration projects, the Iranian Mines and Mining Industries Development & Renovation Organization (IMIDRO) was established in 1999⁶³.

The organization aims to survey, prepare for and undertake construction, development, equipment and renovation projects in metallurgy production industries, mining and exploitation of minerals, as well as operating discovery plans. It comprises eight major companies and some 55 operational subsidiaries active in steel, aluminum, copper, cement, and mineral exploitation⁶⁴.

During 2008-2009, IMIDRO took major steps in line with its objectives and also made new efforts in favor of the development of the country, while paying special attention to the development and improvement of the scientific and practical

⁶¹ H. A. Gilg, C. Allen, M. Boni and F. Moore (2003), *The 3-stage evolution of the Angouran Zn "oxide"-sulfide deposit, Iran*, Mineral Exploration and Sustainable Development, Rotterdam

⁶² SMT Newspaper, *Mahdi Abad mine is looking for foreign and local investors*, p. 9, published on 2016/02/03 (Persian)

⁶³ Center for Techno-Economic Mineral Policy Options (C-TEMPO) (2011), *Country Dossier on Mining & Minerals Iran*, p. 5.

⁶⁴ <http://www.imidro.org/SPage/USPage.aspx?ID=531e50f7-09f3-40e9-971e-54ccfc9e3eaa>

capabilities of its employees. These claims are supported by the production, sales indexed and sales within the domestic and foreign markets, as well as special efforts made regarding the privatization of the subsidiary companies⁶⁵.

As it mentioned in table 1.4, according to the World Bank, IMIDRO was the world's 23rd largest mining company with 0.6% of the world's total mining production in 2007. The Fourth Economic, political, social & Cultural Plan of Iran, commencing in March 2005, has paid special attention to the attraction of foreign investment. Hence, IMIDRO has identified a number of opportunities in the expansion of cooperation with foreign investors in line with the country's strategy⁶⁶.

The direct and indirect employment in IMIDRO's mining and mineral industries sector was 180,000 and 500,000 in 2012/13, respectively⁶⁷.

In accordance with the "20-year Perspective 2025" of Iran, the main objectives in mining and mining industries sector include briefly increasing annual production to 55 Mt of crude steel, 800000 tons of copper cathode, 1.5 Mt of aluminum, 200 Mt mineral products, 300000 tons of zinc and 5000 kg of gold under IMIDRO's supervision⁶⁸.

In Figure 1.6, six main industrial plants which have been constructed by IMIDRO are illustrated.

⁶⁵ <http://www.imidro.org/SPage/USPage.aspx?ID=294df506-4856-4888-b8f0-011a43fa1f1f>

⁶⁶ IMIDRO (2011), *Investment Opportunities in Iran's Mines and Mining Industries Sector, Planning and Strategic Management*, Deputy of Planning and Development, November 2011

⁶⁷ IMIDRO (2013), *IMIDRO's Performance Report*, Tehran, Iran (Persian)

⁶⁸ F. Rashidinejad and K. Karim (2011), *Iran Mining Industry Based on the 20-Year Perspective 2025*, second international future mining conference, Sydney, NSW, November 2011, p. 235-244



Hormozal Aluminum Plant



Mobarakeh Steel Plant



Sarcheshmeh Copper Plant



Hormozgan Steel Plant



Zobeahan Esfahan Steel Plant



Gol-e-Gohar Pelletizing Plant

Figure 1.6 Six main industrial plants of IMIDRO

(Adopted from IMIDRO website, 2012)

1.7 Sangan Iron Ore Mines (SIOM)

1.7.1 General description of SIOM

Sangan Iron Ore Mines (SIOM) is one of the Iran's major iron ore resources, which is located 300 km southeast from Mashhad and 18 km northeast from Sangan town at latitude N34°24', longitude E60°16' in the Khorasan-e-Razavi Province, 30 km west of the Afghanistan border, North-Eastern of Iran. The maximum altitude of iron ore deposit is about 1650 meters above sea level and the plain starts at the foot of the hills at elevation around 1200 m⁶⁹.

SIOM, as the biggest iron ore resources in the Zanjan-Semnan-Mashhad iron ore zone in Iran, belongs to IMIDRO as the state owner⁷⁰. There are two access roads from the mine site to Mashhad, which together with schematic view of Khaf County (black circle), are shown in left and right side of Figure 1.7, respectively.

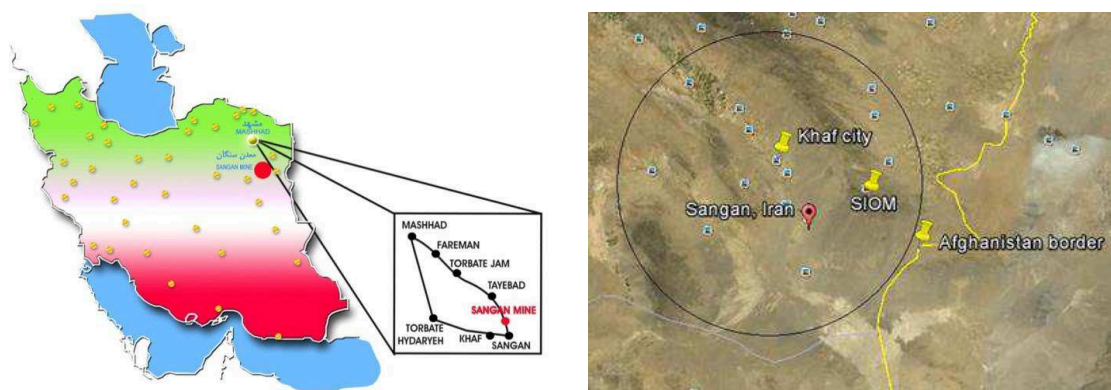


Figure 1.7 SIOM geographical location⁷¹

(The right picture adapted from google earth, 2012)

The deposit of SIOM is also considered to be one of the Middle East's richest deposits. It is located in a rectangular area 26 km long by 8 km wide which has been divided into three major district zones: western, central and eastern. Each of these zones contains several anomalies (Figure 1.8).

⁶⁹ Danieli Co. (2008), *Feasibility Study for Sangan Iron Mine Project*, prepared by AMEC America Ltd.

⁷⁰ IMIDRO (2011), *Investment Opportunities in Iran's Mines and Mining Industries Sector*, Planning and Strategic Management, Deputy of Planning and Development, November 2011

⁷¹ J. Kretschmann and R. Amiri (2013), *Social responsible mining in east Iran: The Sangan Iron Ore Mines*, 23rd World Mining Congress, Montreal, Canada, Canadian Institute of Mining (CIM)

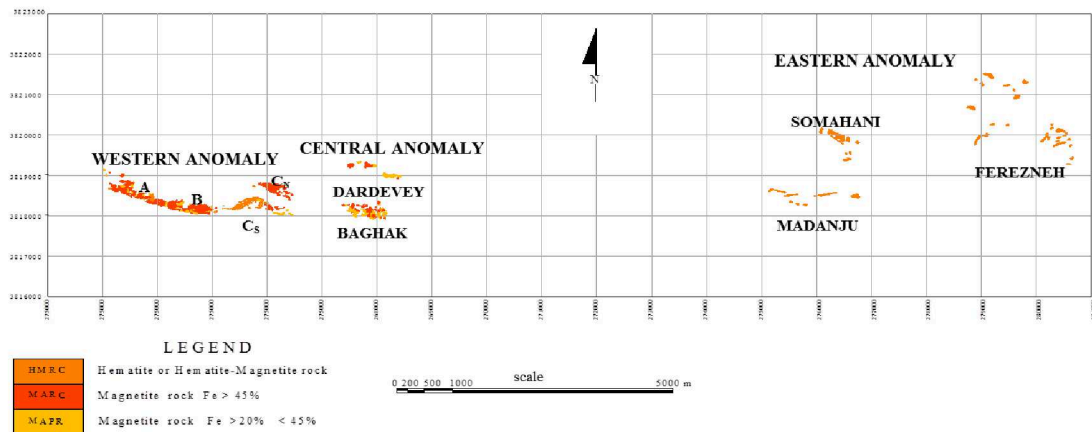


Figure 1.8 SIOM three major zones⁷²

1.7.2 A brief history of SIOM

Remnants of caves and holes in SIOM show that this mine site was known and have been excavated by ancient people. In his book, "Nozhat-Al-Gholub", the first written source to mention these mines, "Hamdollah Mostowfi" has named the place as "Khaf Iron Mine". In other historical sources, it is mentioned that the village "Sangan" has driven its name from the great mass of iron found in the vicinity, and that its original name has been "Sangahan", meaning "iron ore" in Persian language⁷³.

The first official exploration study in Sangan site goes back to 1975, in which "Pey Company", a branch of Iran Barit Company, prepared the primary geological maps of an area of 132 square km and also 63 square km of topographic map⁷⁴. In 1983, National Iranian Steel Company (NISCO) carried out the explorations in Western and Central zones, which continued until 1990⁷⁵. After that and from 1991 to 1993, BHP Engineering performed detailed studies on deposits B and Cn (C north). This Australian Company also prepared the pre-feasibility studies including geological, mineral and metallurgical surveys, along with 1352 meters of drilling⁷⁶.

⁷² Madankav Engineering Company (2012), *Summery of Exploration Reports in Sangan Iron Ore Mines*, February 2012, SIMP technical archive, Sangan, Iran (Persian)

⁷³ H. M. Ghazvini (2010), *Nozhat-ol Gholoob*, Published by Hadise Emrooz, Qazvin, Iran, ISBN: 9647536178 (Persian)

⁷⁴ Madankav Engineering Company (2012), *Summery of Exploration Reports in Sangan Iron Ore Mines*, February 2012, SIMP technical archive, Sangan, Iran (Persian)

⁷⁵ On that time SIOM projects were followed directly by NISCO and IMIDRO doesn't exist.

⁷⁶ Kani Kavan-e-Shargh Company (2005), *Measuring the environmental impact of Sangan Iron Mine Project*, Vol. 1, SIMP technical archive, Sangan, Iran (Persian)

Due to priorities of other activities especially implementation of infrastructures, there was no exploration work done from 1993 to 2004. In 2004 up to September 2010, Madankav Consultant Engineering Company began new exploration studies in central anomalies. About 400 hectares of geological mapping, and 368 borehole drilling that amounted to 96041 meters was done during this time⁷⁷.

Kavoshgaran Consulting Engineers Company undertook further explorations in deposits A and Cs (C south) in western anomalies from September 2010. The result of these explorations so far, has been drilling of 108 wells that amounted to 35276 meters, taking 4447 samples for chemical analysis, revising and preparing geological and topographic maps⁷⁸.

In Figure 1.9 a satellite view of SIOM area is shown.

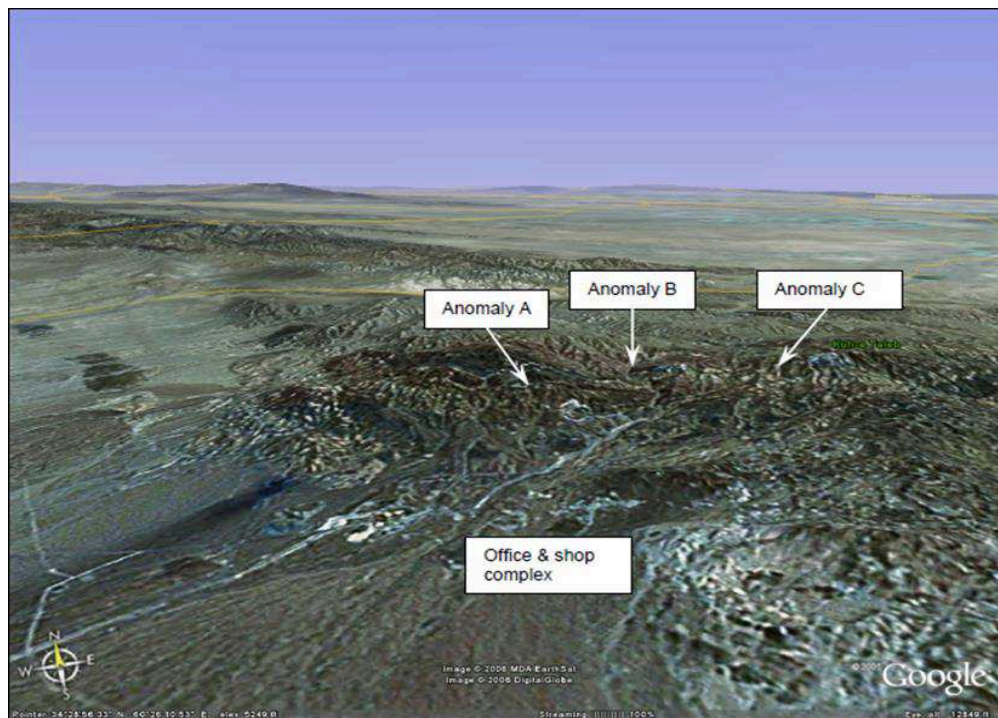


Figure 1.9 Satellite view of SIOM (looking north-east)

(Adopted from google earth, 2012)

⁷⁷ Kavoshgaran Consulting Engineers Company (2011), *Exploration report on anomalies A and C south of Sangam Iron Ore Mines*, SIMP technical archive, Sangam, Iran (Persian)

⁷⁸ Kavoshgaran Consulting Engineers Company (2011), *Exploration report on anomalies A and C south of Sangam Iron Ore Mines*, SIMP technical archive, Sangam, Iran (Persian)

1.7.3 Summery of exploration results

According to the obtained results from exploration activities in the different stages, SIOM contain a total geological resource of 1.2 billion tons of mostly magnetite with a Fe grade ranging from 27 to 61%. The ore deposits are located mainly in Western and Central zone and detailed exploration of the Eastern zone is still ongoing⁷⁹.

In table 1.6, the last exploration details of SIOM according to United Nations Framework Classification (UNFC) Code of mineral resources and reserves are shown.

Zone	Name	Resources and Reserves (Million tons)					Total
		Proved	Probable	Measured	Identified	Inferred	
Western	A	-	-	90	48	35	173
	B	109	22	57	35	12	235
	Cn	51	10	8	28	7	104
	Cs	-	-	108	14	35	157
	A'	-	-	-	14	25	39
Central	Dardvey	99.4	4.2	-	-	31.4	135
	Baghak	139.4	5.7	-	-	39.9	185
Eastern	Anomaly I	-	-	-	-	1	1
	Anomaly II	-	-	-	-	5	5
	Anomaly III	-	-	-	-	10	10
	Anomaly IV	-	-	-	-	10	10
	Anomaly V	-	-	-	-	58	58
	Anomaly VI	-	-	-	-	62	62
Total amount		398.8	41.9	263	139	331.3	1174

Table 1.6 Mineral Resources & Reserves of SIOM based on UNFC code⁸⁰

The Western area includes four big anomalies (A, B, C north and C south) and one smaller anomaly (A') which anomalies A and B are shown in figure 1.10.

⁷⁹ IMIDRO (2011), *Investment Opportunities in Iran's Mines and Mining Industries Sector*, Planning and Strategic Management, Deputy of Planning and Development, November 2011

⁸⁰ Madankav Engineering Company (2012), *Summery of Exploration Reports in Sangam Iron Ore Mines*, February 2012, SIMP technical archive, Sangam, Iran

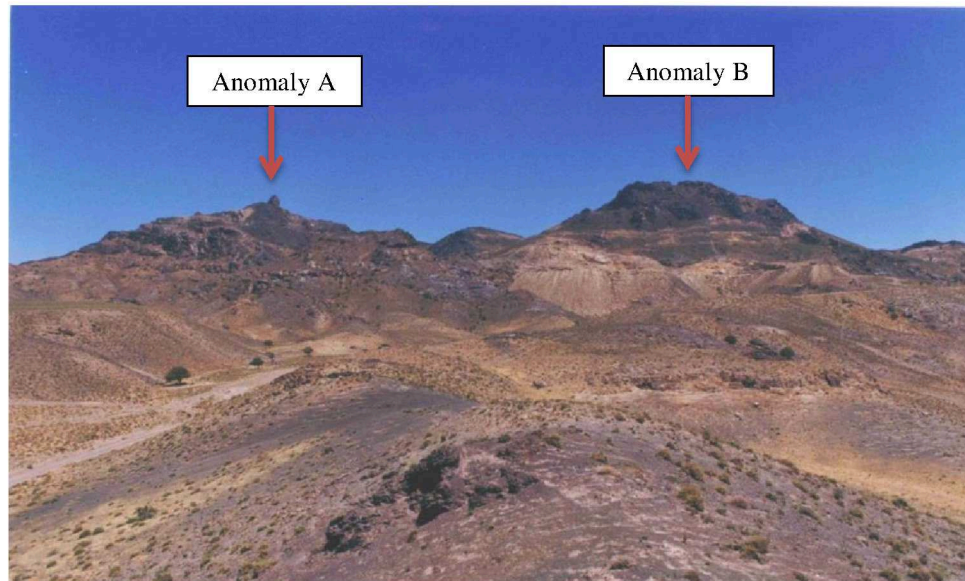


Figure 1.10 Anomalies A and B of SIOM in western zone

(Adopted from SIMP technical archive, 2012)

1.7.4 Structure of the main companies and development projects in SIOM

IMIDRO is developing an open pit mine complex and supporting facilities for the production of iron ore fine and lump, iron oxide concentrate and pellets with private institutions cooperation in SIOM. The total planned production of Sangan projects is about 20.5 million tons per year (MTPY). The iron ore concentrate produced in the process will consist of mainly magnetite, with high iron content which is suitable for the production of direct reduction grade oxide pellets.

The Iranian government has been carrying out exploration (since 1983), building infrastructure (since 2000), preparing mines and constructing an iron ore concentrator plant (since 2008) as the first phase of SIOM development projects which is called Sangan Iron Mines Project (SIMP)⁸¹. In the first phase as the biggest national project in the eastern part of Iran, five MTPY iron ore concentrate and pellet was planned to be produced. In this phase, the first Sangan iron ore concentrator plant with the capacity of 2.6 MTPY (Figure 1.11) was inaugurated in May 2012 and is now in production. The second concentrator plant with the capacity of 2.4 MTPY and pelletizing plant with capacity of 5 MTPY are

⁸¹ J. Kretschmann and R. Amiri (2013), *Social responsible mining in east Iran: The Sangan Iron Ore Mines*, 23rd World Mining Congress, Montreal, Canada, Canadian Institute of Mining (CIM)

under construction as complementary parts of phase one in order to give a total capacity of 5 Mt concentrate and pellet per year⁸².

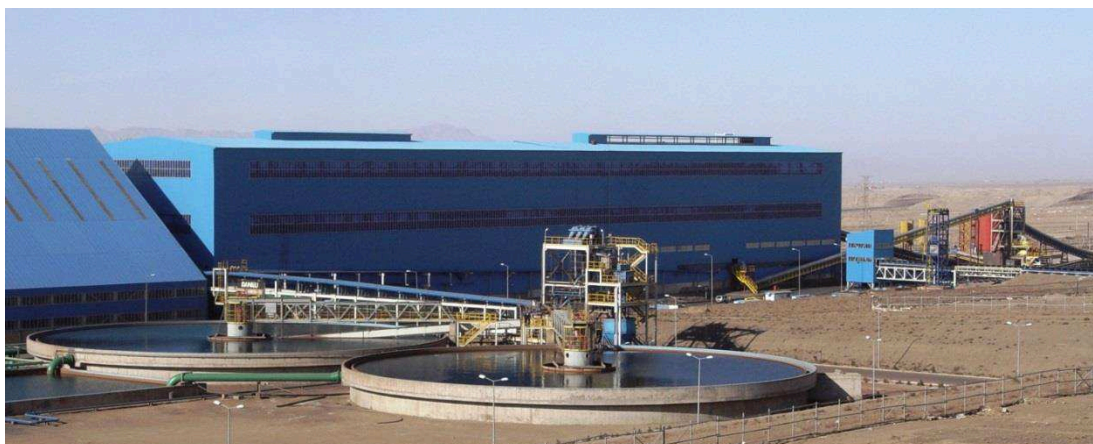


Figure 1.11 The first Sangan iron ore concentrator plant

(Adopted from SIOM technical archive, 2013)

Besides this project, the Iran East Iron Ore Company (IEIOC) as a governmental company has been producing iron ore fine and lump in SIOM since 1989. Sangan Iron Ore Complex (SIOC) has been established by IMIDRO in 2011 to run the first iron ore concentrator plant, too⁸³. SIOC with SIMP and IEIOC were governmental sections and subsidiaries of IMIDRO.

Following to the inviting of the private institutions investors, IMIDRO was transferred 60 % shares of first iron ore concentrator plant with the capacity of 2.6 MTPY and two remaining projects (second concentrator plant with the capacity of 2.4 MTPY and pelletizing plant with capacity of 5 MTPY) in 2015⁸⁴. After that a new private company namely Opal Parsian Sangan Company was established⁸⁵. So, SIMP has finished its activities and the remaining developing projects will be followed by the new private company.

⁸² J. Kretschmann and R. Amiri (2013), *The Sangan Iron Ore Mines: An example for modern mining in Iran*, in Proceedings of the Fourth International Symposium on Mineral Resources and Mine Development, Aachen, Germany, p 517-530

⁸³ Sangan Iron Ore Complex (SIOC) is created by IMIDRO under approval no. H-834/3-7, dated 2011/12/10.

⁸⁴ Donya-e-Eqtesad, Iranian newspaper, *IMIDRO's General Assembly Report*, published on 2015/12/23(Persian)

⁸⁵ According to Iranian law, a private company is that the state's share of it is below 50%.

After establishment of Opal Parsian Sangan Company, SIOC isn't directly involved in operation of the first Sangan iron ore concentrator plant anymore and from 2015 and as a subsidiary of IMIDRO is currently producing 3 MTPY iron ore fine and lump, projects` implementation supervision and preparing the crude iron ore for investors. On the other hand, IEIOC is almost non-operational now and is going to be privatized or merge with SIOC.

The other phases in SIOM will be implemented by Iranian private institutions namely: Mobarakeh Steel Company (5 MTPY iron ore concentrate and pellet plants), Khorasan Steel Complex (2.5 MTPY iron ore concentrate plant⁸⁶), Toseh Melli Investment Company (2.5 MTPY iron ore concentrate and pellet plants) and Kaveh East Steel Company (2.5 MTPY iron ore concentrate and pellet plants)⁸⁷. SIOC on behalf of IMIDRO will be responsible for supplying the all plants feeds. Based on investment contracts, IMIDRO will sell the crude iron ore as raw material to all above mentioned investors at the first stage of crushing point i.e. gyratory crusher area, for 25 years⁸⁸. In the table 1.7, the summery of SIOM suggested products with respect to different groups are shown.

Company (Investor)	Products (MTPY)	Iron ore fine and lump	Concentrate	Pellet
Sangan Iron Ore Complex (SIOC)		3	0	0
Opal Parsian Sangan Company (40 % IMIDRO)		0	2.6 + 2.4	5
Sangan Steel and Iron Ore Company ⁸⁹		0	5	5
Kaveh East Steel Company		0	2.5	2.5
Khorasan Steel Complex Company		0	2.5	0
National Industrial & Mining development Company ⁹⁰		0	2.5	2.5
Total Capacity (which should be transferred)		3	2.5	15

Table 1.7 SIOM suggested products with respect to different investors⁹¹

⁸⁶ The pelletising plant of Khorasan Steel Complex with 2.5 MTPY capacity is under construction in Neyshabour city (in the fence of this complex). So, the produced iron ore concentrate of this complex in Sangan should send to Neyshabour in future.

⁸⁷ IMIDRO (2013), *Summery of Country Steel Master Plan*, Deputy of Infrastructure, Iron Metals Industries Management, December 2013 (Persian)

⁸⁸ The PhD student as the executive director of SIMP was one of the group members in preparation the contracts between IMIDRO and investors in October 2012.

⁸⁹ This company is a subsidiary of Mobarakeh Steel Company.

⁹⁰ This company is a subsidiary of Toseh Melli Investment Company.

1.7.5 Brief geology description of SIOM

The orebody is located in the sequence of sedimentary rocks with Tertiary igneous intrusions located in the Sangam heights forming the northern border of the project site. Limited metamorphism followed by a period of considerable volcanism at this location is believed to be the origin of the regional mineralization producing the iron orebody to be mined. The general stratigraphy of the region comprises a series of alluvial and marine deposits underlain by a sequence of igneous and sedimentary formations ranging from Oligocene to Precambrian. This central eastern portion of the Iranian Plateau is characterized by numerous faults and has resulted in the outcropping of the various strata on both local and regional scales with respect to vicinity to the project site. The current appearance of the regional landscape is believed to result from the late Cretaceous regression of the inland seas from the Iranian plateau that was subsequently uplifted by tectonic movement that included volcanic activity. During the Neogene period, subsidence of this region resulted in the movement of the marine deposits of the Oligocene into the plains resulting in the deposition of conglomerates, limestone, and the Red formation⁹².

1.7.6 SIOM climate data

Climatic data has been recorded at the mine site since 1987. The area is semitropical/arid and semi-alpine with high relief (1700 m altitude in the mineralized areas). Maximum temperatures of 35 to 40°C are experienced in July /August while minimum temperatures of -5 to -15°C occur in January/February. The highest peak, Nole e Khorus, at Sangam falls in orebody A at about 263,900 E, 3,818,520 N and is at 1719.30 m. Less than 150 mm/y of rain is experienced, with rainfall often occurring as torrential showers in April and May. Drainage is generally to the south-west into the alluvial flats of the Khaf basin. Evaporation exceeds rainfall throughout the year and the experiences the Herat high constant winds of 30 to 120 km/h in the summer. Table 1.8 summarizes the climatologic data of Sangam site. Dusty conditions are present. Surface soils are generally of poor quality with gravel predominating. Agriculture is generally limited to

⁹¹ Kavoshgaran Consulting Engineers Company (2016), *General Layout Sangam Comprehensive Map*, Document No.: Rev 02: 79302-KCE-GIS-04-LO-010-02, Jan. 2016

⁹² Danieli Co. (2006), *Geology and model update of Sangam*, prepared by AMEC America Ltd.

irrigated areas. The limited water supply severely restricts vegetation and wildlife⁹³.

Parameters	Amount	Unit
Average Altitude	1240	m ASL
Mean Rainfall	145	mm
Maximum Daily Rainfall	20	mm
Mean Freezing Days	7	days
Maximum Annual Evaporation	3900	mm
Maximum Recorded Daily Snowfall	15	mm
Height of Primary Crusher Area	1440	m ASL
Height of Complex Buildings Area at Plant Site	1150	m ASL
Maximum Temperature at Plant Site (about)	40	°C
Maximum Temperature at Mine Site (about)	32	°C
Minimum Temperature at Plant Site (about)	-2	°C
Minimum Temperature at Mine Site (about)	-15	°C

Table 1.8 Climatologic data of Sangam⁹⁴

1.7.7 Site setting and topography

The concentrator plant located about 5 km south-east of the deposits. The tailings storage facility (TSF) is located to the south-southeast of all the other mine facilities on a broad alluvial plain. The plain is gently graded at approximately 2 to 5 per cent towards the south-southwest and exhibits signs of channelling from water erosion. In the immediate vicinity of the TSF, the elevations range from approximately 1010 m at the southernmost extent to approximately 1120 m at the northern most extent⁹⁵.

1.7.8 Hydrology

At site, water typically drains to the southwest from the hills to the gently sloping terrain. Natural drainages at site are ephemeral and typically do not have well defined bed and banks. Regional flow data was not available for design purposes;

⁹³ F. Rashidinejad and S. Naraghi (2011), *Tailings disposal options study for Sangam Iron Mine Project, Iran*, Proceedings Tailings and Mine Waste, Vancouver, BC, November 2011

⁹⁴ Danieli Co. (2006), *Geology and model update of Sangam*, prepared by AMEC America Ltd.

⁹⁵ Danieli Co. (2006), *Geology and model update of Sangam*, prepared by AMEC America Ltd.

therefore, the design precipitation event combined with watershed information was used to calculate the design flood⁹⁶.

A runoff coefficient of 0.5 representing average runoff conditions was for the water balance. For the calculation of design floods a slightly higher runoff coefficient of 0.6 was used which accounts for more overland flow. These are conservatively high but are considered reasonable estimates of runoff for this area based on the soil conditions and precipitation events. Based on potential ranges in the runoff coefficient, precipitation event and changes in the watershed area caused by avulsions, the 100-year peak flow was estimated to range from 10 m³/s to 26 m³/s⁹⁷.

1.7.9 Mining and milling

Mining is by shovel and truck, open pit method. Ore is hauled to a gyratory crusher located near the mine with the crushed ore delivered from the crusher to the mill via 4.5 km long overland steel cord belt conveyors. Mine waste dumps are created around the periphery of each pit by end-dumping from haul trucks. A geochemical assessment of the waste rock has indicated that waste rock disposal does not represent any significant concern with respect to acid generation or environmental impact. Ore type which contains high sulphur values will require a flotation step to remove pyrite from the concentrate prior to final magnetic separation. The concentration process includes several stages of grinding (AG mill, ball mill and tower mill), with magnetite separation occurring after each grinding stage. Tailings will be produced at each stage, in different proportions depending on the grade and the ore type being processed⁹⁸. A general layout of the first Sangan iron ore concentrator plant and its related mines and tailing storage facility is shown in figure 1.12.

⁹⁶ AMEC Americas Ltd. (2007), *Tailings Dam Design Report*, Report No. DP01R3-AB01-C0000-AS107, SIMP technical archive, Sangan, Iran

⁹⁷ AMEC Americas Ltd. (2007), *Tailings Dam Design Report*, Report No. DP01R3-AB01-C0000-AS107, SIMP technical archive, Sangan, Iran

⁹⁸ Danieli Co. (2008), *Mining Report for Sangan iron mine project*, prepared by AMEC America Ltd.

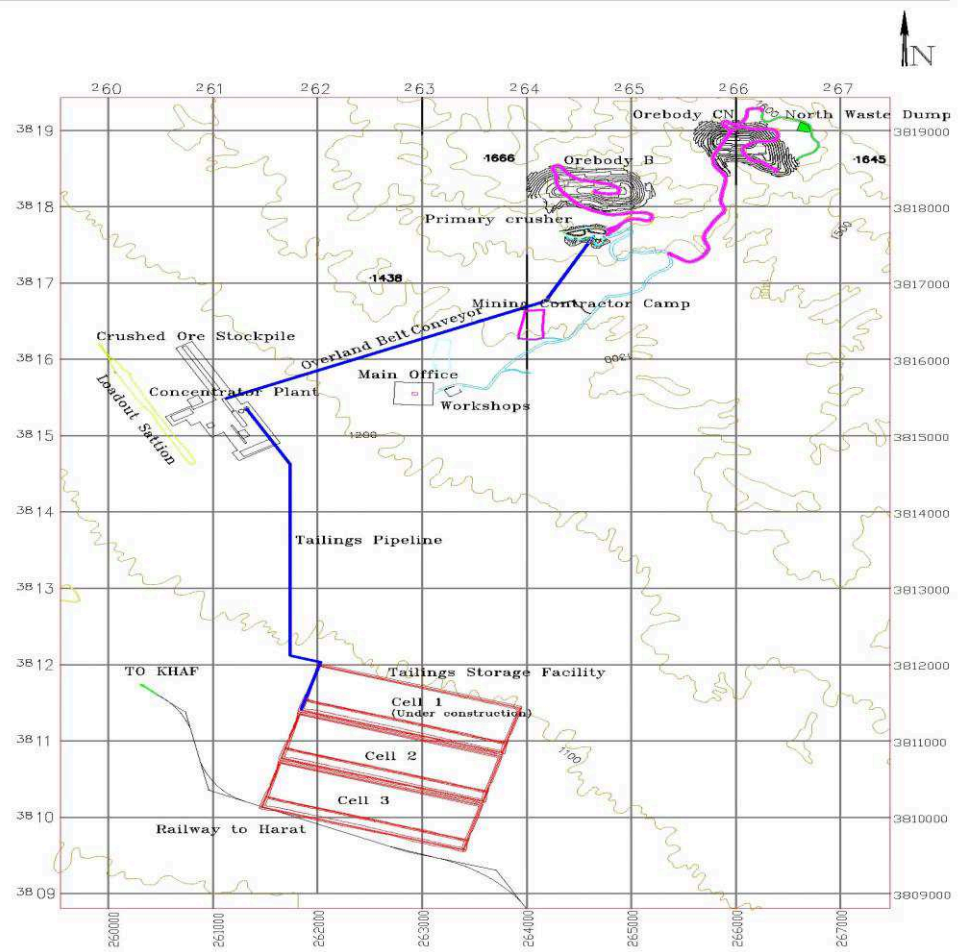


Figure 1.12 General layout of the first Sanganeh iron ore concentrator plant⁹⁹

⁹⁹ F. Rashidinejad and S. Naraghi (2011), *Tailings disposal options study for Sanganeh Iron Mine Project, Iran*, Proceedings Tailings and Mine Waste, Vancouver, BC, November 2011

Chapter 2

General Aspects of Sustainable Development in Mining

2 General aspects of sustainable development in mining

2.1 Sustainable development

2.1.1 Definition

The impact of a rapidly growing human population and the increasing demands for food, water and industrialization are the main causes for the loss of species and impoverishment of ecosystems. Deforestation, as a result of clear felling and slash-and-burn cultivation, together with soil erosion, pollution of inland and marine water bodies, and over-harvesting of species have all resulted in a serious depletion of the world's natural resources. Almost every ecosystem and primal culture on the earth has been disrupted, or totally ruined in some cases. The environmental damage caused to the planet over the last few decades has got to a critical point. Much of that damage is irreversible and the massive use of non-renewable resources has taken little account of the needs of future generations. The situation is getting worse, impacting on human health, biodiversity and the social infrastructure of many societies¹⁰⁰.

In order to embed the concept of sustainability in development projects such as mining and mineral industry, it's initially needed to determine what development really means, and what it is supposed to achieve. Is the goal merely to increase national wealth, or is it something more subtle? Improving the well-being of the majority of the population? Ensuring people's freedom? Increasing their economic security? It is true that **economic growth**, by increasing a nation's total wealth, also enhances its potential for reducing poverty and solving other social problems, but history offers a number of examples where economic growth was not followed by similar progress in human development. Instead, growth was achieved at the cost of greater inequity, higher unemployment, weakened democracy, loss of cultural identity, or overconsumption of resources needed by future generations. As the links between economic growth and social and environmental issues are better understood, experts including economists tend to agree that this kind of growth is inevitably unsustainable—that is, it cannot continue along the same line for long¹⁰¹. In chapter 2

¹⁰⁰ B. A. Larson (2007), *Sustainable development research advances*, Nova Science Publishers, Inc., New York, p. 255

¹⁰¹ T. P. Soubbotina and K. A. Sheram (2000), *Beyond Economic Growth: meeting the challenges of global development*, The World Bank Publications, Washington DC, ISBN 0-8213-4853-1, p. 7-8

of “Our Common Future” report, entitled “Towards Sustainable Development” it is stated that: Development involves a progressive transformation of economy and society. A development path that is sustainable in a physical sense could theoretically be pursued even in a rigid social and political setting. But physical sustainability cannot be secured unless development policies pay attention to such considerations as changes in access to resources and in the distribution of costs and benefits. Even the narrow notion of physical sustainability implies a concern for social equity between generations, a concern that needs logically be extended to equity within each generation¹⁰².

In Iranian sources, development definition includes not only globally accepted aspects, but also incorporates spiritual points of view. Even in constitution law of I.R. Iran, both material and spiritual development are assumed for Iranian communities. In fact, materialistic welfare is only a means of attaining fundamental goals of holistic human development¹⁰³.

In 1987, the United Nations released the Brundtland Report, which included what is now one of the most widely recognized definitions:

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”¹⁰⁴

It contains within it two key concepts:

- the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and
- The idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.

¹⁰² Report of the World Commission on Environment and Development (1987), *Our Common future*, Chapter: *Towards Sustainable development*, article 28, Access at: <http://www.un-documents.net/ocf-02.htm#III.3>, Retrieved January 2014

¹⁰³ A. R. Rezai (2010), *The characteristics of development in the view of Islam, the constitution of the Islamic Republic of Iran and Imam Khomeini*, Political Knowledge 2(1): 125-148, Access at: <http://siyasi.nashriyat.ir/node/24> (Persian)

¹⁰⁴ World Commission on Environment and Development (1987), *Our Common Future*, Access at: <http://www.un-documents.net/wced-ocf.htm>, Retrieved January 2013

Thus the goals of economic and social development should be defined in terms of sustainability in all countries - developed or developing. Interpretations will vary, but need to share certain general features and also flow from a consensus on the basic concept of sustainable development and on a broad strategic framework for achieving it¹⁰⁵. Sustainable development can be achieved through improved environmental management practices and socioeconomic performance¹⁰⁶.

Sustainable development adds a further dimension to the concept of development¹⁰⁷. The Brundtland Commission identified seven strategic factors required for sustainable development. They are¹⁰⁸:

- I. Reviving growth
- II. Changing the quality of growth
- III. Meeting essential needs for employment, food, energy, water and sanitation
- IV. Ensuring a sustainable level of population
- V. Conserving and enhancing the resource base
- VI. Reorienting technology and managing risk
- VII. Merging environment and economics in decision-making.

The overall objective is to improve or restructure the international and national decision-making processes so that consideration of socio-economic and environmental issues is fully integrated and a broader range of public participation assured. Considering that countries will develop their own priorities in accordance

¹⁰⁵ Our Common future, Chapter: Towards Sustainable development, Access at: <http://www.un-documents.net/ocf-02.htm#III.3>. Retrieved January 2014

¹⁰⁶ G. Hilson (2000), *Sustainable Development policies in Canada's mining sector: an overview of government and industry efforts*, Environmental science and Policy, 3/ 2000, p. 201- 211 (Gavin Hilson is a leading global authority on the environmental and social impacts of the small-scale mining sector. He has also provided consultancy services on the subject for a range of organizations: the UK Department for International Development, World Bank and the NGO sector, including the Alliance for Responsible Mining and the WWF Guianas; and corporations such as Newmont Gold Mining and Gold Fields.)

¹⁰⁷ B. A. Larson (2007), *Sustainable development research advances*, Nova Science Publishers, Inc., New York, p. 256

¹⁰⁸ Our Common future, Chapter: Towards Sustainable development, article 28, Access at: <http://www.un-documents.net/ocf-02.htm#III.3>. Retrieved January 2014

with their prevailing conditions, needs, national plans, policies and programmes, the following objectives are proposed by Agenda 21¹⁰⁹:

- a. To conduct a national review of economic, sectoral and environmental policies, strategies and plans to ensure the progressive integration of environmental and developmental issues;
- b. To strengthen institutional structures to allow the full integration of environmental and developmental issues, at all levels of decision-making;
- c. To develop or improve mechanisms to facilitate the involvement of concerned individuals, groups and organizations in decision-making at all levels;
- d. To establish domestically determined procedures to integrate environment and development issues in decision-making¹¹⁰.

2.1.2 Sustainable development and international necessity

Sustainable development isn't just about the environment. It also provides steps for action that will create a better future for those of us who live on this planet aside from environmental issues. It is generally accepted that sustainable development calls for a convergence between the three pillars of economic development, social equity, and environmental protection (Figure 2.1).

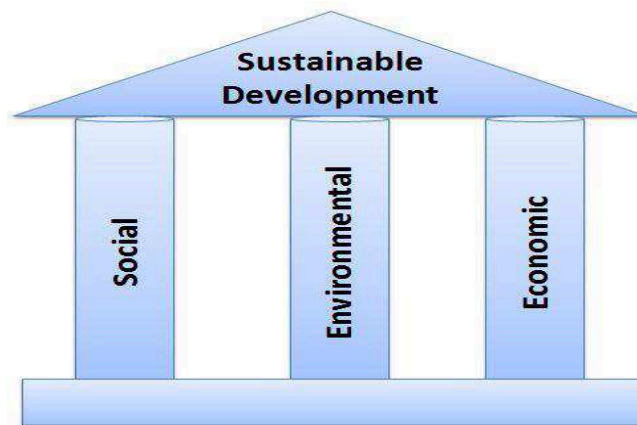


Figure 2.1 Three Pillars of Sustainable Development

¹⁰⁹ United Nations documents cooperation circle (1992), *Agenda 21, Chapter 8: Integrating environment and development in decision-making*, United Nations conference on environment and development, Rio de Janeiro, Brazil, 3 to 14 June 1992, Access at: <http://www.un-documents.net/a21-08.htm>

¹¹⁰ United Nations documents cooperation circle (1992), *Agenda 21, Chapter 8: Integrating environment and development in decision-making*, United Nations conference on environment and development, Rio de Janeiro, Brazil, 3 to 14 June 1992

Sustainable development is a visionary development paradigm; and over the past 25 years governments, businesses, and civil societies have accepted sustainable development as a guiding principle, made progress on sustainable development indicators, and improved business and NGO participation in the sustainable development process¹¹¹.

Along with protecting the earth's renewable resources, sustainable development also brings about long term changes that provide benefits like affordable housing and safe drinking water. The far-reaching benefits of sustainable development include¹¹²:

- It helps build a resilient community
- It ensures the future generations' welfare
- It empowers people to start to meet their own needs sustainably
- It is designed to be environment- friendly
- Benefits local and global economies

Scientists believe that if human continues in its current behavior, he will need at least two more planets to supply the resources and to sustain life in order to reach to development¹¹³; which implies the concept of Ecological Footprint¹¹⁴. Figure 2.2 depicts the difference between the ecological footprint of developed and developing countries. However, there are no two other planets to draw from. The crux of the problem lies in the fact that 80 percent of the world's resources are used by 20 percent of the people. For example, just one individual living in North America uses as much energy as more than 200 West or East Africans¹¹⁵.

¹¹¹ J. Drexhage and D. Murphy (2010), *Sustainable Development: From Brutland to Rio 2012* (Background Paper), United Nations Headquarters, New York, September 2010, Access at: http://www.un.org/wcm/webdav/site/climatechange/shared/gsp/docs/GSP1-6_Background%20on%20Sustainable%20Devt.pdf

¹¹² J. Blewitt, (2008), *Understanding Sustainable Development*, Routledge Publications, ISBN-10: 1844074544

¹¹³ <http://phys.org/news178269435.html>. Retrieved at August 2013. Phys.org is a leading web-based science, research and technology news service which covers a full range of topics. These include physics, earth science, medicine, nanotechnology, electronics, space, biology, chemistry, computer sciences, engineering, mathematics and other sciences and technologies.

¹¹⁴ The ecological footprint is a measure of human demand on the Earth's ecosystems. It is a standardized measure of demand for natural capital. It represents the amount of biologically productive land and sea area necessary to supply the resources a human population consumes, and to assimilate associated waste.

¹¹⁵ J. Blewitt (2008), *Understanding Sustainable Development*, Routledge Publications, ISBN-10: 1844074544

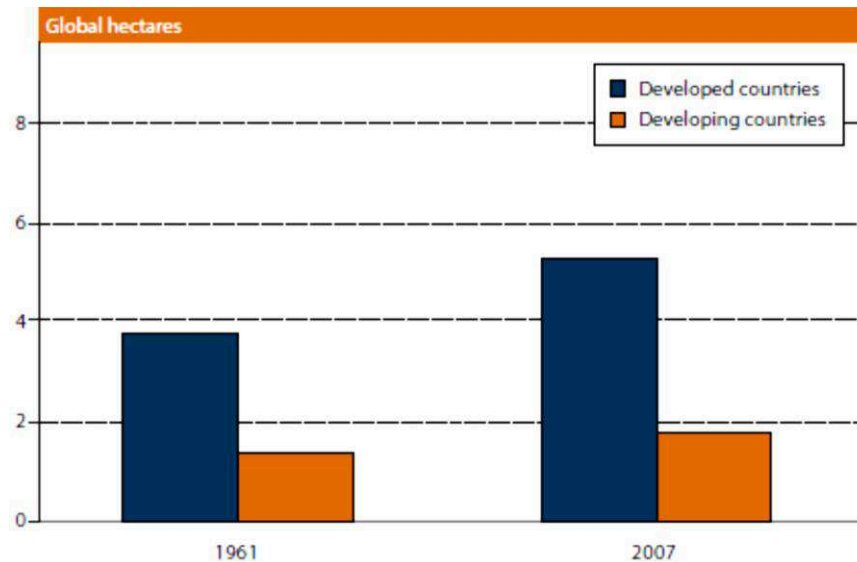


Figure 2.2 Average ecological footprint per person in developed and developing countries, 1961 And 2007¹¹⁶

2.1.3 Difficulties in implementing sustainable development

The official concept and idea of sustainable development is widely accepted by scientists and policy makers from social, economic and environmental fields, and good progress has been made on its indicators; yet the implementation of measures to ensure sustainable development has been largely unsuccessful¹¹⁷. Many of the consensus-driven UN summits have resulted in broad documents, policies, and goals; and the action plans tend to be “sprawling documents that offer something for everyone”¹¹⁸. Hodas¹¹⁹ notes that high-level international meetings—such as those under the CSD¹²⁰ and UNFCCC¹²¹ supervision [For

¹¹⁶ World Economic and Social Survey (2013), *Sustainable Development Challenges*, The department of economic and social affairs of the United Nations, ISBN 978-92-1-109167-0

¹¹⁷ J. Drexhage and D. Murphy (2010), *Sustainable Development: From Brutland to Rio 2012* (Background Paper), United Nations Headquarters, New York, September 2010, Access at: http://www.un.org/wcm/webdav/site/climatechange/shared/gsp/docs/GSP1-6_Background%20on%20Sustainable%20Devt.pdf

¹¹⁸ D. G. Victor (2006), *Recovering Sustainable Development*, published by the council of foreign affairs

Access at: <http://greeneconomics.blogspot.com/2006/06/thoughts-on-sustainable-development.html>

¹¹⁹ D. Hodas (2010), *International Law and Sustainable Energy: A portrait of Failure*, Widener Law School Legal Studies Research Paper, p. 29, no. 10/2010 (David R. Hodas, Distinguished professor of law at Widener University School of Law, Wilmington, Delaware, United States)

¹²⁰ Commission on Sustainable Development: The United Nations Commission on Sustainable Development (CSD) was established in December 1992 by General Assembly Resolution A/RES/47/191 as a functional commission of the UN Economic and Social Council, implementing a recommendation in Chapter 38 of Agenda 21, the landmark global agreement reached at the June 1992 United Nations Conference on Environment and Development/Earth Summit held in Rio de Janeiro (more at: www.un.org/esa/dsd/csd/csd_index.shtml).

instance: Bali action plan¹²² (2007), the Copenhagen accord¹²³ (2009), the Durban Platform for enhanced action¹²⁴ (2012)]—“avoid concrete discussion about how to shift to a more sustainable, low carbon world economy” and “international talks increasingly become disconnected from real-world policy.”

Efforts to implement sustainable development have taken place in an environment of mainstream economic planning and market-based investment, in a manner that will not disrupt overall growth. As such, implementation has not moved beyond slow incremental steps to transformative action. The WBCSD¹²⁵ argued that there is a lack of leadership and each sector waits on the others, limiting real progress toward sustainable development. Experts note that “politicians tend not to run for office on promises of making the price of goods reflect their real (higher) costs for the sake of sustainable development; consumers tend not to demand to pay such higher costs; business tends not to lobby lawmakers for higher prices¹²⁶.”

Developing countries, including Iran, have become more heterogeneous than they were when Agenda 21 was formulated. Some of them have proved successful in achieving industrialization and have reached per capita income levels close to those of developed countries. Others have not been so successful, and the difference between their per capita income levels and those of developed countries has increased further. This diversity among developing countries can be seen with regard

¹²¹ United Nations Framework Convention on Climate Change: In 1992, countries joined an international treaty, the United Nations Framework Convention on Climate Change, to cooperatively consider what they could do to limit average global temperature increases and the resulting climate change, and to cope with whatever impacts were, by then, inevitable. There are now 195 Parties to the Convention. The main functions of the secretariat are to: assist Parties in implementing their commitments; provide support to the compliance regime of the Kyoto Protocol; support negotiations, including through the provision of substantive analysis etc. (more at: http://unfccc.int/secretariat/history_of_the_secretariat/items/1218.php)

¹²² As part of the Bali Action Plan, adopted in 2007, all developed country Parties have agreed to "quantify emission limitation and reduction objectives, while ensuring the comparability of efforts among them, taking into account differences in their national circumstances".

¹²³ The Accord states that global warming should be limited to below 2.0 °C (3.6 °F). It was strengthened in 2015 with a target to limit warming to below 1.5 °C.

¹²⁴ As part of the Durban Platform, parties have agreed to "develop a protocol, another legal instrument or an agreed outcome with legal force under the Convention applicable to all Parties".

¹²⁵ World Business Council for Sustainable Development: The WBCSD was founded on the eve of the 1992 Rio Earth Summit to ensure the business voice was heard at the forum. It was created by Swiss entrepreneur and philanthropist Stephan Schmidheiny who believed that business had an inescapable role to play in sustainable development: at the same time as making significant contributions to the creation of a sustainable society, it is in the interest of business, and its bottom line, to do so. (more at: <http://www.wbcd.org/about.aspx>)

¹²⁶ O. C. Holliday, S. Schmidheiny and P. Watts (2002), *Walking the talk: The business case for sustainable development*, San Francisco: Berrett-Koehler Publishers, ISBN:1-874719-50-0, p. 17

to the achievement of the Millennium Development Goals¹²⁷ as well. While some countries have made remarkable progress in achieving the goals, others have lagged behind. These varied performances with regard to achievement of the goals could be a point of departure in discussions concerning future efforts for sustainable development¹²⁸. Some developing countries argue that lack of financial and technological resources, and unfair terms of trade have plagued their implementation of sustainable development. Many poor countries do not have adequate access to technology, and lack necessary resources, infrastructures, quality of governance, and business environment to stimulate sustainable development¹²⁹.

While national governments have expanded sustainable development strategies and plans, and local governments have been involved in initiatives, these actions have not led to fundamental changes. Chasek, Downie and Brown¹³⁰ (2010) report that few countries have lived up to their Rio commitments, stating that National Agenda 21 efforts led to “increased academic debate, heightened public awareness and minor adjustments in the system of national accounts and taxation rules, but they have not fundamentally altered the way we manage and measure our national economy.”

Part of the reason for the lack of implementation is that actions have tended to emphasize the symptoms of environmental degradation and not the underlying source of the problem. Jim MacNeill, former Secretary General of the Brundtland Commission, asserted that, we are still struggling with an issue raised in the Brundtland report: the institutions and policies we put in place to address sustainable development issues were not only weak but they had been directed one way or another to tackle the symptoms of environmental degradation and to ignore its sources. The sources, of course, are to be found in government (and corporate) fiscal,

¹²⁷ In 2000, 189 nations made a promise to free people from extreme poverty and multiple deprivations. This pledge turned into the eight Millennium Development Goals. More at: <http://www.undp.org/content/undp/en/home/mdgoverview.html>

¹²⁸ World Economic and Social Survey (2013), *Sustainable Development Challenges*, The department of economic and social affairs of the United Nations, ISBN 978-92-1-109167-0, p. 41

¹²⁹ United Nations, Economic Commission for Africa (2002), *Harnessing technologies for sustainable development*, Addis Ababa, UN, ECA, Access at: <http://www.uneca.org/harnessing>

¹³⁰ P. Chasek, D. Downie, and J. W. Brown (2010), *Global Environmental Politics*, fifth edition, Boulder: Westview Press, 2010, p. 37-38

tax, budget, trade, energy, agriculture and other policies and in the values underlying them¹³¹.”

Sustainable development need to be inclusive and take special care of the needs of the poorest and most vulnerable. Strategies need to be ambitious, action-oriented and collaborative, and to adapt to different levels of development. They need to systemically change consumption and production patterns, and might entail significant price corrections; encourage the preservation of natural endowments; reduce inequality; and strengthen economic governance¹³².

Reviewing national sources regarding sustainable development, it is clearly seen that Iranian governors have actively participated in high level international summits and have committed themselves to agendas and conventions¹³³ (70 international conventions¹³⁴ and 210 regional agreements¹³⁵). In national level, too, sustainable development and its implementation has been examined theoretically well. Nevertheless, subtle progress has been made through recent decades in achieving the goals that have been assigned to Iran. For instance, among 149 countries in 2012, Iran has the 114th rank in environmental performance index (EPI)¹³⁶ which is not favourable. This failure can be attributed to several drawbacks such as inappropriate economical-, social- and legal infrastructures. Pursuant to escalating importance of these issues, sustainable development has found its place in legislation and has been discussed thoroughly in country`s development plans and visions¹³⁷. Sustainable development in Iranian Laws and Regulations will be discussed in detail in chapter four of the dissertation.

¹³¹ J. MacNeill (2007), *Our Common Future: Advance or Retreat? Sustainable development: A New Urgency*, Published by Economics International, Switzerland, December 2007, p.5

¹³² Sustainable Development Challenges (2013), World Economic and Social Survey, The department of economic and social affairs of the United Nations, ISBN 978-92-1-109167-0, p. 5

¹³³ www.doe.ir, Website of Iranian Department of Environment, Retrieved at November 2013

¹³⁴ Such as: Convention on Biological Diversity; United Nations Framework Convention on Climate Change; Kyoto Protocol; Basel Convention on the Trans boundary Shipment of Hazardous Waste; Montreal Protocol on Substances that Deplete the Ozone Layer; Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar), etc.

¹³⁵ Such as: Caspian Environment Program; Kuwait Regional Convention for Co-operation of the Marine Environment from Pollution, etc.

¹³⁶ <http://epi.yale.edu/epi2012/countryprofiles>. Retrieved at October 2013. The Yale Center for Environmental Law & Policy seeks to advance cutting edge environmental thinking and policy analysis so that decision-making in the public, business, community, and personal realms promotes sustainability.

¹³⁷ www.doe.ir, Website of Iranian Department of Environment, Retrieved at November 2013

2.1.4 Sustainable development governance at the international, regional and national levels

In order to meet the challenges of sustainable development, current systems of sustainable development governance need to be strengthened at the international, regional and national levels. The overriding objective of strengthening sustainable development governance is to strengthen the governing structures and institutions in the economic, social and environmental fields as well as their respective links, so as to ensure coherence, integrate policies, limit overlap and strengthen implementation and accountability. Success in achieving these objectives requires strengthening of the various aspects of good governance at levels. Following on, brief discussions are presented regarding these linked and mutually inter- dependent levels.

2.1.4.1 Strengthening sustainable development governance at the international level

The principal requirements for strengthening sustainable development governance at the international level are to strengthen monitoring, coordination and implementation of sustainable development including strengthening of links and collaboration between the policy and operational levels. The international system should commit to a development agenda that meets the goals of sustainable development and in this context applies balanced and integrated consideration of economic, social and environment factors in policy development and implementation. A strategic partnership for implementation of sustainable development should be formed at the highest level. The purpose of this strategic partnership would be to provide an effective arrangement for promoting implementation of sustainable development at the international level through a coordinated approach to implementation of Agenda 21, the outcomes of the World Summit on Sustainable Development (WSSD), relevant sustainable development aspects of the Millennium Declaration, etc.¹³⁸.

¹³⁸ O. Anaedu and L. G. Engfeldt (2002), *Sustainable Development Governance at an International, Regional and National Levels*. The text was submitted for consideration at the Third Session of the Preparatory Committee for WSSD. The paper is based on ideas contained in the Report of the Secretary General (E/CN.17/2002/PC.2/7) and comments and suggestions made by delegations at PrepCom2 (28 January – 8 February 2002) and at the informal meeting on governance for sustainable development on 28 February 2002, held at UN Headquarters.
Access at: www.un.org/jsummit/html/.../governance_discussion_paper.doc

2.1.4.2 Strengthening sustainable development governance at the regional level

Implementation of sustainable development needs to be more effectively pursued at the regional level by involving the UN Regional Economic Commissions and Sub-regional groupings. In this regard, the regional level should be much more involved in preparations for CSD meetings. In order to improve regional coordination on sustainable development, regional commissions, UN agencies, regional development banks and sub-regional bodies consider developing, or further enhancing regional sustainable development strategies and action plans that reflect regional priorities and also provide the basis for regional implementation of Agenda 21, WSSD outcomes and future CSD decisions. Review of implementation of the regional strategies and reporting to the CSD would be an important function of the Regional Commissions¹³⁹.

2.1.4.3 Strengthening sustainable development governance at the national level

Countries should continue to promote coherent and coordinated approaches to sustainable development governance at the national level as this, in part, provides an important element for achieving coherence and consistency at regional and international levels. In general, following are key success factors as observed in the experiences of National Councils for Sustainable Development¹⁴⁰ (NCSDs) all over the world¹⁴¹:

- I. **Status and mandate:** The NCSD must have an official status and clear mandate, preferably from the highest authority in government. A legislative fiat is generally desirable as it ensures stability. If this is not feasible, the next best option is for the highest authority in the country to issue the official or legal instrument that forms NCSD.

¹³⁹ O. Anaedu and L. G. Engfeldt (2002), *Sustainable Development Governance at an International, Regional and National Levels*,

Access at: www.un.org/jsummit/html/.../governance_discussion_paper.doc

¹⁴⁰ The National Councils for Sustainable Development mirror the CSD's mandate at the national level. They monitor the state of affairs in national sustainable development efforts; keep sustainability, as a key national priority; enable broad-based partnerships towards sustainable development; generate participatory processes in national sustainable development decision making; and ensure that sustainable development actions taken in their countries are in harmony with each other as well as in harmony with similar actions taken by other countries in their regions and around the world.

¹⁴¹ Economic and Social Commission for Asia and the Pacific (ESCAP). Retrieved: January 2014, Access at: http://www.unescap.org/drpap/vc/orientation/M6_lnk_3.htm

- II. **Leadership and influence:** In as much as the NCSD must be composed of people from different sectors and strata of society, it is always useful to have a leader that has high rank and stature, a comprehensive and oversight view and responsibility, and is neutral and credible. The leader can come from any of the stakeholder groups.
- III. **Composition and participation:** Participation by as many stakeholders as possible must be a major consideration in the establishment of an NCSD. Participation, however, must be balanced with manageability. In terms of membership composition, there should also be a good balance of representation from the major groups, i.e. government, civil society and business.
- IV. **Reach:** The NCSD must have an extensive reach, i.e. the capability to allow participation of stakeholders in various parts of the country to ensure wide coverage and generate mass support. The creation of counterparts or chapters at the local levels has been proven useful.
- V. **Agenda:** It is also important that the NCSD tackles substantive and high-impact agenda and has good technical support that allows it to handle complicated matters. An NCSD that produces well-grounded recommendations or decisions could command respect and wield influence.

2.2 Sustainable development indicators (SDIs)

2.2.1 Purpose and quality of indicators

The high complexity of sustainable development processes, covering a number of politically unlinked dimensions and involving all sectors of society makes decision making a difficult task. The lack of clear-cut solutions and the need for balancing means and targets calls for tools that provide a reliable but easily understandable information base and help monitoring of the progress achieved as well as communication with the public at large¹⁴². Chapter 40 of Agenda 21 calls on countries and the international community to develop indicators of sustainable development. Such indicators are needed to increase focus on sustainable

¹⁴² United Nations' Department of Economic and social Affairs (DESA), *Indicators of Sustainable Development: Guidelines and Methodologies*, Published by UN, New York, third edition, October 2007, ISBN 978-92-1-104577-2, p. 3

development and assist decision-makers at all levels to adopt sound national sustainable development policies¹⁴³.

In 1995, in response to the call of CSD, the Division for Sustainable Development and the Statistics Division, both of the United Nations Department of Economic and Social Affairs, in close collaboration with experts from international organizations and UN member states, developed a set of 134 national Indicators of Sustainable Development (CSD Indicators). The CSD Indicators and their methodology have since been revised twice, in 2001 and in 2006. In 2006 they were modified to reflect themes and sub-themes. The CSD Indicators are voluntary, and are meant to assist member states in their work of reviewing their existing indicators or developing new indicators to measure progress towards nationally defined goals for sustainable development¹⁴⁴.

Indicators perform many functions. They can lead to better decisions and more actions that are effective by simplifying, clarifying and making aggregated information available to policy makers. They can help incorporate physical and social science knowledge into decision-making, and they can help measure and calibrate progress toward sustainable development goals. They can provide an early warning to prevent economic, social and environmental setbacks. They are also useful tools to communicate ideas, thoughts and values¹⁴⁵.

Indicators are designed to fulfil these three tasks¹⁴⁶:

- To generate a simplified but reliable description of reality, helping to identify the core problems and permitting to develop adequate and effective solutions in line with long-term sustainable development targets. If at all possible,

¹⁴³ United Nations, Sustainable development Knowledge Platform, Access at: <http://sustainabledevelopment.un.org/index.php?menu=200>. Retrieved January 2014

¹⁴⁴ RIO 2012 Issues Briefs (2012), *Current ideas on sustainable development and indicators*, UNCSO Secretariat, No. 6, Access at: <http://www.uncsd2012.org/index.php?page=view&type=400&nr=218&menu=45>.

¹⁴⁵ United Nations' Department of Economic and Social Affairs (DESA), *Indicators of Sustainable Development: Guidelines and Methodologies*, Published by UN, New York, third edition, October 2007, ISBN 978-92-1-104577-2, p. 3

¹⁴⁶ Sustainable Development Indicators (SDI), The Sustainable Europe Research Institute (SERI), Access at: old.seri.at/documentupload/sustainabledevelopmentindicators_2.pdf, The Sustainable Europe Research Institute (SERI) is a Pan-European think tank exploring sustainable development options for European societies. It was set up in September 1999. As part of it, SERI Germany was founded in 2005.

targets should be quantitative, or at least defined by directionally safe imperatives, and linked to ordinal scales of measurement. Such indicators must be reproducible; i.e., based on a sound scientific basis; robust, i.e. immune against those small variations in data and methodology that do not indicate a changing trend, and general, i.e. not specific for a single case but applicable in the whole territory.

- To guide data collection for sensitively monitoring the progress achieved, providing early warning signals on the success or failure of adopted policies. For this behalf, indicators must be designed to react early and clearly on relevant changes in what they are intended to monitor. Preferably, they would measure “distance to target” and sound alarm whenever this distance gets larger or the speed of overcoming it, is reduced.
- To explain the challenges of sustainable development, the policy programs developed and implemented, as well as about results achieved so far and the setbacks suffered to the public at large. To serve these communication purposes, they must reduce complexity in a plausible and meaningful manner, be limited in number and thus easily understandable. They should help structure the debate in a clear and simple way that is easily digestible by the stakeholders.

2.2.2 Criteria for sustainable development indicators

Following these lines of thought, the United Nations in the work programme on indicators¹⁴⁷ defined the purpose of sustainable development indicators:

“They should be tools for guiding political decision-making towards sustainable development, improving information and data collection, and enabling a comparative and country specific analysis of the state of and progress towards sustainable development (UNDPCSD 1995).”

According to UNDPDSD in order to properly serve these purposes, they need to be:

¹⁴⁷ United Nations’ Department of Economic and social Affairs (DESA), *Indicators of Sustainable Development: Guidelines and Methodologies*, Published by UN, New York, third edition, October 2007, ISBN 978-92-1-104577-2, p. 6

- ✓ based on a sound scientific basis, widely acknowledged by the scientific community;
- ✓ relevant, i.e. they have to cover crucial aspects of sustainable development;
- ✓ transparent, i.e. their selection, calculation and meaning must be obvious even to non-experts;
- ✓ quantifiable, i.e. they should be based as far as possible - but not exclusively - on existing data and/or on data which is easy to gather and to update;
- ✓ limited in number according to the purposes they are being used for. In particular, a public communication needs just a handful of indicators, policy monitoring some more, expert scrutiny a lot of them.

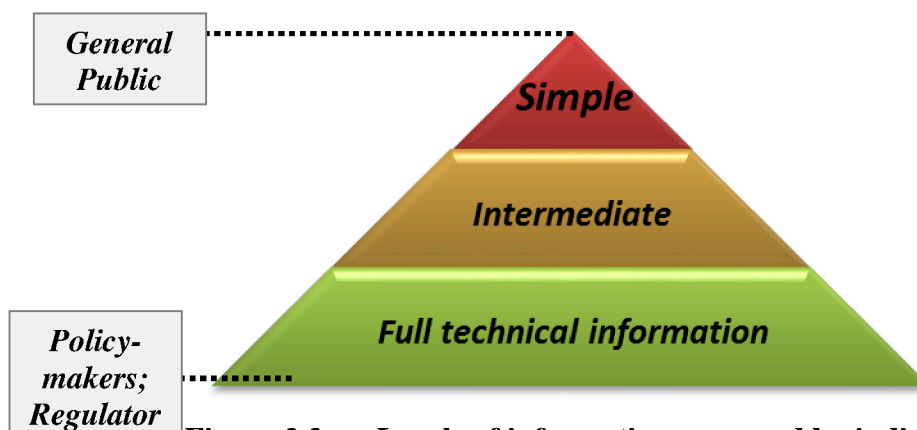


Figure 2.3 Levels of information conveyed by indicators¹⁴⁸

According to figure 2.3, policy-makers and scientists are likely to prefer specific indicators that convey significant amounts of technical information in precise ways, for example indicators of biological status. The public, however, requires simpler indicators in the form of composite, key and simple indicators.

Obviously, neither all of these recommendations can be met at all times, nor are they of equal importance in all situations, but in all cases a good indicator system should try to strike a balance without neglecting a specific element. Prioritising certain

¹⁴⁸ P. Hancock (2001), *Sustainable Development and the Australian Minerals Sector*, Parliament of Australia, Science, Technology, Environment and Resources Group, Research paper 24/2001, Access at: http://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/rp/rp0001/01RP24

indicator qualities however will be much easier once the future field of application for the indicator is known.

Much work has been done on SDI (Table 2.1); consequently, there is a huge archive of different social, environmental and economic indicators that makes it a challenge for decision makers and planners to find a comprehensive set of indicators compatible with the characteristics of the study area. However, in this study the main reference on the basis of which indicators are presented and sieved according to Sangan Iron Ore Mine's economic, environmental and social conditions is the guideline published by United Nations' committee on sustainable development (CSD) in 2007¹⁴⁹, due to its comprehensiveness and global acceptance and validity.

The newly revised CSD indicators contain a core set of 50 indicators. These core indicators are part of a larger set of 96 indicators of sustainable development. The introduction of a core set helps to keep the indicator set manageable, whereas the larger set allows the inclusion of additional indicators that enable countries to do a more comprehensive and differentiated assessment of sustainable development on either national or local scale. Core indicators fulfil three criteria. First, they cover issues that are relevant for sustainable development in most countries. Second, they provide critical information not available from other core indicators. Third, they can be calculated by most countries with data that is either readily available or could be made available within reasonable time and costs. Conversely, indicators that are not part of the core are either relevant only for a smaller set of countries, provide complementary information to core indicators or are not easily available for most countries¹⁵⁰.

¹⁴⁹ United Nations' Department of Economic and social Affairs (DESA), *Indicators of Sustainable Development: Guidelines and Methodologies*, Published by UN, New York, third edition, October 2007, ISBN 978-92-1-104577-2, p. 10-14

¹⁵⁰ United Nations' Department of Economic and social Affairs (DESA), *Indicators of Sustainable Development: Guidelines and Methodologies*, Published by UN, New York, third edition, October 2007, ISBN 978-92-1-104577-2, p. 9

Country	Total	Source
Austria	95	Decision of the ministerial council
Belgium	45	2005 Federal Report
Czech Republic	36	2006 Progress Report
Denmark	119	National strategy for SD
Estonia	95	2006 Indicator Report
Finland	35	National strategy for SD
France	12	National strategy for SD
Germany	28	2006 Indicator Report
Greece	70	2003 Report on Sustainability Indicators
Iceland	56	National strategy for SD
Ireland	36	2002 Report
Latvia	187	2003 Report
Lithuania	75	National strategy for SD
Luxembourg	27	2006 Indicator Report
Malta	24	National strategy for SD
Netherlands	32	2004 Report
Norway	26	2005 Report
Portugal	125	National strategy for SD
Romania	13	National strategy for SD
Slovakia	71	National strategy for SD
Slovenia	71	2004 Indicator Report
Spain	74	2006 Indicator Report
Sweden	91	National strategy for SD
Switzerland	163	2004 Indicator Report
United Kingdom	147	2006 Indicator Report

Table 2.1 Number of Indicators in Some National Sustainable Development Indicators Set ¹⁵¹

The indicator set retains the thematic/sub-thematic framework that was adopted in 2001 (Table 2.2). In doing so, it remains consistent with the practice of most countries applying national sustainable development indicator sets and it is directly relevant to the monitoring of national sustainable development strategies.

¹⁵¹ United Nations Economic commission for Europe (2009), *Measuring Sustainable Development*, Published by UN New York and Geneva, 2009, p. 31-32, Access at: <http://www.oecd.org/greengrowth/41414440.pdf>

CSD indicator themes

- | | | |
|----------------|--------------------|---------------------|
| • Poverty | • Natural hazards | • Economic |
| • Governance | • Atmosphere | development |
| • Health | • Land | • Global economic |
| • Education | • Oceans, seas and | partnership |
| • Demographics | coasts | • Consumption and |
| | • Freshwater | production patterns |
| | • Biodiversity | |
-

Table 2.2 CSD Indicators Themes¹⁵²

In Chapter 5, methodology of selecting applicable indicators to SIOM, reasons, results and trends are fully examined.

2.3 Sustainable mining

2.3.1 General aspects of sustainable mining

The Brundtland Report provides a solid foundation for sustainable development but fails to explain how to implement it. In fact, the Brundtland Report emphasizes that no single blueprint exists for sustainable development and sustainability. This lack of clarity in turn has triggered several academics and industrialists, in an attempt to operationalize the concept, to develop a number of sustainable development policy frameworks, management guidelines, and indicator sets for use by governments and businesses. However, because now an overabundance of interpretations exist, it is often difficult to ascertain exactly what sustainable development means in selected contexts¹⁵³. As the discussion to follow shows, the mining industry is not unique in this regard, as many experts have attempted to outline exactly how sustainable development applies to mining operations and mineral-based economies. Some of these interpretations frequently refer to the non-renewable nature of mineral deposits,

¹⁵² United Nations' Department of Economic and social Affairs (DESA), *Indicators of Sustainable Development: Guidelines and Methodologies*, Published by UN, New York, third edition, October 2007, ISBN 978-92-1-104577-2, p. 9

¹⁵³ G. Ethier (2007), *Sustainable Development: The story of Umicore*, World of Metallurgy, 60(3)/2007, p. 129-132

while others emphasize primarily the environmental subcomponent of sustainable development¹⁵⁴.

Resolution adopted by the General Assembly of United Nations on 27 July 2012 states the importance of mining and mineral industry as follows¹⁵⁵:

227. “We acknowledge that minerals and metals make a major contribution to the world economy and modern societies. We note that mining industries are important to all countries with mineral resources, in particular developing countries. We also note that mining offers the opportunity to catalyze broad-based economic development, reduce poverty and assist countries in meeting internationally agreed development goals, including the Millennium Development Goals, when managed effectively and properly. We acknowledge that countries have the right to develop their mineral resources according to their national priorities and responsibility regarding the exploitation of resources described in the Rio Principles. We further acknowledge that mining activities should maximize social and economic benefits, as well as effectively address negative environmental and social impacts. In this regard, we recognize that governments need strong capacities to develop, manage and regulate their mining industries, in the interest of sustainable development”.

228. “We recognize the importance of strong and effective legal and regulatory frameworks, policies and practices for the mining sector that deliver economic and social benefits and include effective safeguards that reduce social and environmental impacts, as well as conserve biodiversity and ecosystems, including during post-mining closure. We call on governments and businesses to promote the continuous improvement of accountability and transparency, as well as the effectiveness of the relevant existing mechanisms to prevent the illicit financial flows from mining activities”.

World Summit on Sustainable Development (WSSD) defines the role of mining in sustainable development as what has been mentioned in paragraph 46 of the Johannesburg Plan of Implementation (JPOI)¹⁵⁶:

¹⁵⁴ G. Hilson (2000), *Sustainable Development policies in Canada's mining sector: an overview of government and industry efforts*, Environmental Science and Policy, 3/ 2000, p. 201- 211

¹⁵⁵ United Nations (2012), *The future we want- Rio+20*, Resolution adopted by the general assembly on 27 July 2012, 66th Session, Agenda item 19, A/RES/66/288, p. 44, September 2012, Access at: <http://www.se4all.org/sites/default/files/l/2013/10/Rio-outcome-document.pdf>

46. Mining, minerals and metals are important to the economic and social development of many countries. Minerals are essential for modern living. Enhancing the contribution of mining minerals and metals to sustainable development includes actions at all levels to:

1. Support efforts to address the environmental, economic, health and social impacts and benefits of mining, minerals and metals throughout their life cycle, including workers' health and safety, and use a range of partnerships, furthering existing activities at the national and international levels among interested governments, intergovernmental organizations, mining companies and workers and other stakeholders to promote transparency and accountability for sustainable mining and minerals development;
2. Enhance the participation of stakeholders, including local and indigenous communities and women, to play an active role in minerals, metals and mining development throughout the life cycles of mining operations, including after closure for rehabilitation purposes, in accordance with national regulations and taking into account significant trans-boundary impacts;
3. Foster sustainable mining practices through the provision of financial, technical and capacity-building support to developing countries and countries with economies in transition for the mining and processing of minerals, including small-scale mining, and, where possible and appropriate, improve value-added processing, upgrade scientific and technological information and reclaim and rehabilitate degraded sites.

In the minerals sector, sustainable development means that investments in minerals projects should be financially profitable, technically appropriate, environmentally sound and socially responsible. There is no one definition of sustainability that has been universally adopted by the mining industry. Some useful descriptions include the following¹⁵⁷:

¹⁵⁶ United Nations (2002), *Report of the World Summit on Sustainable Development*, Johannesburg, South Africa, 26 August- 4 September, A/CONF.199/20, p. 43, Access at: http://www.unmillenniumproject.org/documents/131302_wssd_report_reissued.pdf

¹⁵⁷ Department of Resources, Energy and Tourism, Australian Government (2011), *A guide to leading practice sustainable development in mining*, ISBN: 78-1-921812-48-4, Access at: <http://www.industry.gov.au/resource/Documents/LPSDP/guideLPSD.pdf>

- Miners can achieve sustainable development by embracing the social, environment and economic pillars.
- Offsetting or reinvesting the benefits from the depleting mineral asset.
- The simultaneous pursuit of sustained or improved environmental quality, economic growth, and social justice.

A working definition for ‘Sustainable Development’ in the Indian mining sector was outlined, based on consultation with sector experts, secondary sources on the subject and the Indian context¹⁵⁸:

“Mining that is financially viable; socially responsible; environmentally, technically and scientifically sound; with a long term view of development; uses mineral resources optimally; and, ensures sustainable post-closure land uses. Also one based on creating long-term, genuine, mutually beneficial partnerships between government, communities and miners, based on integrity, cooperation and transparency”.

A further clarification of some terms is given below to more fully illustrate and define the task¹⁵⁹:

- Socially responsible: mining operations that have a broad-based social license to operate- creating lasting social and economic wealth- which will outlast the life of the mine.
- Environmentally, technically and scientifically sound: implying proper management of natural resources
- Long term view of development: as opposed to a short operational point of view one that goes beyond the life of the mine
- Uses mineral resources optimally: with reference to the Mineral Conservation and Development Rules for conservation and systematic development of minerals.

Hilson and Basu¹⁶⁰ (2003) discuss further the difficulties of applying sustainable development to a mining context. The reasons cited include the existence of

¹⁵⁸ Ministry of Mines (MoM) (2011), *Sustainable Development Framework (SDF) for Indian Mining Sector*, Final report, India, Access at: <http://mines.nic.in/>

¹⁵⁹ Ministry of Mines (MoM) (2011), *Sustainable Development Framework (SDF) for Indian Mining Sector*, Final report, India, Access at: <http://mines.nic.in/>

innumerable frameworks and indicator sets and a multitude of interpretations of sustainable development. The authors propose a framework of sustainable development based on the three pillars underpinned by good governance. The issue of governance implies good government, which includes a sound fiscal and regulatory environment as well as good corporate governance.

Among global efforts toward applying sustainable development into mining and mineral industry, Milos Statement is of considerable importance. The Milos statement was introduced on the occasion of the 14th Annual General Meeting of the Society of Mining Professors (Societaet der Bergbaukunde), May 19 to 21, 2003 and the First International Conference on Sustainable Development Indicators in the Minerals Industry (SDIMI), May 21-23, 2003, held in the Island of Milos, Greece. The main objective of this series of conferences is to assist the global minerals industries in their transition to sustainable development. On SDIMI 2003, the "Milos Declaration" was adopted, a statement of contribution to a sustainable future through the use of scientific, technical, educational, and research skills and knowledge in minerals extraction and utilization that was endorsed by the leading global professional and scientific organizations and institutes representing the minerals professional. Since then, every two years the SDIMI has been held in different countries: 2005 in Aachen, Germany; 2007 in Milos, Greece, 2009 in Brisbane, Australia, 2011 in Aachen, Germany and 2013 returned to Milos, Greece¹⁶¹. The vision assumed for future in Milos Declaration is that¹⁶²:

“Minerals community will contribute to a sustainable future through the use of our scientific, technical, educational, and research skills in minerals, metals, and fuels”

To achieve this vision, works need to be done in three levels, namely: Professional responsibility; education, training and development; and communication. Suggestions are made for each of these levels.

Iranian Mines and Mining Industries Development and Renovation Organization (IMIDRO) has explicitly mentioned in its constitution the importance of environment

¹⁶⁰ G. Hilson and A. J. Basu (2003), *Devising indicators of sustainable development for the mining and minerals industry: an analysis of critical background issues*, International Journal of Sustainable Development and World Ecology, 10(4)/ 2003, p. 319- 332

¹⁶¹ <http://www.sdimi.org/index.html>

¹⁶² SDIMI (2003), *Milos Declaration*, Access at: http://www.sdimi.org/sdimi_milos.htm

preservation in mining activities and has incorporated sustainable development concepts in its future strategies. Besides, special attention is given to material and spiritual right of local communities in IMIDRO`s organizational values¹⁶³. It is noteworthy that after 20th world mining congress in 2005 held in Tehran- Iran, with the motto “mining and sustainable development”, application of sustainable development approaches in mineral industry has been taken more into consideration. This event was a milestone in Iranian industry and also academic centers¹⁶⁴. Since then, various conferences regarding research and sustainable development in mining section are annually organized; such as: Mineral Industry Congress held by Kerman University- Iran every two years¹⁶⁵; Mining Engineering and sustainable development held by Shahid- Rajai university¹⁶⁶, Iran etc. Sustainable development in Iran from religious and juridical points of view is in detail examined in Chapter four of dissertation.

2.3.2 Outlining the sustainable development agenda for mines

Specifically, how can mining operations contribute to sustainable development? They need first heavily commit to environmental protection, which involves completely redesigning and improving environmental management techniques, everything from training through planning to audit. Further, they are to become environmentally proactive in a number of areas, including control, mitigation, monitoring, and resource consumption. Committing to sustainable development in the environmental arena, therefore, requires adopting systems of ‘good environmental management’, defined by Plaut¹⁶⁷ (1998) as those that go beyond compliance with laws and regulations, and implementing equipment and techniques that foster pollution prevention. For mines intent on promoting sustainable development within their environmental management practices, changes may have to be made on numerous industrial fronts, since the possible environmental impacts resulting from mineral extraction and processing are wide ranging. Potential

¹⁶³ <http://www.imidro.gov.ir/SPage/USPage.aspx?ID=294df506-4856-4888-b8f0-011a43fa1f1f>

¹⁶⁴ M. Shahriari (2011), *Main sustainable development principles in mining and mineral industries*, Retrieved: December 2013, Access at: www.stoneassoc-ir.com (Persian), Stone Association of Iran has been established in 2000 Aiming at the improvement of the production quality of Iranian stones and the achievement of appropriate position in the global market.

¹⁶⁵ <http://mirc.uk.ac.ir>

¹⁶⁶ <http://eesd.ir>

¹⁶⁷ J. Plaut (1998), *Industry environmental processes: beyond compliance*, Technology in Society, 20/1998, p. 469-479

damages, which include everything from heavy metal contamination, through acid mine drainage (AMD), and pollution from noxious gases to soil erosion can be enormous if effective management tools and equipment are not in place. Environmental management fostering sustainable development emphasizes preventing these pollution problems before they manifest into environmental crises. Sustainable development, however, extends beyond simply committing to improving environmental performance. Principle I of the Rio Declaration proclaims that ‘Human beings are at the centre of concerns for sustainable development’ and ‘are entitled to a healthy and productive life in harmony with nature’¹⁶⁸. Another essential element of sustainable development, therefore, is social responsibility, which, in an industrial context, means accounting for the needs of stakeholder groups. Mining companies are in contact with a number of stakeholder groups, more than the average industry. In addition to having to establish positive relations with banks, insurance companies, and other lending agencies, most importantly efforts should be made to create harmony with residents of the communities in which operations exist. This can be an enormous challenge for firms since most perceive mining activities as being environmentally and ecologically destructive. Being socially active, such as providing locals with employment benefits, contributing to pension funds, and utilizing local services, eases community acceptance of mining operations, and in turn contributes to sustainable development. In short, by establishing positive relationships with those parties potentially impacted by industrial activities, mining companies decrease the stresses and difficulties of operating, and help to improve socioeconomic quality of life. The priority for mining companies is usually to maximize profits and remain competitive in the international market, and if gone about correctly, improved environmental management practices and extended social responsibility generates some kind of economic return on investment for business, although usually over the long-term. A documented reduction in effluent discharges, for example, leads to a reduction in costly government inspections and auditing practices. Similarly, involving a community in a wide-range of industrial activities puts a mining company in a better position to explore and excavate at other locations, which are more likely to ‘accept’ an operation. A commitment to sustainable development in the mining industry benefits all parties, and those mines that have

¹⁶⁸ J. M. Epps (1997), *The social agenda in mine development*, *Industry and Environment*, 20(4)/1997, p. 32-35

already adopted sustainable development as their guiding principle have reduced pollution and have improved relations with stakeholder groups¹⁶⁹.

2.3.3 Sustainable mining practices – a holistic model

A body of literature exists suggesting that mining can contribute to sustainable development by focusing on successful economic, environmental and community outcomes. However, in a mining context, these pillars (the triple bottom-line) fail to adequately account for two important areas, essential for a sustainable mining operation. One “missing” dimension is safety, which receives more attention in the mining sector than arguably any other industry. The media coverage and political focus applied to any mine “accident” exceeds in comparison to all other industries. It is not unusual for regulators to force a mine to close on the basis of a poor mine safety record. Although acknowledged as extremely significant by regulators and mining companies, its importance is not borne out in the literature on mining and sustainable development¹⁷⁰.

The second missing dimension is a focus on extraction practices of the mineral resource itself. In the literature, researchers have tended to concentrate on the exhaustibility of the resource as a depleting asset¹⁷¹. However, the researchers approach the subject from a macro level and usually from an economic perspective. It is suggested that there is a need to focus on the micro level, at the individual mine site, where the resource is managed sustainably or unsustainably. This element or dimension can be termed ‘resource efficiency’ or simply ‘efficiency’ (discussed following). It differentiates mining from other industries and is the basis or platform for any sustainable benefit to flow to the community. In most countries, the mineral resource is “owned” by the State on behalf of the community; therefore, there is an immediate link to the triple bottom-line. Mine managers will be on track in establishing a sustainable mining operation if they focus on the following five areas:

¹⁶⁹ G. Hilson (2000), *Sustainable Development policies in Canada’s mining sector: an overview of government and industry efforts*, Environmental science and Policy, 3: 201- 211

¹⁷⁰ Department of Resources, Energy and Tourism, Australian Government (2011), *A guide to leading practice sustainable development in mining*, ISBN: 78-1-921812-48-4, Access at: <http://www.industry.gov.au/resource/Documents/LPSDP/guideLPSD.pdf>

¹⁷¹ R. M. Auty, and R. F. Mikesell (1998), *Sustainable development in Mineral Economic*, Clarendon Press, Oxford

safety, environment, economy, efficiency and the community¹⁷² (Figure 2.4). A brief description of each dimension follows.

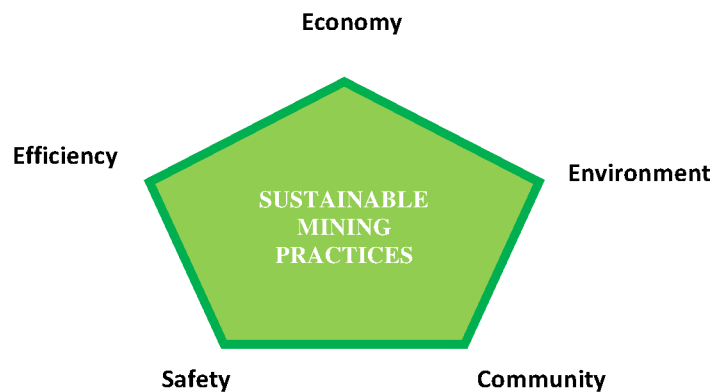


Figure 2.4 Sustainable mining practices¹⁷³

✓ **Safety**

In spite of being a crucial provider for every person`s needs, the mining industry is a complex and risky business: plenty of high risk factors can occur and severely affect nature and the miner`s life and health¹⁷⁴. Globally there is increased pressure for mines to operate safely and move towards zero harm. Best practices have used programmes such as behaviour-based safety to produce significant improvements¹⁷⁵. Characteristics of safe mines include a commitment to risk management; appropriate attitudes and behaviours; reporting systems need to be in place; a focus on education and training; and a focus on processes and equipment¹⁷⁶. E.L. Melnich and B. Everitt (2008) define risk as the probability that a substance or situation will produce harm under specified conditions and is combined of two factors: the probability and adverse event will occur and the consequences of the adverse event¹⁷⁷. Risk management is the discipline, by which an organization in any industry assesses,

¹⁷² Department of Resources, Energy and Tourism, Australian Government (2011), *A guide to leading practice sustainable development in mining*, ISBN: 78-1-921812-48-4, Access at: <http://www.industry.gov.au/resource/Documents/LPSDP/guideLPSD.pdf>

¹⁷³ D. C. Laurence (2011), *Establishing a Sustainable Mining Operation: An Overview*, Journal of Cleaner Production, Elsevier Science Ltd., 19/2011, p. 278-284

¹⁷⁴ J. Kretschmann and H. Ehnes (2011), *Success By Systematic Safety: Risk Management Orientated Concepts For Small And Medium Size Mine Operations*, Society for mining, metallurgy and exploration (SME) annual meeting, Denver, Colorado

¹⁷⁵ Deloitte & Touche (2009), *Mining Safety, A business Imperative*, Access at: <http://old.cognitive-edge.com/wp-content/uploads/2010/10/101027-Deloitte-PoV-on-Mine-Safety-Feb09v2lowres.pdf>

¹⁷⁶ D. C. Laurence (2005), *Safety Rules and Regulations on Mine Sites- The Problem and a Solution*, Journal of Safety Research, 36(1)/2005, p. 39-50

¹⁷⁷ E.L Melnich and B. Everitt (2008), *Encyclopedia of quantitative risk analysis and assessment*, Band 1, Wiley, ISBN: 978-0-470-03549-8, p. 574

controls, exploits, finances, and monitors risks from all sources for the purpose of increasing the organization's short- and long-term value to its stakeholders¹⁷⁸. Implementing plausible risk management is a process of contingency with reasonable expenses, dealing with risks in fields of business. Consequently, it can create long-term advantages in terms of competition. In other words, companies should adopt risk management system as part of their sustainable business strategy.¹⁷⁹ It should be noted that ensuring health and safety at the mine site makes good business sense, since the company can often recoup costs associated with nurturing a safe working environment through lower insurance premiums. Reduced costs, a healthy work force and the good will of neighbouring settlements can all result from ensuring a safe working environment¹⁸⁰.

The aspiration vision of 'zero harm' is popular in today's mining world. Zero harm involves creating a culture through behaviours where it is possible to work without incidents and injuries. To achieve this goal may require new approaches to advance or enhance safety standards and improve performance¹⁸¹.

The goals of a zero harm organisation include¹⁸²:

- Identifying, evaluating and improving current culture status
- Developing a strategic approach to improve safety standards
- Identifying safety systems, processes and behaviours to eliminate inherent hazards and risks
- Demonstrating effective safety leadership from senior leaders by monitoring and observing activities
- Recognising and developing goals based on safety requirements and standards, and
- Auditing safety performance.

¹⁷⁸ Casualty Actuarial Society Enterprise Risk Management Committee (2003), *Overview of Enterprise Risk Management*, Access at: <https://www.casact.org/area/erm/overview.pdf>

¹⁷⁹ T. N. Nguyen (2013), *The risk management system in German hard coal companies and the transference to Southeast Asia*, Dissertation at RWTH Aachen University, Aachen, Germany, p.31, Access at: <http://darwin.bth.rwth-aachen.de/opus3/volltexte/2013/4727/pdf/4727.pdf>

¹⁸⁰ L. A. Lapalme (2003), *The social dimension of sustainable development and the mining industry*, Natural Resources Canada, Minerals and Metals Sector, ISBN: 0-662-35211-4

¹⁸¹ <http://www.aprs.com.au/australian-safety-news/australian-construction-safety-journal-spring-2011-industry-q-and-a>

¹⁸² A. Vecchio- Sadus (2012), *The safety leadership challenge in CSIRO- pathway to impact*, the safety conference, Sydney Australia, 23- 25 October 2012

The behaviours demonstrated in a 'zero harm culture' can be¹⁸³:

- Leadership is visibly committed to and strongly owns the zero harm vision
- Leadership creates the environment that encourages the behaviours and beliefs that bring about lasting improvement
- HSE is an embedded value rather than an annual target – it is entrenched in the organisation's culture
- People are skilled and knowledgeable
- People take responsibility for the safety of those around them as well as themselves
- People feel empowered to take action
- People freely contribute discretionary effort and are recognised for this behaviour
- People do not see conflict between safety objectives and business objectives, and
- Compliance is not an option.

✓ *Economy*

The mining companies can contribute to economic growth in the community through two main channels. The first channel goes via taxation. Tax revenues are suggested to be used for strengthening the areas of the economy that have the greatest potential to create economic growth in the long run – areas to which the mining companies do not contribute simply by virtue of their presence. These might include the strengthening of preschools and primary schooling, infrastructural investments, etc. However, there is no need to select areas to which the mining companies already contribute through their mere presence. Here, the use of more funds is likely to give a lower return to society. Neither is there any reason to force the mining companies into contributing directly to, for example, the expansion of primary schooling, as this would be considered an additional tax on the companies.

The second channel goes via the company's specifically mining-related activities, such as the recruitment of local people to work in mines, or the provision of scholarships to local people to study mining-related subjects at domestic or foreign

¹⁸³ Workplace Health and Safety Queensland (WHS Qld) (2009), *What does a zero harm at work culture look like?*, Sheet 6,
Access at: <http://zeroharm.info/wp-content/uploads/downloads/2011/02/zeroharm-culture.pdf>

educational institutions. Both of these possibilities are rooted in the mining company's core activity, and it is therefore also relatively inexpensive for the company to contribute more to the local community in these areas, as part of the gain will accrue to the company itself, for example in the form of locally-available workers with greater skills¹⁸⁴.

Figure 2.5 illustrates the direct and indirect employment generated by mining companies. Figure 2.6 presents the 28 years statistics of employment in mining section in Iran. As can be seen, the overall trend is upward with some fluctuations in the beginning years.

¹⁸⁴ C. Jervelund, N. C. Fredslund, R. R. Rasmussen, D. Mekonnen, and S. Larsen (2012), *Mining and sustainable economic growth*, Employers` Association of Greenland (GA), Copenhagen Economics, p. 9, Access at: <http://www.ga.gl/LinkClick.aspx?fileticket=LHEHGwF1EPA%3D&tabid=36&language=da-DK>

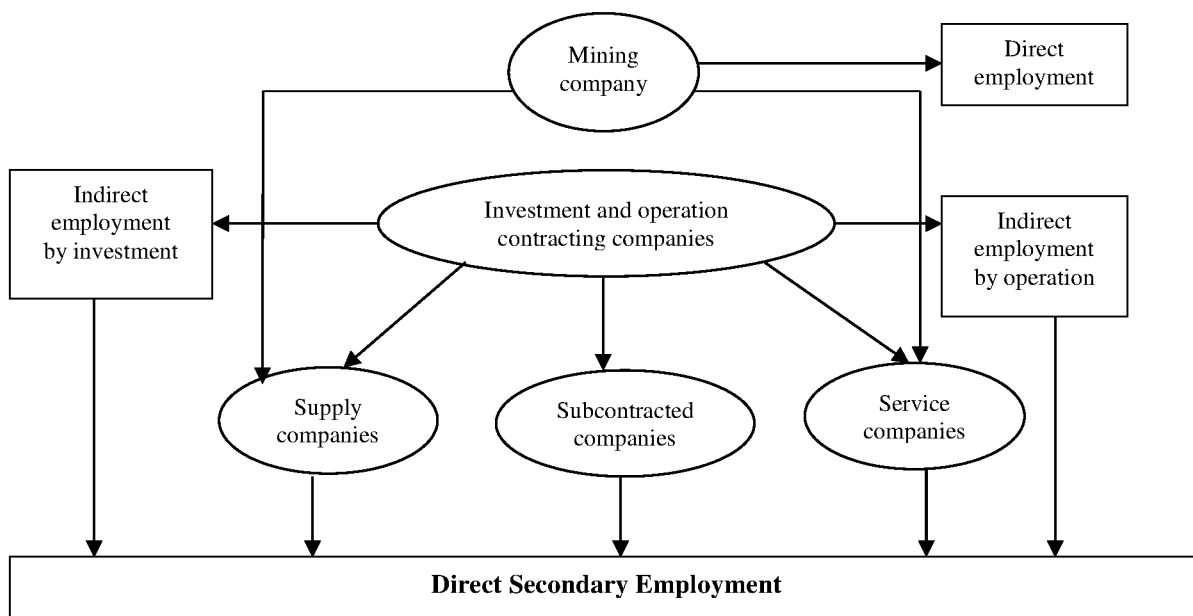


Figure 2.5 Direct and indirect employment generated by mining

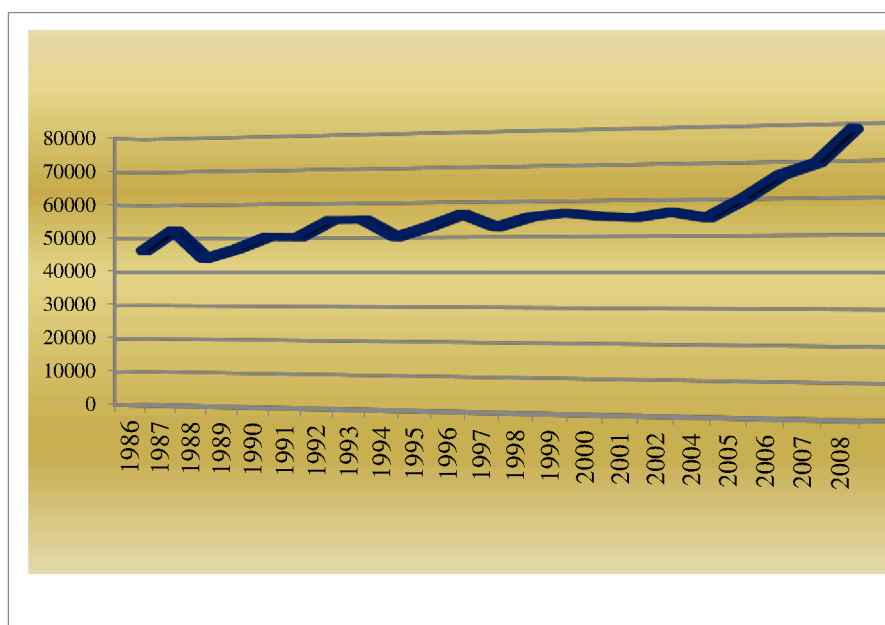


Figure 2.6 Number of employment in Iranian Mining Sector¹⁸⁶

¹⁸⁵ CIPMA (2000), *Confronting sustainability in the mining sector- what role for a sustainability fund*, first report to UNEP, October 2000

¹⁸⁶ <http://www.amar.org.ir/Default.aspx?tabid=108>, Official website of statistical center of Iran, Retrieved January 2013. In July 1965, the Statistical Centre of Iran (SCI) was established. The SCI was assigned to collect data through implementation of sampling surveys and censuses and all government agencies were duty-bound to provide the SCI with its required statistics and data. Preparation of national statistical yearbook became one of the SCI's responsibilities.

✓ *Resource efficiency*

A mine also has to be efficient in the way the deposit is managed and extracted. Mining managers and engineers, geologists and metallurgists should collaborate to optimize resource extraction. Examples of non-sustainable mining practices abound and include “high grading” the ore body, which entails mining only the highest-grade material for short-term gain. This is a practice used by responsible decision makers within those companies with a short time frame. This, in turn, is a symptom of the high turnover in short term at mine sites and the motivation of mine managers to “make one’s name” as quickly as possible without regard for the longer-term extraction of the deposit. Particularly in the times of high commodity prices, it can be profitable mining lower grades, which will extend the mine life and thus stakeholder benefits, without compromising the revenue stream. Efficiency also encompasses the management dimension at a mine site, as management decisions can be often led to production difficulties or equipment breakdown, industrial relations or other factors that impact on optimum resource extraction¹⁸⁷.

✓ *Environment*

In spite of high expenses, adopting leading environmental management is a necessity to improve the favourable business culture. Unless steps are taken in the planning and operational stages to protect environmental values, long-term liabilities such as acid mine drainage, may result. Thanks in part to the increasing awareness of environmental issues, there is considerable literature relating to the environment and sustainable development¹⁸⁸. Regarding this issue, developing and implementing environmental management systems (EMSs) is suggested to a company’s unique operating circumstance and management culture. An EMS provides a clearly defined and structured approach to managing environmental performance; it includes all of the procedures, practices, people, equipment, and technology at a facility. An EMS typically follows a “plan-do-check-act” continuous improvement process. Simply

¹⁸⁷ Department of Resources, Energy and Tourism, Australian Government (2011), *A guide to leading practice sustainable development in mining*, p. 13, ISBN: 78-1-921812-48-4, Access at: <http://www.industry.gov.au/resource/Documents/LPSPDP/guideLPSPD.pdf>

¹⁸⁸ Department of Resources, Energy and Tourism, Australian Government (2011), *A guide to leading practice sustainable development in mining*, p. 14, ISBN: 78-1-921812-48-4, Access at: <http://www.industry.gov.au/resource/Documents/LPSPDP/guideLPSPD.pdf>

stated, an EMS is how you manage environmental performance. The essence of the EMS concept is straightforward:

- Identify which aspects of your operations need to be controlled to achieve your environmental objectives (e.g., compliance with environmental permits and regulations, reducing environmental impacts and controlling long-term and short-term environmental risks).
- Ensure that processes are in place to effectively manage those aspects.
- Monitor the implementation of those processes and controls as well as the resulting environmental performance.
- Set goals and take actions to continually improve¹⁸⁹.

✓ *Community*

A KPMG (2002) survey of the sustainability reports of 40 of the World's largest mining companies shows the importance of community as an external issue, with 85% of reports addressing community issues, third behind commodity prices and the environment. Social sustainability refers to the formal and informal processes, systems, structures and relationships within a community that actively support the capacity of current and future generations to create healthy and liveable communities. Socially sustainable communities are equitable, diverse, connected and democratic, and provide a good quality of life¹⁹⁰.

Community development programs provide an important mechanism through which a mining company can contribute to social sustainability. Community development is centrally concerned with increasing the strength and effectiveness of communities in determining and managing their own futures¹⁹¹. It involves planning and implementing initiatives, often in partnership with other stakeholders, to provide long-term positive outcomes for affected communities. Community development

¹⁸⁹ Society for mining, metallurgy and exploration (SME) (2012), *Hardrock mining and beneficiation environmental management system guide*, p. 3-4, September 2012

¹⁹⁰ Western Australian Council of Social Services (2002), *Submission to the state sustainability strategy consultation paper*, WACOSS, Perth, Access at: www.wacoss.org.au

¹⁹¹ ESMAP/World Bank/ICMM 2005, *Community development toolkit—pioneering New Approaches in support of sustainable development in the extractive sector*, Energy Sector Management Assistance Program, Washington, DC, World Bank, Washington, DC, International Council on Mining and Metals, London. Available online from www.icmm.com or www.esmap.org

should be driven by the needs of the community, not the company and should seek to contribute to the long-term strengthening of community viability.

In many remote and regional areas, mining operations provide the only significant mainstream economic activity and have a critical role and contribution to make to regional economic development. Mining operations provide clear training and employment opportunities across the professions, skills and services. In some cases, mining companies are extending their commitment to local economic development and capacity building by requiring that contractors also target their training and employment opportunities to the local community, and by giving preference to a local supply chain. Mining companies are also seeking to provide appropriate skills-transfer and employment opportunities through the development of local business enterprises. The establishment of a mining or minerals operation almost always brings significant infrastructure to the mine site, to the local community and to the broader region¹⁹².

Corporate social responsibility has been defined as the voluntary social and environmental practices of companies that go beyond existing legal obligations. It comprises of all those activities that companies undertake to boost the benefits of projects while controlling the risks of impacts, which extend beyond what is required by the laws of the countries where they operate. Voluntary activities, within the realm of corporate social responsibility, are believed to be vital to ensure the competitiveness of industry. A large part of competing and working in a globalized world rests on the reputation of companies, which is based partly on the quality of their products and partly on the activities of those companies outside of production. Being involved with communities and working with the people of nearby settlements can serve to enhance a company's reputation and to facilitate future acquisitions. This is especially important for the mining industry, which has a reputation as being the cause of serious environmental damage. Furthermore, mines are often located in remote areas where they are the only significant economic activity. The reputation of companies, based on their actions in other areas, is reflected in the idea of the social

¹⁹² Department of Industry, tourism and resources (2006), *Mine closure and completion*, Australian Government, October 2006, ISBN 0642 72475 X, p. 8, Access at: <http://www.industry.gov.au/resource/Documents/LPSDP/LPSDP-MineClosureCompletionHandbook.pdf>

licence to operate¹⁹³. Countries and settlements are beginning to look at specific companies and deciding whether to give a company a social licence to operate, and mining companies are receiving increased scrutiny around the world. This is reflected in the fact that more and more mining companies are adopting codes of conduct and publishing sustainable development reports that look at the company's economic, environmental and social activities. There is no benchmark or standard for corporate social responsibility, but leading companies are attempting to set directions through both practices and reports. Corporate social responsibility involves activities that are integrated throughout a company and its business strategies. It cannot be an activity that occurs only on one site or only in one country. Corporate social responsibility is not just a series of practices; it is also a business culture that integrates social, economic and environmental factors in all the activities of a company¹⁹⁴.

2.3.4 Main principles of sustainable development in mining and mineral industries

In May 2003, International Council on Mining and Metals (ICMM)¹⁹⁵ committed companies to implement and measure their performance against 10 sustainable development principles. These principles are based on the issues identified in the Mining, Minerals and Sustainable Development project and were benchmarked against leading international standards. These standards include the Rio Declaration, the Global Reporting Initiative, the Global Compact, OECD Guidelines on Multinational Enterprises, World Bank Operational Guidelines, OECD Convention

¹⁹³ The social license is the level of acceptance or approval continually granted to an organization's operations or project by the local community and other stakeholders. The social license to operate is inversely correlated with social risk – the higher the social license, the lower the social risk. The social license to operate' began as a metaphor to bring attention to the need for companies to earn acceptance from their host communities. Today, it is a necessary management framework for complex times. A social license strategy is essentially a stakeholder engagement strategy for navigating complex socio-political environments. Access at: <http://www.accsr.com.au/html/sociallicense.html>; Australian Centre for Corporate Social Responsibility (ACCSR) helps organizations create lasting value through responsible business strategies and productive stakeholder relationships. ACCSR is certified by the Global Reporting Initiative to provide training in sustainability reporting in Australia and New Zealand.

¹⁹⁴ L. A. Lapalme (2003), *The social dimension of sustainable development and the mining industry*, Natural Resources Canada, Minerals and Metals Sector, ISBN: 0-662-35211-4, p.24-25

¹⁹⁵ The International Council on Mining and Metals (ICMM) was founded in 2001 to improve sustainable development performance in the mining and metals industry. ICMM now serves as an agent for change and continual improvement on issues relating to mining and sustainable development. ICMM's Council sets strategic direction, determines priorities, and decides on policy.

on Combating Bribery, ILO Conventions 98, 169, 176, and the Voluntary Principles on Security and Human Rights¹⁹⁶. The 10 principles and their explanations include:

1. Implement and maintain ethical business practices and sound systems of corporate governance.

- Develop and implement company statements of ethical business principles, and practices that management is committed to enforcing
- Implement policies and practices that seek to prevent bribery and corruption
- Comply with or exceed the requirements of host-country laws and regulations
- Work with governments, industry and other stakeholders to achieve appropriate and effective public policy, laws, regulations and procedures that facilitate the mining, minerals and metals sector's contribution to sustainable development within national sustainable development strategies.

2. Integrate sustainable development considerations within the corporate decision-making process.

- Integrate sustainable development principles into company policies and practices
- Plan, design, operate and close operations in a manner that enhances sustainable development
- Implement good practice and innovate to improve social, environmental and economic performance while enhancing shareholder value
- Encourage customers, business partners and suppliers of goods and services to adopt principles and practices that are comparable to our own
- Provide sustainable development training to ensure adequate competency at all levels among our own employees and those of contractors
- Support public policies and practices that foster open and competitive markets.

3. Uphold fundamental human rights and respect cultures, customs and values in dealings with employees and others who are affected by our activities.

¹⁹⁶ International Council on Mining and Metals; <http://www.icmm.com/our-work/sustainable-development-framework/10-principles>, Retrieved: 1 June 2013

- Ensure fair remuneration and work conditions for all employees and do not use forced, compulsory or child labor
- Provide for the constructive engagement of employees on matters of mutual concern
- Implement policies and practices designed to eliminate harassment and unfair discrimination in all aspects of our activities
- Ensure that all relevant staff, including security personnel, are provided with appropriate cultural and human rights training and guidance
- Minimize involuntary resettlement, and compensate fairly for adverse effects on the community where they cannot be avoided
- Respect the culture and heritage of local communities, including indigenous peoples.

4. Implement risk management strategies based on valid data and sound science.

- Consult with interested and affected parties in the identification, assessment and management of all significant social, health, safety, environmental and economic impacts associated with our activities
- Ensure regular review and updating of risk management systems
- Inform potentially affected parties of significant risks from mining, minerals and metals operations and of the measures that will be taken to manage the potential risks effectively
- Develop, maintain and test effective emergency response procedures in collaboration with potentially affected parties.

5. Seek continual improvement of our health and safety performance.

- Implement a management system focused on continual improvement of all aspects of operations that could have a significant impact on the health and safety of our own employees, those of contractors and the communities where we operate
- Take all practical and reasonable measures to eliminate workplace fatalities, injuries and diseases among our own employees and those of contractors
- Provide all employees with health and safety training, and require employees of contractors to have undergone such training

- Implement regular health surveillance and risk-based monitoring of employees
- Rehabilitate and reintegrate employees into operations following illness or injury, where feasible.

6. Seek continual improvement of our environmental performance.

- Assess the positive and negative, the direct and indirect, and the cumulative environmental impacts of new projects – from exploration through closure
- Implement an environmental management system focused on continual improvement to review, prevent, mitigate or ameliorate adverse environmental impacts
- Rehabilitate land disturbed or occupied by operations in accordance with appropriate post-mining land uses
- Provide for safe storage and disposal of residual wastes and process residues
- Design and plan all operations so that adequate resources are available to meet the closure requirements of all operations.

7. Contribute to conservation of biodiversity and integrated approaches to land use planning.

- Respect legally designated protected areas
- Disseminate scientific data on and promote practices and experiences in biodiversity assessment and management
- Support the development and implementation of scientifically sound, inclusive and transparent procedures for integrated approaches to land use planning, biodiversity, conservation and mining.

8. Facilitate and encourage responsible product design, use, re-use, recycling and disposal of our products.

- Advance understanding of the properties of metals and minerals and their life-cycle effects on human health and the environment
- Conduct or support research and innovation that promotes the use of products and technologies that are safe and efficient in their use of energy, natural resources and other materials

- Develop and promote the concept of integrated materials management throughout the metals and minerals value chain
- Provide regulators and other stakeholders with scientifically sound data and analysis regarding our products and operations as a basis for regulatory decisions
- Support the development of scientifically sound policies, regulations, product standards and material choice decisions that encourage the safe use of mineral and metal products.

9. Contribute to the social, economic and institutional development of the communities in which we operate.

- Engage at the earliest practical stage with likely affected parties to discuss and respond to issues and conflicts concerning the management of social impacts
- Ensure that appropriate systems are in place for ongoing interaction with affected parties, making sure that minorities and other marginalized groups have equitable and culturally appropriate means of engagement
- Contribute to community development from project development through closure in collaboration with host communities and their representatives
- Encourage partnerships with governments and non-governmental organizations to ensure that programs (such as community health, education, local business development) are well designed and effectively delivered
- Enhance social and economic development by seeking opportunities to address poverty.

10. Implement effective and transparent engagement, communication and independently verified reporting arrangements with our stakeholders.

- Report on our economic, social and environmental performance and contribution to sustainable development
- Provide information that is timely, accurate and relevant
- Engage with and respond to stakeholders through open consultation processes.

Integrating the sustainable mining practices suggested by Laurence (2011)¹⁹⁷ and 10 main sustainable development principals recommended by ICMM¹⁹⁸, following model is presented (Figure 2.7):

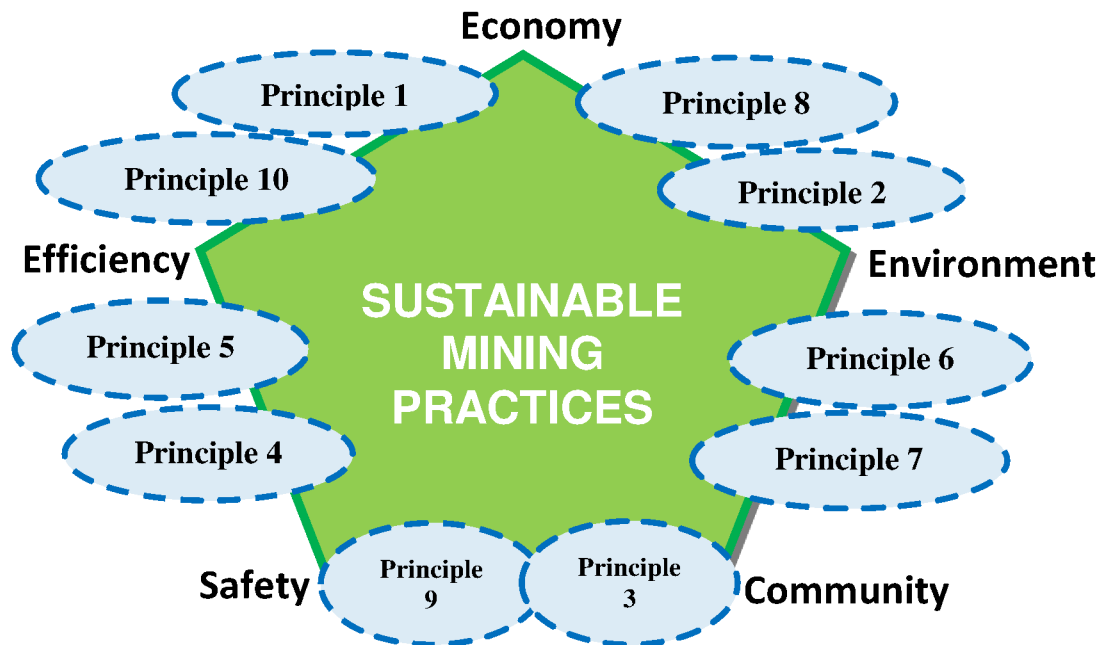


Figure 2.7 Interrelation between sustainable mining practices and SD principles recommended by ICMM

2.4 Sustainable development issues for mine closure

The future of the mining industry is dependent on the legacy it leaves. Its reputation is affected when mines are abandoned or long-term detrimental environmental issues emerge because they have not been appropriately addressed. The industry needs to embrace the concept of completion of mining as a defined end point rather than just closure, when the operational stage of a mine ceases and decommissioning is complete¹⁹⁹.

¹⁹⁷ D. C. Laurence (2011), *Establishing a Sustainable Mining Operation: An Overview*, Journal of Cleaner Production, Elsevier Science Ltd., 19/2011, p. 278-284

¹⁹⁸ International Council on Mining and Metals; <http://www.icmm.com/our-work/sustainable-development->

¹⁹⁹ Department of Industry, tourism and resources (2006), *Mine closure and completion*, Australian Government, October 2006, ISBN 0642 72475 X, p.1

The objectives of a mine closure and completion plan are²⁰⁰:

- enable all stakeholders to have their interests considered during the mine closure process
- ensure the process of closure occurs in an orderly, cost-effective and timely manner
- ensure the cost of closure is adequately represented in company accounts and that the community is not left with a liability
- ensure there is clear accountability and adequate resources for the implementation of the closure plan
- establish a set of indicators which will demonstrate the successful completion of the closure process
- reach a point where the company has met agreed completion criteria to the satisfaction of the responsible authority.

Planning for mine closure is a critical component of environmental management in the mining industry. Nationally and internationally, industry-leading practice requires that planning for mine closure should start before mining commences and should continue throughout the life of the mine until final closure and relinquishment. This approach enables better environmental outcomes. It is also good business practice, as it avoids the need for costly remedial earthworks late in the project lifecycle²⁰¹. Progressive development of a Mine Closure Plan through the mine lifecycle, as shown in Figure 2.8 and 2.9, and progressive rehabilitation, are critical to the successful implementation of mine closure planning. Progressive rehabilitation has many benefits including²⁰²:

- A reduction in project costs by maximising the use of on-site resources during mine life;
- Allowing rehabilitation costs to be spread over the life of the mine;

²⁰⁰ Australian and New Zealand Minerals and Energy Council (ANZMEC) and Minerals council of Australia (2000), *Strategic framework for mine closure*, ISBN 0642 72138 6, p.24, Access at: <http://www.sernageomin.cl/pdf/mineria/cierrefaena/DocumentosRelacionados/Strategic-Framework-Mine-Closure.pdf>

²⁰¹ Department of mines and petroleum (2011), *Guidelines for preparing mine closure plans*, Government of Western Australia, p.3, June 2011, Access at: http://www.epa.wa.gov.au/EPADocLib/153549_WEB%20VERSION%20%E2%80%93%20Guidelines%20for%20Preparing%20Mine%20Closure%20Plans.pdf

²⁰² Department of Industry, tourism and resources (2006), *Mine closure and completion*, Australian Government, October 2006, ISBN 0642 72475 X, p.18

- The potential for better rehabilitation outcomes through the use of recently disturbed topsoil;
- Knowledge gained from past rehabilitation trials and efforts; and
- Minimizing the amount of time required for monitoring and maintenance post mine life.

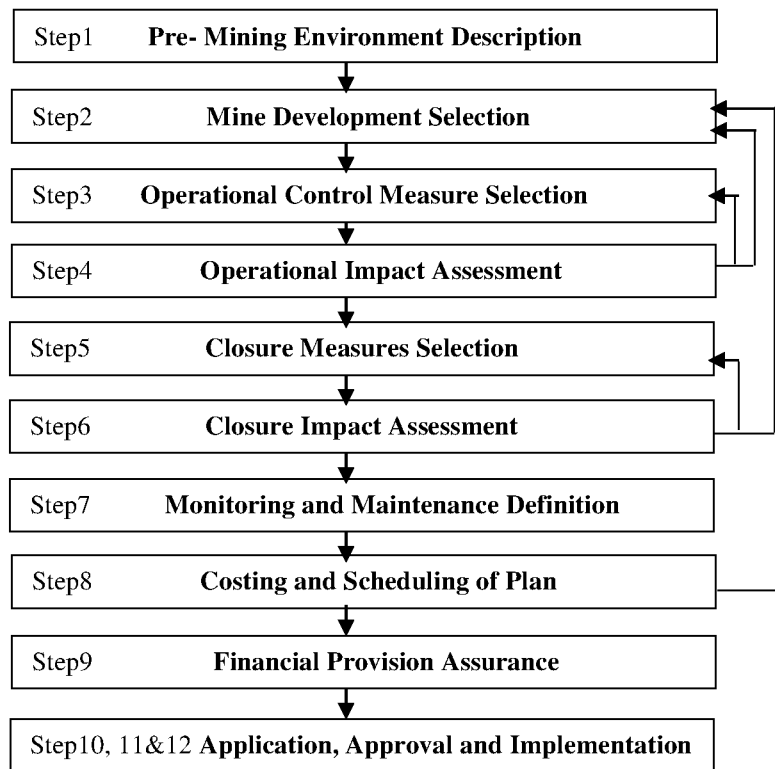


Figure 2.8 Typical steps in the closure plan development process²⁰³

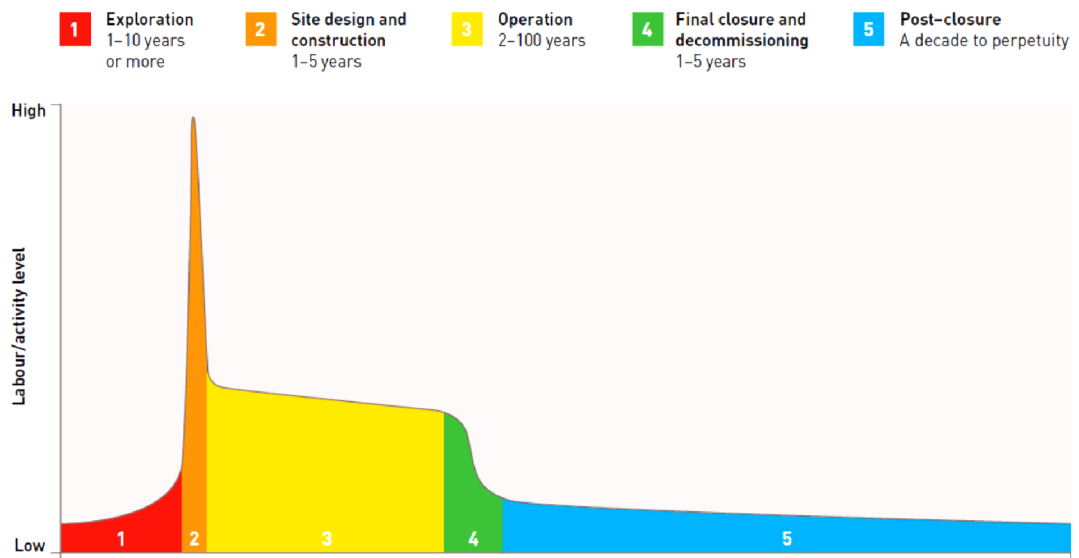


Figure 2.9 The mine project life cycle²⁰⁴

²⁰³ Robertson Geo-Consultants Inc., *Closure Plan Development Steps*, Access at: <http://www.robertsongeoconsultants.com>, Robertson GeoConsultants Inc. (RGC) is a highly-specialized consulting firm that provides geotechnical, geochemical, and hydro geological expertise to the mining industry worldwide.

²⁰⁴ International Council on Mining and Metals (ICMM) (2012), *Mining's contribution to sustainable development- an overview*, In brief version, published: June 2012, p. 4, Access at: <https://www.icmm.com/document/3716>

2.4.1 Environmental issues

Central to a closure plan is the development of a progressive rehabilitation plan which ensures²⁰⁵:

- The post-mined landscape is safe and is stable from physical, geochemical and ecological perspectives
- The quality of the surrounding water resources is protected
- The agreed sustainable post-mining land use is established and clearly defined to the satisfaction of the community and government
- Success criteria are agreed with relevant stakeholders, monitored and reported to stakeholders.

The development of a mining operation, including associated processing facilities and infrastructure, usually involves the permanent alteration of existing landforms, disturbance to vegetation and flora, disruption of fauna habitats, hydrological impacts and potentially some level of contamination.

2.4.2 Socio-economic issues

Planning for mine closure can assist in mitigating the consequent reduction in access to useful infrastructure. With advanced and careful planning, it may be possible to develop capacity to maintain certain infrastructure facilities and services for future community or local government ownership or as part of arising business development opportunities.

A company's community development program will be informed by the company's community engagement strategy which should be a dynamic and ongoing process throughout the life cycle of the mining operation. Planning for mine closure should be raised with the community as early as possible prior to the planning and design phase. The project design should consider how to lessen the adverse impacts of mine closure and to optimize the opportunities for community development that arise from the active mining and mine closure phases. An early and effective community

²⁰⁵ Department of Industry, tourism and resources (2006), *Mine closure and completion*, Australian Government, October 2006, ISBN 0642 72475 X, p. 5-6

engagement strategy should be established and the community engaged throughout the life of the operation²⁰⁶.

2.4.3 Business case

There is a business case for approaching mine closure within a sustainable development framework in a planned, structured and systematic manner that is progressively implemented over the whole project cycle. The benefits include:

A) Improved mine management:

- Opportunities to optimize mine planning and operations during active mine life for efficient resource extraction and post-mining land use (for example reduction of double-handling for waste materials and topsoil, and reduced areas of land disturbance)
- Identification of areas of high risk as priorities for ongoing research or remediation
- Progressive implementation of a mine closure plan with opportunities for ongoing effectiveness testing, assessment and feedback
- Lower risk of non-compliance regulatory.

B) Improved stakeholder engagement in planning and decision-making:

- understanding the likely impacts on affected communities in terms of environmental, social and economic impacts of mine closure
- informed development of strategies and programs to address closure impacts, ideally as part of a community development approach from early in the mine's life
- increased support from employees, government, landholders, local community and other stakeholders for closure decisions
- improved community receptiveness to future mining proposals
- enhanced public image and reputation.

²⁰⁶ Department of Industry, tourism and resources (2006), *Mine closure and completion*, Australian Government, October 2006, ISBN 0642 72475 X, p. 8

C) Reduction of risks and liabilities:

- assured financial and material provision for mine closure through early estimation of mine closure costs
- Continual reduction of liabilities by optimizing operational works during active mine life in alignment with closure plan
- Reduction of exposure to contingent liabilities related to public safety and environmental hazards and risks
- Reduction of ongoing responsibilities for the site and facilitation of timely relinquishment of tenements and bond recovery²⁰⁷.

²⁰⁷ Department of Industry, tourism and resources (2006), *Mine closure and completion*, Australian Government, October 2006, ISBN 0642 72475 X, p. 8

Chapter 3

Status of Sustainable Development

in

Sangan Iron Ore Mines (SIOM)

3 Status of sustainable development in Sangan Iron Ore Mines (SIOM)

3.1 Sustainable development in SIOM

3.1.1 Social aspects

There is no doubt that the huge iron-ore resources in east of Iran have been a main factor for the development in this particular region. SIMP and IEIOC as governmental organizations in SIOM have carried out actively-managed social and cultural responsible activities from the beginning of their operation. Senior managers of SIMP and IEIOC, selected by IMIDRO, are collaborating with administrative council members of Khaf County including Khaf governor, Khaf security forces, Khaf physical education department, Khaf social welfare department and Khaf Red Crescent office. They support a variety of cultural, educational, civic and sport initiatives so as to improve the acceptance of SIMP and similar projects in the local communities.

Some of the most important examples of Social Responsibilities Activities (SRA) realized by SIMP and IEIOC during the last 25 years in the Sangan region are the following ones.

3.1.1.1 Building high school for girls

One of the most important SRAs at the first years of operation of SIMP and IEIOC was the foundation of a high school for girls in Sangan town (in Iran boys and girls are educated separately). IMIDRO didn't exist during that time. The costs were paid by SIMP as subset of NISCO. Since there had been no such considerable educational facility in Sangan, the opening of this high school was an important and a useful contribution to the development of the region community. The high school was inaugurated with a special opening ceremony at the first day of autumn²⁰⁸ 1992, and till 2012, a number of 920 students have been graduated. The high school building was constructed in less than 2 years in an area of 15,000 square meters provided by Sangan council members. The two-floor building includes 12 classrooms with 2,000 square meters total area. Construction costs amounted to 380,000,000 Rials equal with 264,541 U.S Dollar (average exchange rate in 1992:1USD=1458.5 Rials). In addition to 12 classrooms, the project includes examination halls, laboratory, library,

²⁰⁸ Iranian educational year begins in first day of the autumn.

warehouse, non-local teachers' rest room and a house for the school watch-man. The entire necessary equipment provided for this school have relatively high quality²⁰⁹.

Ten graduates from this high school progressed to medical schools in different universities and some have returned to work as doctors in Sangam or other towns in Khaf. Other graduates are studying in different academic fields such as paramedical, electric engineering, agriculture engineering, law, geography, accounting, etc. Some of them are working for SIMP and IEIOC now. In addition, during the recent years, most of the managers and teachers were locals who graduated from this high school²¹⁰.

In sum, the main purpose of such project was active and fair involvement of local people in SIMP's performance. Usually, people in the vicinity of Sangam expect the companies to support them; this is the main purpose of SRA. In these case, educated girls will have more competences and yet better prospective. On the other hand, an enhanced rate of literacy of women was one of the long term objectives of the Iranian Government during that time. This project contributed a lot to reach this aim, as shown in Figure 3.1. As can be seen, the literacy rate of men has been stable during time, while the rate of women had a drastic increase from 1996 to 2005. Literacy is defined in Iranian sources as at least 5 years of education; hence, the increase in number has been shown up in upcoming years, i.e. 2005 and 2011. Besides, the inauguration of this school motivated the girls to continue their studies, because the lack of school for higher education in the vicinity was a big problem and disappointed girls from even primary learning. It is noteworthy that SIOM was pioneer in the region in recruiting female staff. Figure 3.2 shows the number of male and female personnel during 2001 and 2013 in SIMP and IEIOC without considering contractors and consultants. Although the number of female personnel is still low in comparison to male staff, this is a great achievement. Due to cultural and educational constraints, women were rarely incorporated in business activities; however, SIOM policies had a substantial role in empowering women in the region.

²⁰⁹ J. Kretschmann and R. Amiri (2013), *Social responsible mining in east Iran: The Sangam Iron Ore Mines*, 23rd World Mining Congress, Montreal, Canada, Canadian Institute of Mining (CIM)

²¹⁰ J. Kretschmann and R. Amiri (2013), *Social responsible mining in east Iran: The Sangam Iron Ore Mines*, 23rd World Mining Congress, Montreal, Canada, Canadian Institute of Mining (CIM)

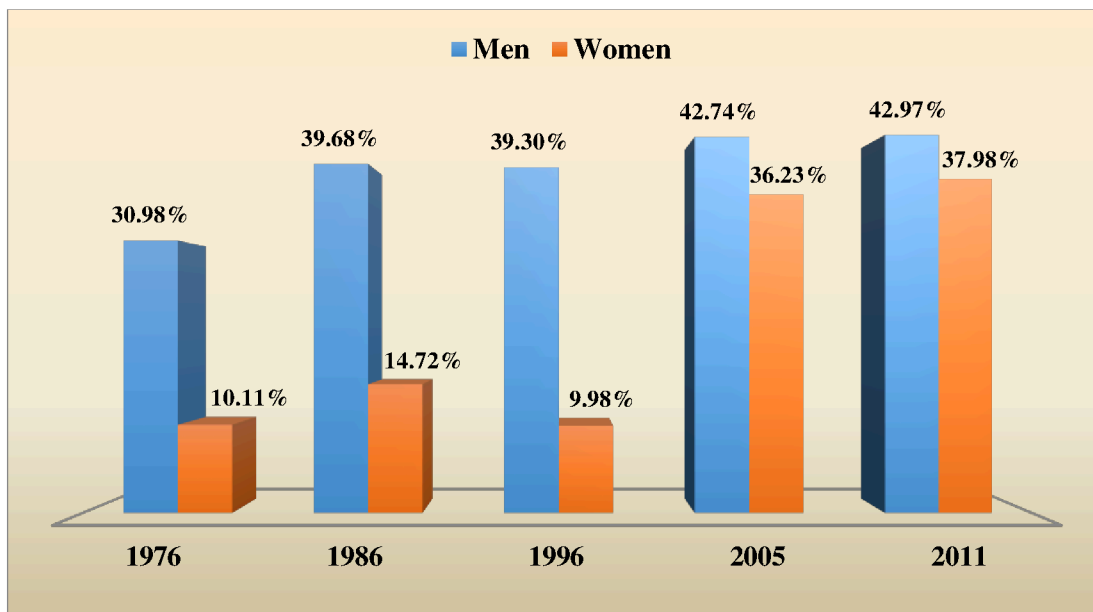


Figure 3.1 Percentage of literate men and women in Khaf County²¹¹

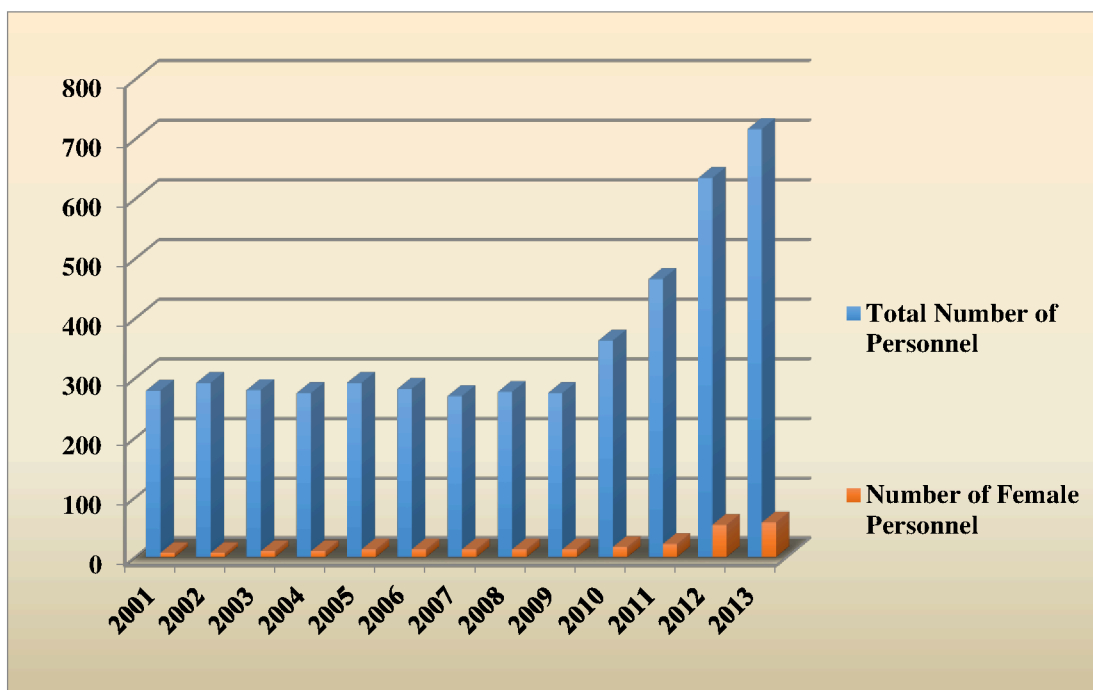


Figure 3.2 Number of female personnel in SIMP and IEIOC²¹²

²¹¹ Statistical Center of Iran (2012), *Education Report of Khorasan-e- Razavi in Province*
 Access at: <http://www.amar.org.ir/Default.aspx?tabid=133>

²¹² SIMP and IEIOC's Human Resources Management Departments (2014), *Internal report* (Persian)

3.1.1.2 Construction of a new technical school

In 2001, a technical school named Khajeh Nasiraddin Toosi was founded in Sangan near the mine, starting with limited equipment and space available for 30 mining students. SIMP provided the educational staff. The development of the mining operations had created a higher demand for skilled staff; hence steps were taken to build a new technical school. It was realized through a cooperation of SIMP, IEIOC and Khorasan-e-Razavi School Tooling and Renovation Organization. This joint project with total costs of 1.5 billion Rials started in 2006 and was finished in 2010. One third of the costs, 0.5 billion Rials (SIOM financial department) equal to 483,793 USD (average exchange rate in 2010: 1USD = 10,335 Rials) was covered by SIMP. This school with its magnificent architecture is located at Sangan town entrance. It covers an area of 27,000 square meters. A dormitory for students, a self-service restaurant and a library provide a suitable environment for studying and apprenticeship. In 2012, 350 students are studying in different fields, namely mining, mechanics, computer and surveying in four grades. Some graduates went to well-known universities and got even M.S degrees²¹³. In the table 3.1, the total number of graduates since inception is shown.

Training the required skilled human forces for SIMP, improving the education facilities in the region and introducing SIMP as a considerate corporate were the aims of this project. It is noteworthy that several similar ore reservoirs are located in the neighbor country, Afghanistan, which has not been extracted yet. In the long run, there might be a mutual relationship between the skilled Iranian technicians and uneducated Afghani workers²¹⁴ to benefit from these resources²¹⁵.

According to the SIMP, IEIOC and SIOC human resources department, 59 graduates (about 11 per cent of total graduates) are working directly in SIMP, IEIOC and SIOC in 2015. Regarding the few number of graduates working in this project, there are a couple of issues that are worth mentioning. Firstly, the largest part of SIOM is under

²¹³ J. Kretschmann and R. Amiri (2013), *Social responsible mining in east Iran: The Sangan Iron Ore Mines*, 23rd World Mining Congress, Montreal, Canada, Canadian Institute of Mining (CIM)

²¹⁴ J. Kretschmann, R. Amiri and A. Zarekar, (2013), *Realization of Sustainable Development in Iranian Mining Sector- case study: Sangan Iron Ore Mines (SIOM)*, The first International Conference on Economic Management in Mining Activities, HaNoi, VietNam, 8-9 Nov, p. 459-466

²¹⁵ This is an anticipation and is not explicitly mentioned in SIMP's strategies. Since the numbers of graduates are currently higher than the average rate of demand in Khaf County, there will be undoubtedly the probability of educated forces' migration to other parts of the country or even abroad. However, this imbalance will be offset with escalating probability of job creation in long run.

construction currently and in future more skilled workers will be needed so that more graduates will be employed. Secondly, these statistics are only restricted to SIMP, IEIOC and SIOC and information from other operating organizations, contractors or engineering consultants are excluded.

Study year	Mining (person ²¹⁶)	Mechanics (person)	Computer (person)	Surveying (person)	Total (person)
2001-2002	30	-	-	-	30
2002-2003	29	15	-	-	44
2003-2004	28	20	-	-	48
2004-2005	27	23	-	-	50
2005-2006	20	22	-	-	42
2006-2007	19	23	-	-	42
2007-2008	13	21	15	-	49
2008-2009	13	24	24	-	61
2009-2010	14	23	13	-	50
2010-2011	9	21	14	15	59
2011-2012	8	22	11	19	60
Sum	210	214	77	34	535

Table 3.1 Technical school graduates statistics since inception²¹⁷



Figure 3.3 Girl high school (left) and new technical school (right) in Sangam town

²¹⁶ In spite of development in mining operations in the region, it can be seen that the number of graduates in mining field has decreased from 2005 till 2012. This can be attributed to saturation of employment capacities in SIOM and consequently, less motivation to study in this field. Besides, there is high number of graduates in this field in other nearby cities which affects the tendency to study mining in Khaf. It should be noted that this trend may change in future due to alteration in strategic plans and the need to more mining excavation and new processing plants.

²¹⁷ Khaf County Educational Department (2012) , *Internal report* (Persian)

3.1.1.3 SIMP and IEIOC employees' charity

Workers in SIOM, who have averagely higher income than other residents in the region, established a charity fund in 2004. The objective of this fund was to enhance the average welfare in the whole County and provide residents in need with necessary living facilities; besides, they will be motivated to support the project.

In 2012, the charity had 275 employees, 215 locals and 60 non-local mine employees. The number of employees increases every year. This charity is managed by a board of trustees. At the beginning of the Iranian New Year, a list including all members' names is prepared by the board of trustees comprising everybody's monthly payment to the charity. This list is signed by the members and presented to the financial departments of SIMP and IEIOC. So the departments can deduct the determined amount of money from the personnel salaries for charity²¹⁸. The fund can be used in various way; e.g. financial support of destitute residents in case of expensive remedial needs, cooperation in house building for people in need, conforming charity's monetary abilities, etc. In fact, the fund can be used flexibly and variously. Based on the board of trustees' act, the destitute students of Khaf County are twice a year supported in the form of cash and kind including clothes, shoes, stationeries and other educational materials²¹⁹. In table 3.2, brief information related to the aids paid by Sangan mine employees' charity from the beginning of the establishment till the end of Dec. 20. 2012 is shown.

²¹⁸ J. Kretschmann and R. Amiri (2013), *Social responsible mining in east Iran: The Sangan Iron Ore Mines*, 23rd World Mining Congress, Montreal, Canada, Canadian Institute of Mining (CIM)

²¹⁹ SIMP and IEIOC's Charity Board of Trustees (2013), *Internal report* (Persian)

Persian calendar	Equivalent in Gregorian calendar	Paid amount (Rial) ²²⁰	Average exchange rate for 1USD (Rial) ²²¹	Paid amount (USD)
1383	Mar. 2004 - Feb. 2005	15,836,000	8,719	1,816
1384	Mar. 2005 - Feb. 2006	29,300,000	9,023	3,247
1385	Mar. 2006 - Feb. 2007	17,059,250	9,195	1,855
1386	Mar. 2007 - Feb. 2008	75,681,000	9,285	8,151
1387	Mar. 2008 - Feb. 2009	71,400,000	9,574	7,458
1388	Mar. 2009 - Feb. 2010	53,638,900	9,917	5,409
1389	Mar. 2010 - Feb. 2011	132,128,000	10,335	12,785
1390	Mar. 2011 - Feb. 2012	122,430,000	10,962	11,169
till 1391/9/30	Mar. 2012 – Dec/20/2012	60,000,000	12,260	4,894
Sum		577,473,150		56,783

Table 3.2 Brief information related to the aids paid by SIMP and IEIOC employees' charity²²²

3.1.1.4 Construction of three residential homes

Unfortunately, three workers in the exploration-drilling unit of SIMP were killed in October 1990 by a car accident. As it was at the beginning of the exploration activities, the accident had, from psychological point of view, an unfavorable effect on the mine staff and local people and consequently caused a disappointing atmosphere related to the mining project. After the accident, the SIMP decided to build three new residential houses for the killed workers' families on their own land by getting the required legal grounds. The houses which were modern in comparison to the previous ones were built with the costs of 15,900,000 Rials (SIMP financial department) equal with 234,513 USD (average exchange rate in 1991: 1USD =6780 Rials)²²³.

This activity was not a legal necessity. It was merely to support the killed workers' families and to soothe the mental and psychological impressions in the mining area. According to the evidences and satisfaction of the bereaved family members, this strategy was fortunately followed by favorable effects in the region. Since no similar accident was reported after that, no strategy alike was conducted.

²²⁰ These amounts are based on the last SIMP and IEIOC employees' charity board of trustees report.

²²¹ Central Bank of Iran (2013), Access at: http://www.cbi.ir/exrates/rates_fa.aspx

²²² J. Kretschmann and R. Amiri (2013), *Social responsible mining in east Iran: The Sangan Iron Ore Mines*. 23rd World Mining Congress, Montreal, Canada, Canadian Institute of Mining (CIM)

²²³ SIMP and IEIOC's Human Resources Management and Financial Departments (1992), *Internal report* (Persian)

3.1.1.5 Assistances to different organizations of Khaf County

The Sangan area in Khaf County has its own special geographical and geopolitical attributes; such as: severe weather condition, low rate precipitation, semi desert region, special geographical location on the border to Afghanistan, infrastructure limitation, water shortage, low rate of employment, suitable areas for criminal activities like smuggling, etc. which make this region less developed and poor. From the beginning of mining operations, SIMP has been the biggest industrial and economical project in Khaf County. These assistances were often based on the delivery of second hand used but worthwhile goods²²⁴. In table 3.3, these 6 assistances are shown. The prices of second hand used goods were estimated based on SIMP and IEIOC financial department documents²²⁵.

Unit of help target	Total goods	Value (USD)
Khaje Nasiraddin Toosi Technical School of Sangan	3,449	240,839
Girl high school of Sangan	547	33,666
Khaf County educational department	245	12,132
Khaf road police and Sangan police force	96	2,026
Sangan Sherifdom	10	1,756
Two regional guidance schools	81	1,219
Khaf red crescent	4	580
Others	233	1,590
Total	4,665	293,808

Table 3.3 Assistances paid to different organizations of Khaf County by SIMP and IEIOC²²⁶

Table 3.4 includes the total costs of assistances (in USD) covered by SIMP and IEIOC for the Khaf County as SRA till the end of Dec. 20. 2012.

²²⁴ The goods include: telephone, television, computer, refrigerator, over, air conditioner etc.

²²⁵ SIMP and IEIOC's Financial Management Departments (2008), *Internal report* (Persian)

²²⁶ J. Kretschmann and R. Amiri (2013), *Social responsible mining in east Iran: The Sangan Iron Ore Mines*. 23rd World Mining Congress, Montreal, Canada, Canadian Institute of Mining (CIM)

Description	Values (USD)
Girls` high school	264,541
New technical school	483,793
Sangan mine employees` charity	56,783
Construction of three residential homes	234,513
Governmental and non-governmental organizations	293,808
Sum	1,333,438

Table 3.4 Total costs of assistances paid by SIMP and IEIOC²²⁷ as SRA from 1990 till 2012²²⁸

It's noteworthy that above-mentioned social responsibility activities aimed at attracting local community's attention and support. In fact, there was no legal force from government on SIMP and IEIOC to assign part of its income to SRAs; however, sustainable social development is included as an aim in very important sources of the country such as Vision 1404²²⁹ and the first till fifth five-years- plans. For example, the Iranian society at the dawn of the national vision [the year 2024] is supposed to have these features: "Endowed with [public] health, welfare, food security, social security, equal opportunities, appropriate income distribution, strong family foundations; [and] distanced from poverty, corruption, discrimination, and benefitting from a favorable natural environment"²³⁰. Also, in fourth development plan of Iran, ratified in 2003, is stated: "Trying to achieve social equity, creating equal job opportunities, and improving indicators such as education, health, food security, and annual income and fighting corruption"²³¹. There are many other acts and provisos in the Iranian legal system which will be discussed in detail in chapter four.

²²⁷ J. Kretschmann and R. Amiri (2013), *Social responsible mining in east Iran: The Sangan Iron Ore Mines*, 23rd World Mining Congress, Montreal, Canada, Canadian Institute of Mining (CIM)

²²⁸ Among items mentioned in table 3.3 as assistances paid by SIMP and IEIOC, three of them were conducted during the management period of PhD student; namely: new technical school, Sangan mine employees' charity, and governmental and non-governmental organizations.

²²⁹ The 20-Year National Vision of the Islamic Republic of Iran for the dawn of the Solar Calendar Year 1404 [2025 C.E.]

²³⁰ <http://www.ichto.ir/Default.aspx?tabid=1741>; website of Iran Cultural Heritage, Handicrafts and Tourism retrieved: 15 December 2013.

²³¹ <http://old.maslahat.ir/Contents.aspx?p=6e386897-5584-4ac0-835c-861690ab72f8>; website of Iran Expediency Council. This council determines the main strategies of development in country and reviews the conflicts among different organization. Retrieved at 15 December 2013

3.1.1.6 Employment

Generally, the mining sector has brought important economic gains to both mining companies and local communities (win-win situations). The main economic benefit for the communities has been an increase in employment opportunities²³². This can be seen in the case of SIMP, IEIOC and SIOC, too. In Khaf County, the annual unemployment rate was around 7.5% between 1996 and 2001, but because of new job opportunities related to SIMP and IEIOC the rate decreased to 3.5% until 2009. According to the studies, the mining activities had considerable effect on job creation²³³. It has been widely accepted that in mining section, usually 4 times the direct jobs, indirect jobs are created²³⁴. In Figure 3.4, the average direct employment of SIMP, IEIOC and SIOC from 2006 to 2013 is shown. The numbers are calculated based on SIMP, IEIOC and SIOC Human Resources Managements monthly statistics.

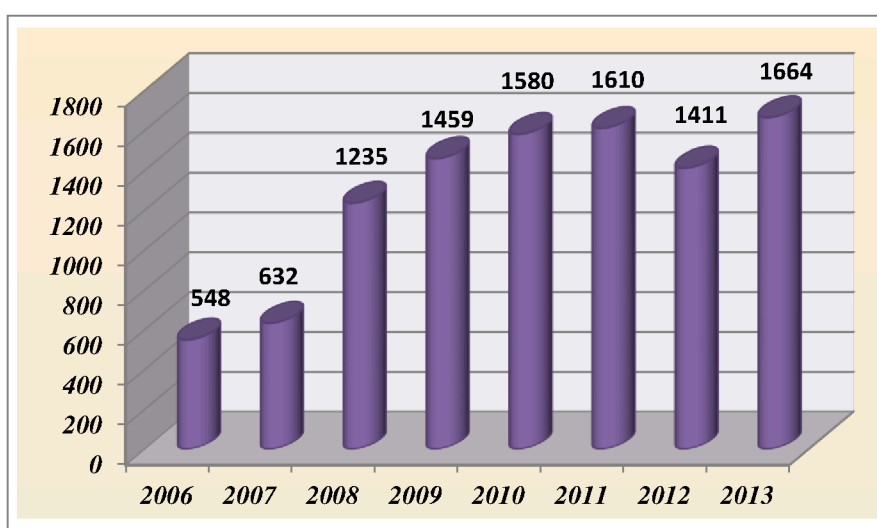


Figure 3.4 SIMP and IEIOC direct employment in recent years²³⁵

By creating jobs and earnings for the local population, it is obvious that mining activities have positively affected the socio-economic development in Sangam area²³⁶.

²³² <http://issuu.com/action/openurl?url=www.fraserinstitute.org>, last access 12/2012

²³³ A. Tavakoliroodi (2012), *Security, political and economic effects of mining activities in SIOM*, Published by Taybad Azad University, p. 183 (Persian). It is notable that the author (Dr. Tavakoliroodi) was the Meyer of Khaf city from 2013 till 2015.

²³⁴ Tadbir Gostar-e-Asia, Project Control and Planning Consultant of Sangam Iron Ore Mine Project, monthly management report, September 2013, p. 8 (Persian). According to this report, 2500 direct jobs and 10000 indirect jobs were created during the operational phase of SIMP.

²³⁵ SIMP, IEIOC and SIOC's Human Resources Management Departments (2014), *Internal report* (Persian)

3.1.1.7 Decreasing criminal activities

SIMP and IEIOC could help to raise the living standard in the region which directly affected the social security. According to a comprehensive study conducted on security, political and economic effects of mining industry in Khaf, as SIOM is located near the border of Afghanistan, a big producer of illegal drugs, in some parts of border areas people live on drug trafficking. Presumably, the creation of jobs, the perspective of a better future and the economic improvement in the region will decrease drug smuggling and criminal activities like robbery, murder or addiction²³⁷.

3.1.1.8 Measures to improve occupational safety and health²³⁸

Occupational safety and health issues in the mining industry come from technical risks, which are rooted from both external and internal factors. The aims of occupational safety and health are to promote and maintain the highest degree of workers' physical, mental and social well-being to prevent risks resulting in dangers to health; to place and maintain the workers in an occupational environment adapted to his physiological and psychological capabilities; and in general to adapt work to the man and each man to his job²³⁹. Being cautious during production (risk management) does not restrict productivity but helps reduce accident rates, and therefore, prevent the company from loss and damages. Safety competence plays an important part in the framework of risk management. It is also a cross-disciplinary area concerned with protecting the safety, health and welfare of the people engaged in work²⁴⁰.

The structure of a risk management process has been widely discussed and there are various models in each country's guidelines. The one presented below (Figure 3.5) is the risk-and-chance management process (RCM) presented by German hard coal

²³⁶ J. Kretschmann and R. Amiri (2013), *The Sangam Iron Ore Mines: An example for modern mining in Iran*, in Proceedings of the Fourth International Symposium on Mineral Resources and Mine Development, Aachen, Germany, pp 517-530

²³⁷ A. Tavakoliroodi (2012), *Security, political and economic effects of mining activities in SIOM*, Published by Taybad Azad University (Persian). As it mentioned before, the author (Dr. Tavakoliroodi) was the Mayor of Khaf city from 2013 till 2015.

²³⁸ As far as Environmental aspects are separately discussed, here is only Health and Safety explained.

²³⁹ Official website of International Labor Organization,

http://www.ilo.org/safework_bookshelf/english?content&nd=857170174: *Definition of occupational health adopted by the Joint ILO/WHO Committee on Occupational Health* (1950)

²⁴⁰ J. Kretschmann and T. N. Nguyen (2013), *Adaptation Saves Lives! Transferring Excellence In Occupational Safety And Health Management From German To Southeast Asian Mining*, HongDuc Publishing House, ISBN: 978-604-86-0395-3, p. 15

mining company, RAG Aktiengesellschaft (RAG) which defines risk as “negative deviation from target” while chance is “an event with positive deviation from a target”²⁴¹.

Such structure is highly recommended to be defined and implemented in SIOM to improve the OHS situation. Therefore, managerial strategies should encompass these concepts in their target.

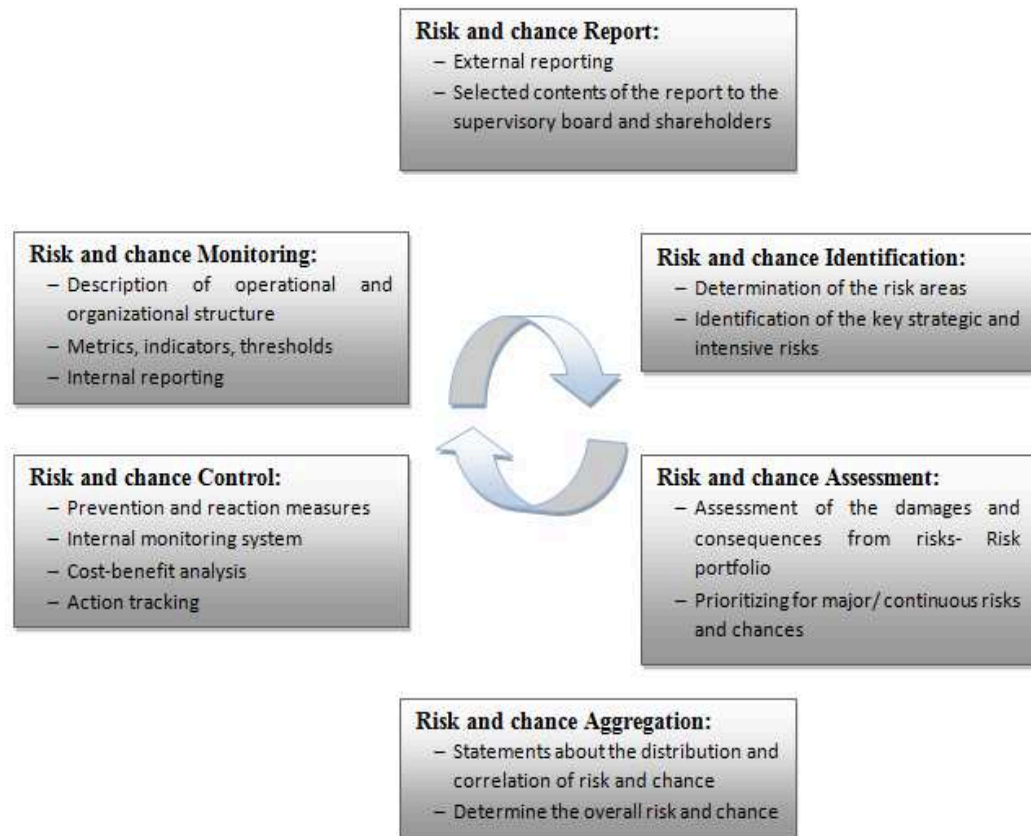


Figure 3.5 Organizational structure of the risk and chance management process²⁴²

The only existing guideline about health and safety in mines in Iran dates back to March 2000 which includes 13 chapters and 475 articles. Although some companies have dependently decided to set Health and Safety considerations, due to not being

²⁴¹ J. Kretschmann and T. N. Nguyen (2013), *Adaptation Saves Lives! Transferring Excellence In Occupational Safety And Health Management From German To Southeast Asian Mining*, HongDuc Publishing House, ISBN: 978-604-86-0395-3, p. 11

²⁴² J. Kretschmann and T. N. Nguyen (2013), *Adaptation Saves Lives! Transferring Excellence In Occupational Safety And Health Management From German To Southeast Asian Mining*, HongDuc Publishing House, ISBN: 978-604-86-0395-3, p. 35

mentioned in national legislative laws, these regulations are not formally executed. Another drawback that needs mentioning is that in existing guidelines, there are no specific rules for open pit mining. Also, some crucial issues such as combustion, transportation, first aid help, etc. are not stated in existing laws.

It should be noted that in Iran, the Ministry of Industry, Mine and Trade and the Iranian Mining Engineering Organization have sections to supervise and control of OSH in mines, but they don't have adequate tools to make mines safer. Moreover, the only approved safety regulation for Iranian mining is almost 16 years old (in 2016) and not adequate for the current situation anymore²⁴³.

Hence, regarding SD approaches, SIMP management signed a contract under number 91-739/GH in July 2012 with engineering faculty of *University of Tehran*, entitled "*Occupational Health and Safety Standards and Guidelines in SIOM*". The resultant reports, presented in two volumes in January 2013, involves an overview on history of HSE, national regulations about mining, status quo of mining activities in SIMP, presenting safety and environment guidelines for each certain activity specialized for SIMP condition, suggestions for employees' training, etc.²⁴⁴. Although the guideline was prepared for SIMP, the resultant report is also beneficial to IEIOC, SIOC and other development phases in SIOM.

IEIOC and SIMP health and safety centre have eight staff workers plus six fire-fighters. However, suggestions are made to improve its activities²⁴⁵:

- As operations and extractions commence, the HS centre has to employ more skilled employees for better and detailed observation.
- Due to an extended range of activities, it is recommended to divide the staff into separate groups (e.g. crushing group, concentrate production group, railway transportation group and so on) and establish HS affiliation in each section.

²⁴³ J. Kretschmann and R. Amiri (2013), *The Sangan Iron Ore Mines: An example for modern mining in Iran*, in Proceedings of the Fourth International Symposium on Mineral Resources and Mine Development, Aachen, Germany, pp 517-530

²⁴⁴ Research Office of Faculty of Engineering at University of Tehran (2013), *Occupational Health and Safety Standards and Guidelines in SIOM*, SIMP technical archive, Sangan, Iran, January 2013 (Persian)

²⁴⁵ Research Office of Faculty of Engineering at University of Tehran (2013), *Occupational Health and Safety Standards and Guidelines in SIOM*, SIMP technical archive, Sangan, Iran, January 2013 (Persian)

- A database for gathering regular up-to-date statistics should be designed which helps with accurate analysis of HS centre performance.
- Distribution of HS guideline among authorities, employers, contractors and workers.
- Offering training courses in which safe and unsafe situation are introduced, analyzed and mitigation measures are suggested.

Figure 3.6 illustrates the organizational chart of SIMP and position of Health, Safety and Environment section in it.

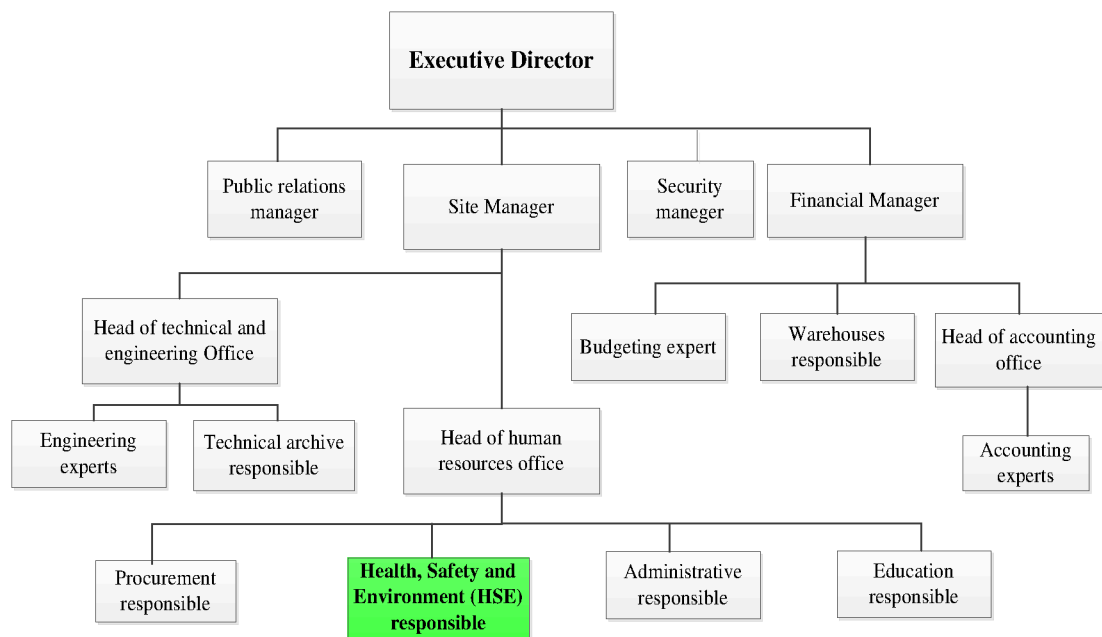


Figure 3.6 Organizational chart of SIMP²⁴⁶

The very recent strategy of IMIDRO for realizing HSE is legalizing the status of HSE office in all tributary companies, which should have the ISO 14001 and OHSAS 18001 certificates for their managerial systems. These systems will be monitored regularly and annually to ensure the implementation of regulations. Moreover, online forms have been prepared to be filled by HSE expert in each company, which enable the decision makers in IMIDRO to supervise the functions and efficiency of HSE offices in action. Besides, regular meetings and workshops for sharing experience are among approaches defined for OHS management in Iranian Mines. Meanwhile, contractors have to hand in their HSE plan to mining companies before signing any contracts. Not very favourable at the beginning, but currently

²⁴⁶ SIMP Human Resources Management Department (2011), *Internal report* (Persian)

mineral industry in Iran is known as one of the pioneers of this strategy for enhancing OHS principles²⁴⁷.

Regarding the importance of a zero harm vision in action, figure 3.7 illustrates the envisaged framework by SIMP, IEIOC and SIOC to achieve its “zero harm vision” in their daily business.

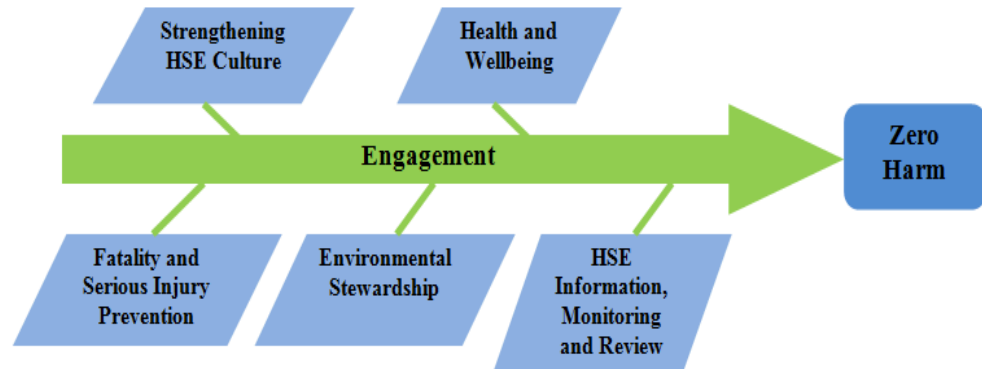


Figure 3.7 Envisaged strategy framework of SIMP, IEIOC and SIOC for HSE²⁴⁸

- ❖ Strengthening HSE culture: Cultivate an environment that encourages the behaviours and beliefs that will deliver lasting improvements in HSE performance. Figure 3.8 shows banners on which safety tips are written so that all workers are informed about them.

²⁴⁷ F. Fereidooni (2014), *An interview with Mining Development Monthly Magazine*, 6(47)/2014, p. 18-24, Access at: <http://maaden.ir> (Persian)

²⁴⁸ C. Miller (2011), *CSIRO HSE Restructure- furthering a shift in culture*, AUSA Conference, July 2011, Access at: www.csiro.au



Wear the helmets till end of the working hour

Wear your earmuffs due to high noise pollution

Think safe and act safe

Figure 3.8 Safety tips at working places²⁴⁹

- ❖ Health & Wellbeing: Identify and control exposures to occupational health risks and provide opportunities to improve staff personal health and wellbeing. Figure 3.9 shows the facilities available in SIOC complex for accident prevention.

²⁴⁹ HSE Office of SIOC (2013), *Internal report* (Persian)



Figure 3.9 Trainings and facilities in SIOC for accident prevention manoeuvre²⁵⁰

- ❖ Fatality & serious injury prevention: Develop an organisational mindset where fatality risks and controls are understood by leaders and staff and multiple layers of control are identified, implemented and regularly reviewed to ensure they do not fail. Figure 3.10 shows an example of periodic safety trainings at SIOC workplaces.

²⁵⁰ HSE Office of SIOC (2013), *Internal report* (Persian)



Figure 3.10 Periodic safety training at work place²⁵¹

- ❖ Environmental stewardship: Motivate management and staff to a more sustainable footing through targeted water, waste and carbon reduction initiatives and revitalised focus on environmental risk management processes. Figure 3.11 shows 2 banners which are prepared by HSE office of SIOC for encouraging workers to pay attention to their environment.



Figure 3.11 Banners for encouraging workers to keep their environment ambient²⁵²

²⁵¹ HSE Office of SIOC (2013), *Internal report* (Persian)

²⁵² HSE Office of SIOC (2013), *Internal report* (Persian)

- ❖ HSE information, monitoring & review: Provide management, leadership and staff with ready access to reliable, integrated, accurate HSE information that enables timely and informed decisions and interventions to be made at all levels of the organisation. In 1st day of May 2009 (International Workers Day), HSE office of SIMP was inaugurated with the presence of the Head of the Khorasan-e-Razavi Department of Environment and also Khaf County's governor (Figure 3.12). This office had cooperation with Tarbiat-e-Modares University for environmental monitoring issues. Now, the name of this office is changed to HSE office of SIOC and it is active for the SIMP, IEIOC and SIOC and the cooperation with Tarbiat-e-Modares University is currently continued.

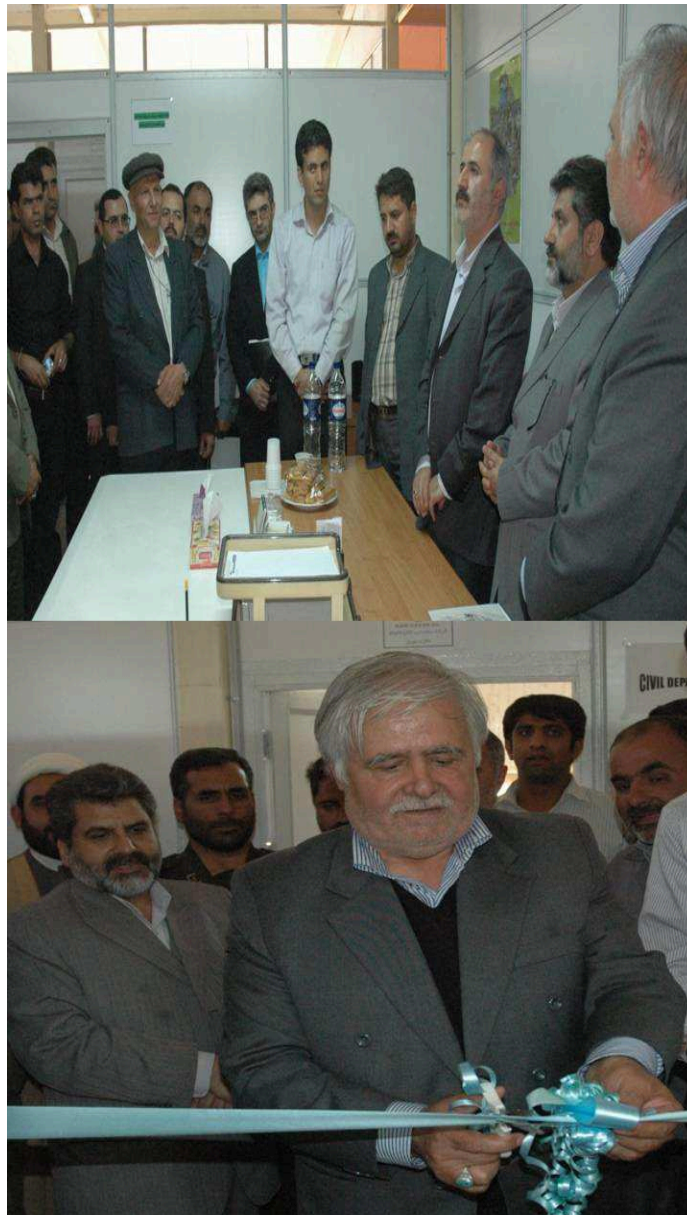


Figure 3.12 Inauguration of HSE office in SIOM

Table 3.5 presents the training courses and relevant statistics regarding HSE culture and improvement in SIOM (SIMP, IEIOC and SIOC) from 2006 till end of 2013. As can be seen, the number and diversity of courses have increased in course of the time, which signifies the attentiveness of project leaders to health, safety and environmental issues.

Year	Training courses	Duration (hour)	Number of participants	Man hour	Man hour in year	Average of total personnel ²⁵³	HSE training index ²⁵⁴
2006	Firefighting and rescue maneuver	1	255	255	255	255	1
2007	HSE motivation management	16	1	16	286	270	1.06
	Firefighting and rescue maneuver	1	270	270			
2008	Environmental principals of mining activities	12	1	12	1609	277	5.81
	General and Industrial Health	16	20	320			
	Safety in mining	40	25	1000			
	Firefighting and rescue maneuver	1	277	277			
2009	Firefighting and rescue maneuver	1	275	275	275	275	1
2010	Environmental impacts assessment	6	1	6	2009	363	5.53
	Human resources empowerment (health and environment)	160	1	160			
	Explosive material's protection	32	30	960			
	Safety first aid and fire extinguishing	8	65	520			
	Firefighting and rescue maneuver	1	363	363			
2011	HSE in mining	32	34	1088	1554	466	3.33
	Firefighting and rescue maneuver	1	466	466			
2012	Introduction of OHS management system	16	1	16	2333	635	3.67
	Blasting operator in mines	160	6	960			
	Human resources empowerment (health and environment)	112	1	112			
	Fire extinguishing; Rescue; Store keeping	8	30	240			
	Addiction prevention	2	185	370			
	Firefighting and rescue maneuver	1	635	635			
2013	Safe keeping of stores	16	1	16	1705	717	2.38
	Conference on Health and Environment	16	1	16			
	Stress control in work places	2	52	104			
	Safety management in civil projects	16	1	16			
	First aid and rescue	35	4	140			
	HSE management	16	1	16			
	Role of supervisors in occupational incidents reduction	8	35	280			
	Introduction of occupational health	16	2	32			
	Introduction of HSE	16	1	16			
	Safety in electricity	32	6	192			
	Training blasting with "Nonel detonator"	8	20	160			
	Firefighting and rescue maneuver	1	717	717			

Table 3.5 Information and indicators of HSE training courses in SIOM²⁵⁵

²⁵³ It is equal to yearly average number of total personnel in governmental sections (SIMP+IEIOC+SIOC) without consultants and contractors.

²⁵⁴ HSE training index is calculated by dividing man hour in year to average of total personnel.

²⁵⁵ SIMP, IEIOC and SIOC Human Resources Departments (2014), *Internal report* (Persian).

There are many ways to sample and establish the favourable organizational culture. This is a key part of the process to determine how best to facilitate a successful and sustainable safety culture change. Safety culture is generally defined as “The safety culture of an organization is the product of individual and group values, attitudes, perceptions, competencies and patterns of behaviour that determine commitment to, and the style and proficiency of an organization’s health and safety management²⁵⁶”. Table 3.6 presents some roles that SIOM projects leaders can play to succeed in safety culture change. Figure 3.13 suggests also new steps to improve change in any organization which can be the signboard of HSE Centre in SIOM.

Engage people for the challenge	<p>Motivate people to work differently:</p> <ul style="list-style-type: none"> • Express dissatisfaction with the present state-put forward both the rational and emotional case for change • Reinforce the vision for safety (what we want to be and the benefits of working a different way) • Involving people in generating the solution
Create accountability and clear standards	<p>Support people to work differently:</p> <ul style="list-style-type: none"> • Clarify what I need to do differently- to what standard and how I need to do it • Give positive and corrective feedback to reinforce standards
Develop people	<ul style="list-style-type: none"> • Role model HSE behaviours • Train and develop people to attain the new standard • Reward the new behaviours

Table 3.6 Leader’s role in creating safety culture change²⁵⁷

²⁵⁶ Department of Consumer and Employment Protection (2007), *Safety culture in practice in Australian mining*, Government of Western Australia

²⁵⁷ A. Vecchio- Sadus (2012), *The safety leadership challenge in CSIRO- pathway to impact*, the safety conference, Sydney Australia, 23- 25 October 2012



Figure 3.13 Steps of improving change in safety culture²⁵⁸

Pursuant to Table 3.6, that presents general steps to achieve safety culture change, some actions are specifically implemented in SIMP, IEIOC and SIOC; namely: planned and unplanned VIP supervisions, firefighting manoeuvres, training the personnel, and electing the superior safety supervisor among IMIDRO units. Moreover, the contract with University of Tehran for preparing the HSE report conforming to international standards and methods was a major step in improving the safety culture²⁵⁹. Figures 3.14, 3.15 and 3.16 present records of injuries in SIMP, IEIOC and SIOC from 2009 till 2013 according to working shift, age group and injured organ respectively. Figure 3.17 shows incident frequency and severity in SIMP, IEIOC and SIOC. Fortunately, none of these incidents led to death during this period.

²⁵⁸http://www.coresafety.org/resources/module7/nmasafetytoolbox/inside_safetyculture/safetyculture_incontext/safetyculture_inmining.html., Retrieved: March 2014

²⁵⁹ Research Office of Faculty of Engineering at University of Tehran (2013), *Occupational Health and Safety Standards and Guidelines in SIOM*, SIMP technical archive, Sangan, Iran, January 2013 (Persian)

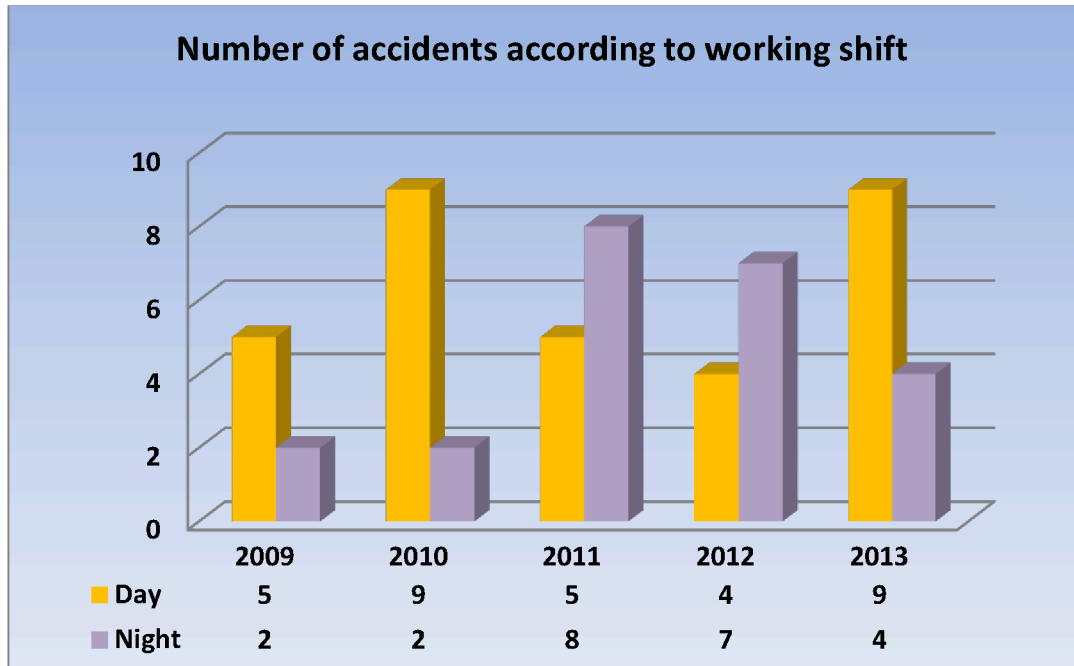


Figure 3.14 Number of accidents in SIMP, IEIOC and SIOC according to working shift per year²⁶⁰

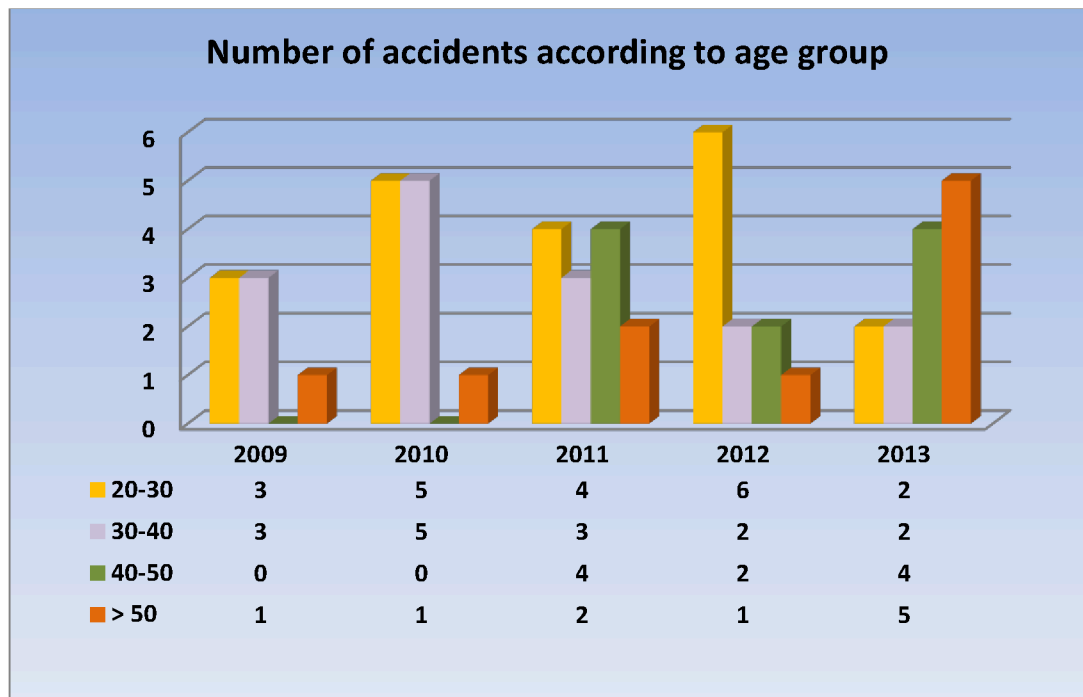


Figure 3.15 Number of accidents in SIMP, IEIOC and SIOC according to age group²⁶¹

²⁶⁰ HSE Office of SIOC (2013), *Internal report* (Persian)

²⁶¹ HSE Office of SIOC (2013), *Internal report* (Persian)

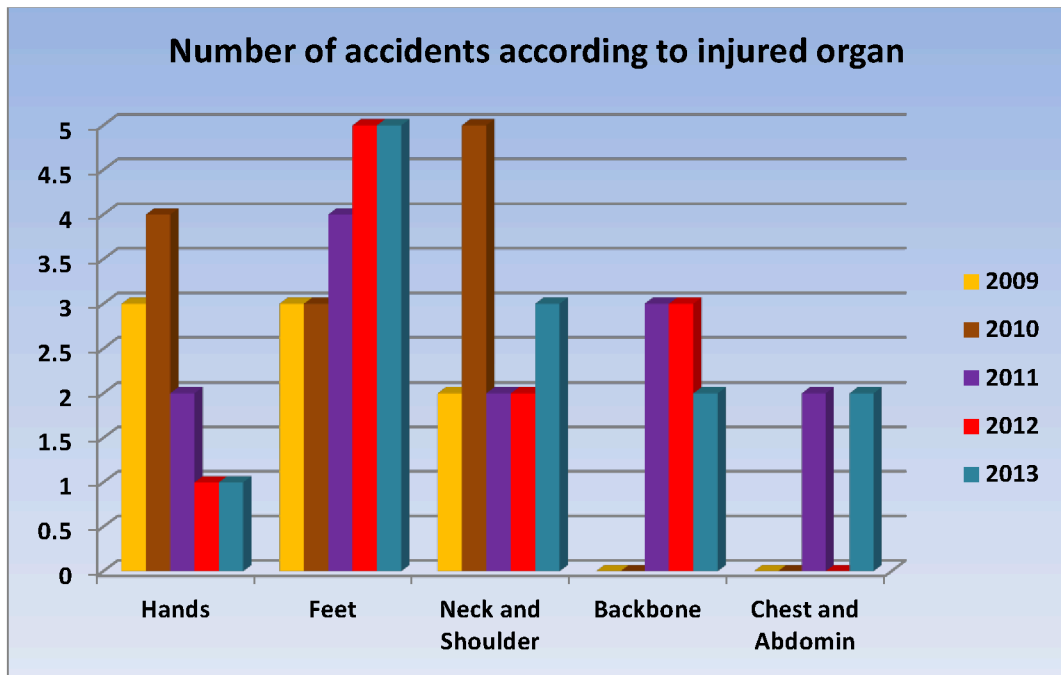


Figure 3.16 Number of accidents in SIMP, IEIOC and SIOC according to injured organ²⁶²

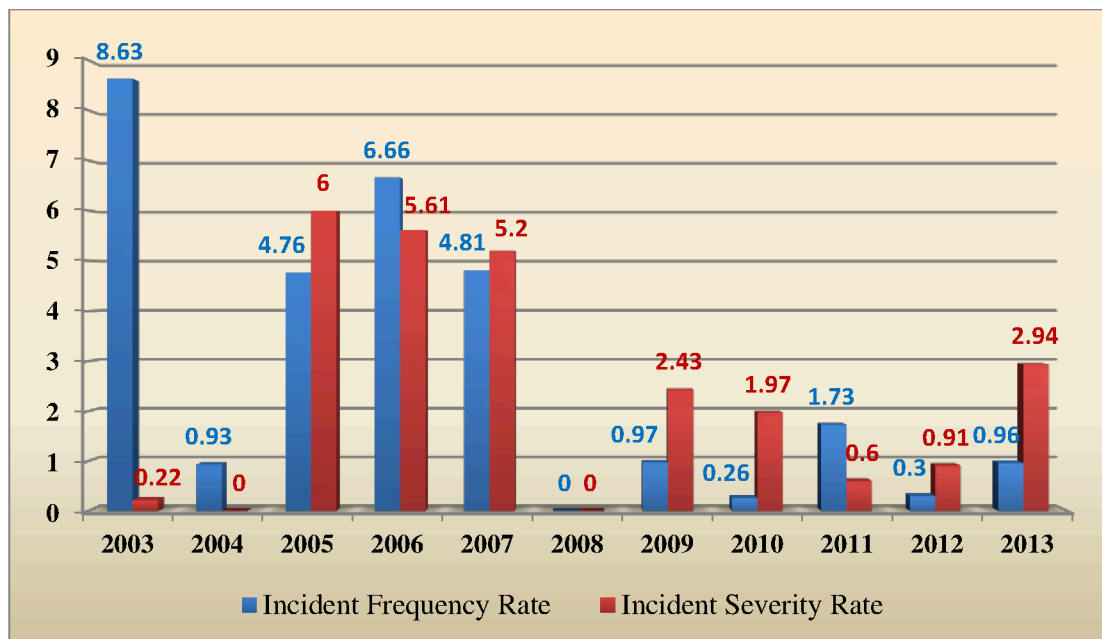


Figure 3.17 Incident frequency and severity rate in SIMP, IEIOC and SIOC²⁶³

²⁶² HSE Office of SIOC (2013), *Internal report* (Persian)

²⁶³ HSE Office of SIOC (2013), *Internal report* (Persian)

Where²⁶⁴:

Frequency Rate (FR): The number of occupational injuries expressed as a rate per million hours worked. This rate is calculated using the following formula:

$$FR = \frac{\text{number of occupational injuries} \times 1.000.000}{\text{number of hours worked}}$$

Severity Rate (SR): The average number of days lost per one million hours worked:

$$SR = \frac{\text{number of Days lost} \times 1.000.000}{\text{number of hours worked}}$$

Injuries are generally classified in 3 groups²⁶⁵:

- Fatal injury: an injury that results in death.
- Lost time injury: an injury that results in a minimum of one full shift's absence.
- Severe injury: an injury that results in a minimum of two weeks off work.

Iranian Social Security Organization accounts fatal and severe injuries as incident in national safety reports. According to aforementioned organization, complexes with incident frequency rate of 0 to 10 are categorized under the good status of occupational health and safety²⁶⁶. Hence, Sangan Iron Ore Mines with Incident Frequency Rate (IFR) of 8.63 till 0.0 during the years 2003 and 2013 has an acceptable status of OHS according to national standards.

As can be seen in figure 3.17, FR is the highest at 2003, which is probably the new stage of work has been started and workers were not exactly informed about possible risks; and on that time, the HSE department was not active enough. Low SR can be attributed to open mining methodology which has less danger in comparison to underground mining. However, it is obvious that since 2005 serious steps were taken

²⁶⁴ B. Abbas Pour and F. Rashidinejad (2013), *Future's vision: a review on effectiveness of safety regulations in mines of IMIDRO and its comparison with world's developed countries*, Mining Engineering System, 20 (26), p. 12-21 (Persian)

²⁶⁵ Minerals Council of Australia (1999), *Safety and health performance report of the Australian Minerals Industry*, p. 3, Access at: www.minerals.org.au

²⁶⁶ Website of Iranian Social Security Organization: <http://www.markazi.sso.ir/web/sso-en>, Retrieved April 2014

and both trends decline in spite of annual fluctuations. In period 2005-2007, a sudden rise in SR and FR was reported. Increasing rate of accidents in 2009 till 2011 can be attributed to considerable increase in activities of IEIOC and SIMP. Besides, the first concentrate plant was inaugurated in May 2012, and during these three years (2009-2011), the basic measures were conducted; subsequently, rate of accidents boosted. The overall decreasing trend during last 6 years is mainly due to special attention of the SIMP and IEIOC management to safety issues; besides, planned and unplanned VIP supervision during work hours, periodic trainings, maneuver operations and comprehensive studies of health and safety issues, conducted by university of Tehran, had immense influence on the downward trend of the incidents²⁶⁷. Regarding conducted analysis, high incident frequency can be attributed to several causes such as employing non-skilled workers, not familiar with safety issues²⁶⁸, lack of approved organizational chart for HSE etc. The rapid plunge since 2007 heralds the SIMP and IEIOC authorities' attentiveness to Health and Safety issues²⁶⁹. Taking the downward trend of incidents in SIMP (Figure 3.17) into consideration, achieving zero harm vision does not seem a farfetched strategy. With escalating awareness of and sensitivity to health issues in work spaces, managers in Sangan, specifically, try to pave the way to coordinate various sectors with the purpose of having no injuries, illnesses, environmental harm and unsafe behaviours in the territory of project site.

However, following measures are recommended to improve the status of HSE in SIOM:

- CEOs, senior and junior managers and also supervisors need to be completely aware of necessity of HSE in the success of their business, which is achievable by education.
- Preparation of HSE plan by contractors should be strictly emphasized and supervised. The outputs of different plans need to be compared and amended.
- HSE offices need to have enough budgets to realize effective measures.
- Spreading the HSE culture among all levels of hierarchy, and also as a value to distinguish workers.

²⁶⁷ The last four cases were applied during the management period of PhD student.

²⁶⁸ J. Kretschmann, R. Amiri and F. Rashidnejad (2013), *Sustainable mining approach to Sangan iron ore mines project*, Proceedings of 6th international conference on sustainable development in the minerals industry, 30 June- 3 July, Milos Island, Greece, p. 678-682

²⁶⁹ The analysis was conducted by Mr. Esmail Papaie (HSE expert) on the data related to Figure 3.17.

3.1.2 Environmental aspects

Mining impacts are widely known and it goes beyond scope of this part to discuss; however, main issues regarding environmental aspects are here examined.

SIMP has signed a contract under number 82- 559/ GH in March 2004 according to which an Environmental Impact Assessment (EIA) report of SIOM had to be prepared²⁷⁰. The main content of this report includes a detailed study of 3 buffer zones regarding the domain of influence. Afterwards potential impacts of construction and operational phases on physical, biological and socio-economic environments were anticipated and impacts were assessed, using the Leopold Matrix²⁷¹. Consequently the most negative impacts were identified and mitigation measures were recommended. Also, monitoring and auditing programs according to study area's circumstances and project's characteristics were finally suggested. According to EIA report, main social, economic and environmental cumulative impacts of SIMP's activities are tabulated as below. However, it should be mentioned that due to an increasing production capacity of SIOM, an up-to-date EIA report is without question needed. New Environmental Impact Assessment report for the first phase (SIMP) should be implemented by IMIDRO; while for other development phases, it should be prepared by private companies, responsible for projects. Anticipated short term and long term impacts of SIOM projects are tabulated in table 3.7 according to stage of occurrence.

²⁷⁰ Kani Kavan-e-Shargh Engineering Company (2004), *Environmental Impact Assessment of Sangan Iron Ore Mines*, SIMP technical archive, Sangan, Iran (Persian)

²⁷¹ The Leopold matrix is the best known matrix methodology available for predicting the impact of a project on the environment. It is a two dimensional matrix cross-referencing: 1) the activities linked to the projects that are supposed to have an impact on man and the environment; 2) the existing environmental and social conditions that could possibly be affected by the project. The Leopold matrix proposes a three-step process to estimate the impact: A) for all the interactions considered significant by the authors, the first step is to mark the corresponding boxes in the matrix with a diagonal line; B) once the boxes with supposed significant interactions are slashed, the author evaluates each box by applying a number from 1 to 10 (1 is the minimum and 10 the maximum) to register the magnitude of the interaction. This number is transferred to the upper left hand corner. It represents the scale of the action and its theoretical extent; C) the final step for this method is to mark (from 1 to 10), in the lower right hand corner, the real importance of the phenomenon for the given project. It then gives an evaluation of the extent of the environmental impact according to the assessor's judgments.

Stage	Positive Impacts			
	Direct		Indirect	
	Short-term	Long-term	Short-term	Long-term
Primary	<ul style="list-style-type: none"> • Access road construction • Employment • Salary payment 	<ul style="list-style-type: none"> • Increase in population • Increase in literacy rate • Permanent occupation 	<ul style="list-style-type: none"> • Importance of study area • Tribal unity • urban development 	<ul style="list-style-type: none"> • Creation of side occupations • Positive immigration • Social and economic security
Secondary	<ul style="list-style-type: none"> • Transportation • Money circulation • Return of migrants 	<p>Increase in:</p> <ul style="list-style-type: none"> • Housing • Recreation infrastructures • Job worth • Green space 	<ul style="list-style-type: none"> • Improvement of literacy and health in region • Life facilities • Side services in all levels 	<ul style="list-style-type: none"> • Trade improvement • Tourism • Growth in culture
Ternary	<ul style="list-style-type: none"> • Increase in income • Increase in tourism 	<ul style="list-style-type: none"> • Improvement of life style • Improvement of environmental conditions • Cultural relationships 	<ul style="list-style-type: none"> • Decrease of drug trafficking impacts • Industrializing the region • Region's security • Construction in region 	<ul style="list-style-type: none"> • Social and psychological security • Importance of region • Elimination of region's poor quality
Stage	Negative Impacts*			
	Direct		Indirect	
	Short-term	Long-term	Short-term	Long-term
Primary	<ul style="list-style-type: none"> • Elimination of vegetation cover • Alteration in land use and landscape • Construction 	<ul style="list-style-type: none"> • Iron ore transfer • Waste pit • Ground water consumption 	<ul style="list-style-type: none"> • Increase in prices • Occupational competence • Transportation • Restrictions in some regions 	<ul style="list-style-type: none"> • Decrease in aquifers' level • Social and cultural oppositions • Legislative flaws
Secondary	<ul style="list-style-type: none"> • Water consumption • People and vehicle traffic • Waste production • Decrease of villages and habitats 	<ul style="list-style-type: none"> • Air and noise pollution • Decrease in aquifer level • Occupation of 800 hectares of land for dry and wet paste disposal 	<ul style="list-style-type: none"> • Informal jobs • Dissatisfaction of indigenous people 	<ul style="list-style-type: none"> • Decrease in soil moisture • Decrease in leisure time
Ternary	<ul style="list-style-type: none"> • Waste water production • Air pollution • Decrease in biodiversity • Temporary housing 	<ul style="list-style-type: none"> • Escape of wildlife • Increase of potential water contamination • Alteration of social texture • Decrease of agriculture and pasturing 	<ul style="list-style-type: none"> • Decrease of native biologic diversity • Alteration in settlers' life pattern • Increase in traffic in regional level • Social abnormalities 	<ul style="list-style-type: none"> • Peoples' dissatisfaction • Disobeying

Table 3.7 Main positive and negative impacts of SIOM projects²⁷²

* A set of mitigation measures are presented for each negative impact

²⁷² Kani Kavan-e-Shargh Engineering Company (2004), *Environmental Impact Assessment of Sangam Iron Ore Mines*, (Persian) SIMP technical archive, Sangam, Iran, It is notable that the EIA report was prepared for the 2.6 MTPY production capacity on that time, but some parts of the report can be generalized to SIOM.

In the 8th chapter of the above-mentioned EIA report, the Environmental Management Plan (EMP) of Sangam Iron Ore Mines was presented; which comprises four sections including: (1) establishment of environmental organizations, (2) auditing, (3) environmental monitoring and (4) environmental training. Each section is fully explained in the report and the corresponding responsible organization and the frequency of controls are determined²⁷³.

Pursuant to the monitoring section of EMP, SIMP has signed an agreement with Tarbiat-e-Modares University to supervise the progress of mining activities and their probable opposition with environmental considerations in both constructional and operational phases. Since 2009, supervision reports are seasonally prepared and they take following issues into consideration: air pollution, water pollution (Table 3.8), soil contamination, wastewater treatment²⁷⁴, noise and vibration, residential and industrial waste production and OHS regulations. Besides, mitigation measures are suggested and they have become part of seasonal examinations²⁷⁵.

No.	Parameter	Unit	Water quality standards		Status		
			Max. permissive range	Acceptable range	June 2010	November 2010	April 2011
1	EC				80	710	901
2	pH	-	6.5-9.2	7-8.5	7.9	7.6	7.9
3	Alkalinity	Mg/LCaCO ₃	-	-	230	240	200
4	NO ₂	Mg/L	0.004	0	0	<1	0.2
5	NO ₃	Mg/L	4.5	0	0	5.5	0.04
6	NH ₃	Mg/L	0.05	0.002	0	0.5	0.03

Table 3.8 An example of monitoring environmental parameters according to prepared EMP²⁷⁶

²⁷³ Kani Kavan-e-Shargh Engineering Company (2004), *Environmental Impact Assessment of Sangam Iron Ore Mines*, SIMP technical archive, Sangam, Iran (Persian)

²⁷⁴ J. Kretschmann, R. Amiri and A. Zarekar, (2013), *Realization of Sustainable Development in Iranian Mining Sector- case study: Sangam Iron Ore Mines (SIOM)*, The first International Conference on Economic Management in Mining Activities, HaNoi, VietNam, 8-9 Nov, p. 459-466

²⁷⁵ Kani Kavan-e-Shargh Engineering Company (2004), *Environmental Impact Assessment of Sangam Iron Ore Mines*, SIMP technical archive, Sangam, Iran (Persian)

²⁷⁶ Tarbiat-e-Modaress University (2010), *Environmental Monitoring and Auditing of Sangam Iron Ore Mines` Equipping Plan*, seasonal reports, SIMP technical archive, Sangam, Iran (Persian)

Pursuant to positive impacts mentioned in table 3.7, it should be noted that some of them have been realized after 10 years. For example, the direct impact on access roads which was supposed to be actualized in short term can be comprehended from table 3.9. The impacts on education and employment have already been discussed. According to conducted studies, other issues such as enhanced life quality, decreasing drug trafficking, increasing numbers of tourists, higher security, improvement in infrastructures etc. are realized in the region but there is still no quantitative data about them²⁷⁷.

Year	1981	1986	1991	1996	2001	2006	2011	2013
Cumulative asphalted road under operation (Km)	0	8	17	113	122	172	279	283
Constructed road in comparison to last base year (Km)	0	8	9	96	9	50	107	4
Cumulative railway under operation (Km)	0	0	0	0	0	0	84	111.6
Constructed railway in comparison to last base year (Km)	0	0	0	0	0	0	84	27.6

Table 3.9 Road and railway development in Khaf Township from 1981 till 2013²⁷⁸

Sangan Iron Ore Mines are located in Khaf Township. Historically, Khaf is known of arid and dry weather at summer and temperate winters. Generally, due to high distance from sea and low precipitation, there is no specific permanent river in the area, just temporary ones in winter after rainfall²⁷⁹. Besides, it is 120 days windy in year, called “Sistan 120 Days Wind” which boots the rate of evaporation. Beside these natural characteristics, over exploitation of water supplies, growing population

²⁷⁷ A. Tavakoliroodi (2012), *Security, political and economic effects of SIOM` mining activities*, Taybad Azad University

²⁷⁸ J. Kretschmann, R. Amiri and A. Zarekar, (2013), *Realization of Sustainable Development in Iranian Mining Sector- case study: Sangan Iron Ore Mines (SIOM)*, The first International Conference on Economic Management in Mining Activities, HaNoi, VietNam, 8-9 Nov, p. 459-466

²⁷⁹ A. K. Ahrari Rody (2003), *Khaf, in the course of history*, Ahmad Jam publications, Torbat-e-Jam-Iran, ISBN: 964-8688-15 (Persian)

and also increasing water consumption in industry are the constraints that restrict the possibility of agriculture and threaten the future development in the region. To emphasize the importance of this issue and its subsequent role in determining management strategies, figures 3.18 and 3.19 have been prepared according to average temperatures and precipitation data within 15 years. As can be seen, the mine site faces serious water shortage during summer (0 mm) and the highest amount of precipitation is in March (35 mm). It is considerable that in comparison to precipitation, evaporation is usually high with a minimum of 60.2 in February and a maximum of 773.6 in July. Also, it can be deduced that the whole region is prone to water crisis and efficient consumption and rational management is a necessity²⁸⁰.

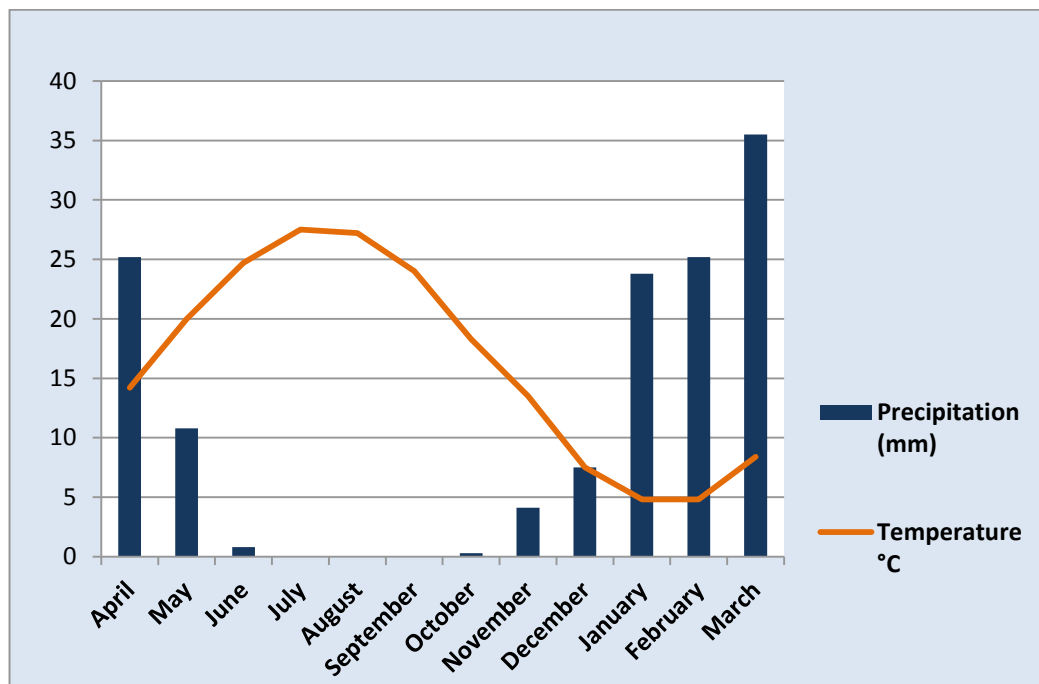


Figure 3.18 Mean temperature and precipitation in 15 years period (1991-2005) in Sangam mine Site²⁸¹

²⁸⁰ J. Kretschmann and R. Amiri (2014), *Solutions for a Sustainable Water Consumption Reduction in Sangam Iron Ore Mines in Iran*, in Proceedings of Sixth Aachen International Mining Symposia (AIMS), The Sixth International Symposium on Mineral Resources and Mine Development, Aachen, Germany, ISBN: 978-3-941277-20-5, p. 445-456

²⁸¹ SIMP Technical and Engineering Office (2006), *Internal report* (Persian)

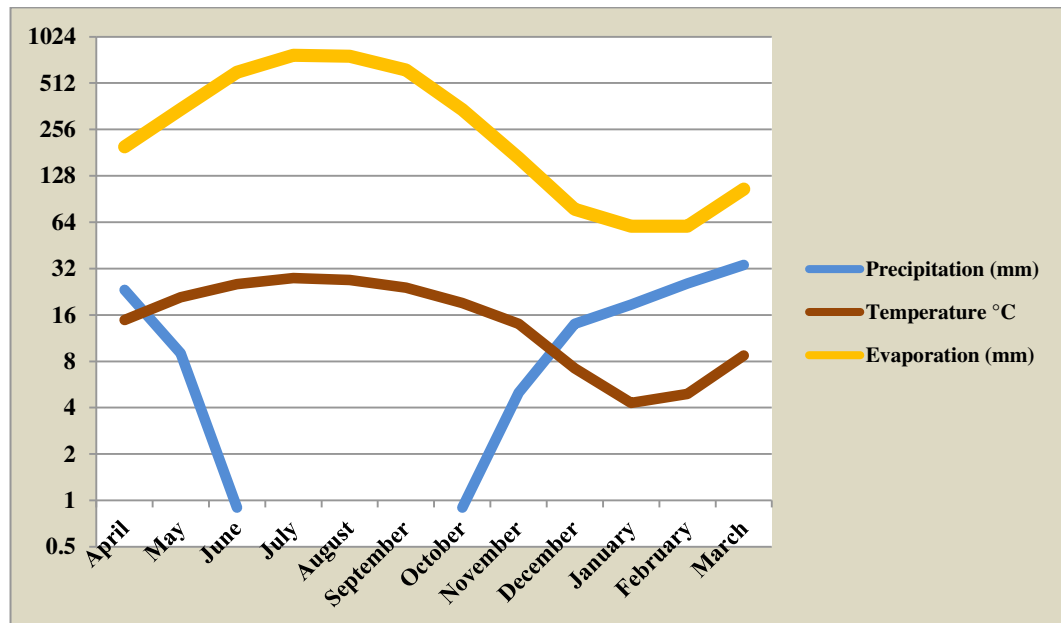


Figure 3.19 Comparison of precipitation, temperature and evaporation in Sangam city²⁸²

According to a study, main challenges of Khaf Township in water section are as follows²⁸³:

- Over exploitation and consumption more than potential capacity of water supplies, especially ground water sources.
- Population growth, Changing lifestyle and escalation need in different sections
- Occupation of river buffers which leads to floods and waste of water
- Cultural problems and unfamiliarity with importance of water

Hence, following solutions are suggested as probable and applicable strategies that ameliorate the water crisis management in SIOM²⁸⁴:

- A. Investment on optimization of water consumption in region farmlands
- B. Recycling the water from tailings
- C. Collecting the rain fall and artificial recharge to Khaf plain aquifer

²⁸² <http://www.irimo.ir>, Website of Iran Meteorological Organization, Retrieved: 20 February 2014

²⁸³ Amayesh va toseh-e-shargh Institute (2004), *Social, economic and cultural effects of Sangam Iron ore Projects on Sangam area*, SIMP technical archive, Sangam, Iran (Persian)

²⁸⁴ J. Kretschmann and R. Amiri (2014), *Solutions for a Sustainable Water Consumption Reduction in Sangam Iron Ore Mines in Iran*, in Proceedings of Sixth Aachen International Mining Symposia (AIMS), The Sixth International Symposium on Mineral Resources and Mine Development, Aachen, Germany, ISBN: 978-3-941277-20-5, p. 445-456

- D. Using a kind of mulch fluid for mining roads stabilization and dust control instead of water
- E. Transferring water from reliable water sources in the vicinity such as Harir Rood River, Karat Plain and Mousa Abad area (which are rich in water) to mine site
- F. Sweetening the water of the Zoozan plain water resources and transfer to mine site
- G. Recycling the waste water of Khaf, Sangan and Mashhad cities and transfer to mine site
- H. Purchasing the water wells in nearby and using them for mineral industries instead of agriculture
- I. Sweetening and transferring the water from Persian Gulf/Oman Sea²⁸⁵.

Mining activities will need an increasing share of water in the region. Aforementioned solutions need to be realized to ensure a sustainable water supply for both, mining industry and the local community. Most of the private companies investing in SIOM are at the first steps of executing their projects. They should focus on innovative technologies to reduce the water consumption in the future. Finally, as the majority of settlements in the vicinity of the SIOM Project are religious, special attention should be paid to attract the consideration on the subject of water saving, storage and preservation²⁸⁶.

3.1.3 Economic aspects

Economic viability and competitiveness of the mining and minerals sector is important for sustainable development as the industry brings various economic benefits to society, including provision of employment and generation of wealth. This may lead to macro-economic benefits through various investments and injection of ‘hard’ currency (particularly in poorer countries), contribution to GDP and tax, royalty and other payments to the public institutions. As a rule of thumb, the win-win situation should be acquired for both investors and stakeholders and income-centred

²⁸⁵ This solution is under implementation for similar mining regions in Iran such as Sarcheshmeh, Gol-e-Gohar and Chadormalu by Persian Gulf water supply and transferring company in 2016.

²⁸⁶ J. Kretschmann and R. Amiri (2014), *Solutions for a Sustainable Water Consumption Reduction in Sangan Iron Ore Mines in Iran*, in Proceedings of Sixth Aachen International Mining Symposia (AIMS), The Sixth International Symposium on Mineral Resources and Mine Development, Aachen, Germany, ISBN: 978-3-941277-20-5, p. 445-456

economy is going to be replaced with satisfaction-centred economy. However, a number of factors can influence the ultimate responses to society from mineral industry developments. One of these factors is management and distribution of mineral wealth and revenues. The micro-economic issues have traditionally dominated business decision making with a focus on short-term returns, which is in the mining and minerals industry often based on production volumes rather than on value-added products and services. This, combined with price volatility of some minerals, has in some cases led to an excessive use of mineral resources and a faster depletion of minerals reserves causing greater environmental damage and returning less than possible economic benefit to society. One of the ways to partly offset this unsustainable resource depletion is to increase added value of minerals by further processing the raw materials closer to the front-end of the supply chain. This can not only increase financial returns to the industry, but would also enable producer countries to derive more benefits from their resources. However, one of the great obstacles in adding more value to exporting minerals at source is the tariff imposed by industrial countries on imports of processed goods²⁸⁷. Raw materials are essential for the sustainable functioning of modern societies. Access to and affordability of mineral raw materials is crucial for the sound functioning of the economy²⁸⁸. As a consequence, raw material policy, as a key issue in economic policy should be integrated within sustainable mining framework and is defined as: “The long-term security and continuity of industrial supply chains at all processing stages from the mineral deposit to the finished product”. The principle underlying this goal is sustainable development, the equilateral, well-balanced triangle of supply security, environmental protection and economic growth. Although all the large industrialized nations have made up their mind on the allocation of tasks between government and the private institutions, it is the job of industry to secure its own resource supply. For its part, government should set out a raw material policy framework that enables industry to obtain its primary resources in the most effective way²⁸⁹.

²⁸⁷ International Institute for Environment and Development (2002), *Breaking new ground: Mining, minerals and sustainable development*, Final report on the Mining Minerals and Sustainable Development Project (MMSd), October 2002, ISBN 1-85383-907-8, Access at: <http://pubs.iied.org/9084IIED.html>

²⁸⁸ Commission of the European Communities (2008), *The raw materials initiative- meeting our critical needs for growth and jobs in future*, Brussels, COM(2008)699

²⁸⁹ D. Mager (2007), *Developments in Raw Material Policy*, World of Metallurgy/Erzmetall, 60(4)/2007, p. 195-198

3.1.3.1 IMIDRO`s economic strategy

IMIDRO has its policy regarding guaranteeing raw materials. In 2013, a memorandum of understanding has been signed among Geological Survey of Iran, IMIDRO and mining department of Ministry of Industry, Mine, and Trade. According to this memorandum, cooperation of private and governmental institutions is needed to have a significant growth in mining sector up to five times higher than what currently is. Also, more emphasis is on preventing selling raw mineral materials and instead utilizing them in industries in the value chain. The main aim of ratifying this agreement is stated as boosting the capacity of exploration in SIOM up to 200,000 Km². IMIDRO is responsible for assigning 135 billion Rials to these activities and completing them in near future²⁹⁰.

A further challenge is the distribution of revenues from minerals among private institutions, central government and local communities. This is a contentious issue, which has often created tension, political controversy and sometimes even armed conflicts. The common practice has been to split the earnings between the company and the central government, thus bringing little benefit to the local communities. Governments often use corporate taxation and royalty payments to gain an adequate share of revenues from a mineral development. Developing countries as a whole derive 80% of their mineral revenues from taxes on corporate profits²⁹¹. However, this approach can deprive these economies of valuable income in case of non-profitable mineral developments. Royalty payments and other taxes (e.g. value-added, stamp duty and fuel) are also used to further increase government's gains from minerals resources. However, high taxes can also deter investors, thus depriving a country of perhaps a vitally important income. To encourage investments, some countries introduce subsidies; this approach has often been criticised for under-pricing mineral resources and stimulating unsustainable levels of production thus leading to a faster depletion of mineral reserves²⁹². Detailed regulations of Iranian Mining Act have two explicit provisos related to benefits of

²⁹⁰<http://www.imidro.gov.ir/news/unews.aspx?id=3daf4782-16aa-4c46-98fd-db5c3a4a7939&UiStatus=Print>

²⁹¹ F. Cawood (2001), *Aligning mineral wealth with sustainable development: The South African perspective*, Published by International Institute for Environment and Development (iied), Access at: <http://pubs.iied.org/pdfs/G02453.pdf>

²⁹² A. Azapagic (2004), *Developing a framework for sustainable development indicators for the mining and minerals industry*, Journal of Cleaner Production, 12/2004, p. 396-662

local community. Proviso 5 states that investors who try to maintain the environment of mine site during exploration, excavation and operation are exempted from royalty till 20% of government rights. Proviso 6 charges the government with the duty to assign 15% of its royalty from mining section to the relevant province, which will be all applied to develop that region²⁹³.

Equitable distribution of wealth is one of the prerequisites for more sustainable societies, making this not only an important economic but also a social issue. Following this approach, it is worth mentioning that Sangan Iron Ore Mine will be excavated during at least 30 years in 4 phases; some parts are currently under operation; and some under construction. It can be deduced that maybe not explicitly stated, but implicitly the preliminary strategy of IMIDRO has surely been sustainable in utilizing resources. Also, as discussed before, SIMP management has taken serious steps to distribute incomes among all parts of communities including local people. However, development of SIOM is faced with critical economic issues. The investors from private organizations are responsible for investment from primary crushers near the pit to final product storage and loading facilities. IMIDRO is responsible for mine development. The private mining companies are not fully capable to undertake the needed mining operations due to the lack of sufficient mining equipment²⁹⁴. The solution would be purchasing of the required mining equipment by contractors or through IMIDRO. In this case, a considerable budget must be supplied by IMIDRO; not only for purchasing mining equipment, but also for extraction of minerals by the contractors. A specific challenge is the United Nation Security Council decision on unilateral sanctions against Iran, which is still causing difficulties to purchase the required mining equipment.

3.1.3.2 Economic achievements

Following, Sangan Iron Ore Mines are examined from economic point of view. Table 3.10 presents the financial performance of IEIOC from 2005 to 2013 in TUSD, and the trend is illustrated in figure 3.20. As can be seen, IEIOC has been a profiting company during study period, with the total of 33 MUSD net profits. The highest

²⁹³ <http://asl44.mefa.ir/Portal/Home/Default.aspx?CategoryID=741abf06-86e5-46e7-8673-ca9b0d5df361>

²⁹⁴ J. Kretschmann, R. Amiri and F. Rashidnejad (2013), *Sustainable mining approach to Sangan iron ore mines project*, Proceedings of 6th international conference on sustainable development in the minerals industry, 30 June- 3 July, Milos Island, Greece, p. 678-682

annual profit was during March 2010-2011, with 10 MUSD which only is 31 percent of total profit during all years. It should be noted that during this period almost 10 MUSD tax was paid to government.

Item	March 2005-March 2006	March 2006-March 2007	March 2007-March 2008	March 2008-March 2009	March 2009-March 2010	March 2010-March 2011	March 2011-March 2012	March 2012-March 2013	March 2013-March 2014
Income	6,929	6,575	12,025	15,351	14,400	33,528	38,610	54,492	2,903
Cost	3,138	3,796	5,960	9,136	9,467	19,701	35,011	53,159	1,520
Profit Before Tax	3,791	2,779	6,065	6,215	4,933	13,826	3,599	1,333	1,383
Tax	874	695	1,516	1,554	1,233	3,457	900	333	346
Net Profit	2,917	2,084	4,549	4,662	3,700	10,370	2,699	1,000	1,037

Table 3.10 Summary financial performance of IEIOC from 2005 to 2014 (in TUSD)²⁹⁵

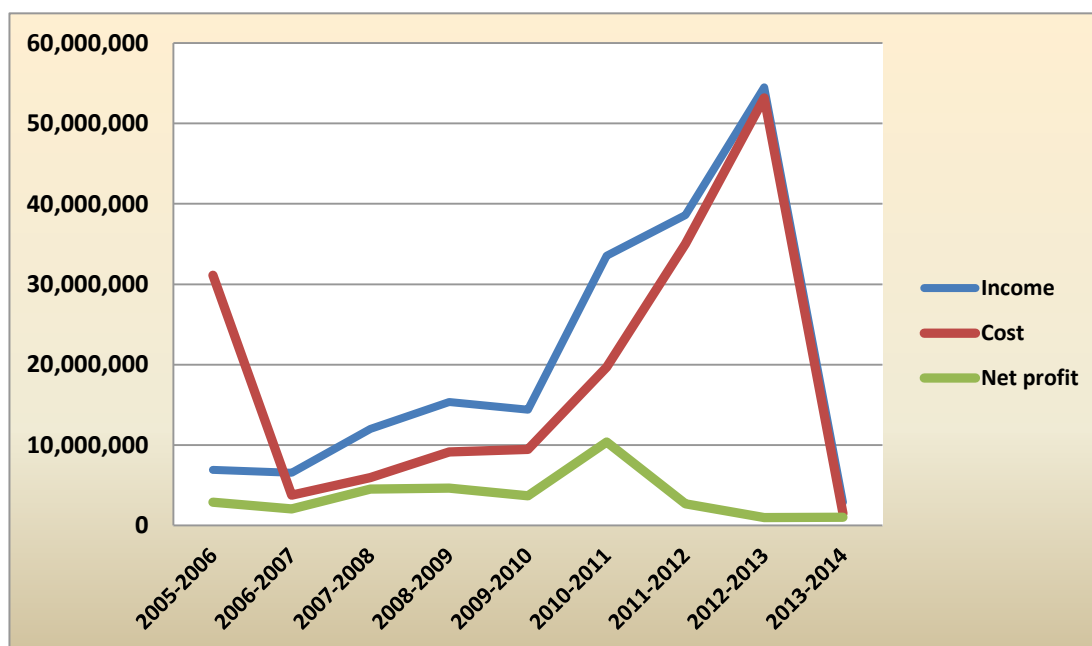


Figure 3.20 Trend of Financial Performance of IEIOC (in USD)

Sangan Iron Ore Mine Project investment chart has been illustrated in figure 3.21. The least amount of investment was in the year 2007-2008 with 11 Million USD;

²⁹⁵ IEIOC board of directors summary reports to the General Assembly of shareholders (2005 to 2014), *Internal reports* (Persian)

while the highest was in 2008-2009 with 136 Million USD. The overall investment from 2007- 2014 equals to 435 Million USD.

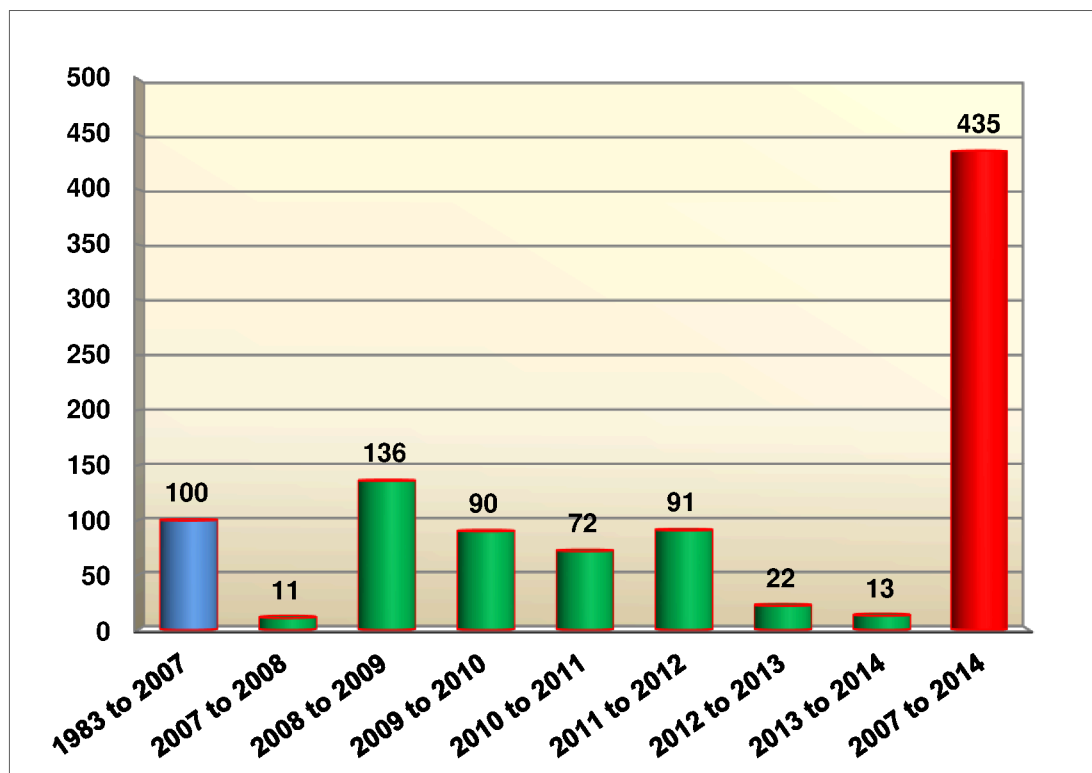


Figure 3.21 Investment in Sanghan Iron Ore Mine Project (MUSD)²⁹⁶

As can be seen, the investment in SIMP from 2012 till 2014 has been decreased²⁹⁷. Investment in SIMP and investment in Iranian mining sector from 2007 till 2012 have been compared in table 3.11. The highest investments were discerningly in 2008, 2009, 2011, 2010, 2007 and 2012.

²⁹⁶ Tadbir Gostar-e-Asia, Project Control and Planning Consultant of Sanghan Iron Ore Mine Project, *yearly management reports*, 2007 to 2014 (Persian)

²⁹⁷ The declining trend of investment from 2012 till 2014 can be attributed to termination of constructing the first iron ore concentrate plant, lack of pecuniary sources and conflicts in IMIDRO regarding construction of the second concentration phase. As it mentioned in chapter one, from 2015 IMIDRO decided to cooperate with other investing partners to provide its financial sources for continuation of the project. Via an auction, 60% of Sagan's first phase share, belonged to IMIDRO, was transferred to private institutions. Since then, the amount of investment and also the progress of implementing the projects and plans increased.

Year	2007	2008	2009	2010	2011	2012
Investment in SIMP - Billion Rials (BIRR) ²⁹⁸	103.8	1356.9	829.9	751	979	272
Investment in Iranian mining sector (BIRR) ²⁹⁹	2583	3302	3631	6341	6149	8607
The ratio of investment in SIMP to the investment in Iranian mining sector (%)	4.02	41.09	22.86	11.84	15.92	3.16

Table 3.11 Investment in SIMP and Iranian mining sector

Figure 3.22 presents the average direct job creation in SIMP and IEIOC. 548 employee in 2006 reached 1610 in 2011 and then in 2012 the number decreased to 1411. This can be attributed to the fact that necessary working forces have already been employed and the same rate of direct job creation cannot be expected till end of the project. However, a number of personnel remain in long run at project site and only workers for construction phases leave.

²⁹⁸ Tadbir Gostar-e-Asia, Project Control and Planning Consultant of Sangan Iron Ore Mine Project, *yearly management reports*, 2007 to 2014 (Persian), The amounts include investment in mining, infrastructures and first iron ore concentrator.

²⁹⁹ Statistical Center of Iran (only investment in mining), Access at: http://nnt.sci.org.ir/sites/Apps/yearbook/Lists/year_book_req/Item/newifs.aspx?List=97c00882-734c-4417-831a-633d795b18ce&RootFolder=&Web=f9aca984-16ee-4860-8c00-bb43c696d32d

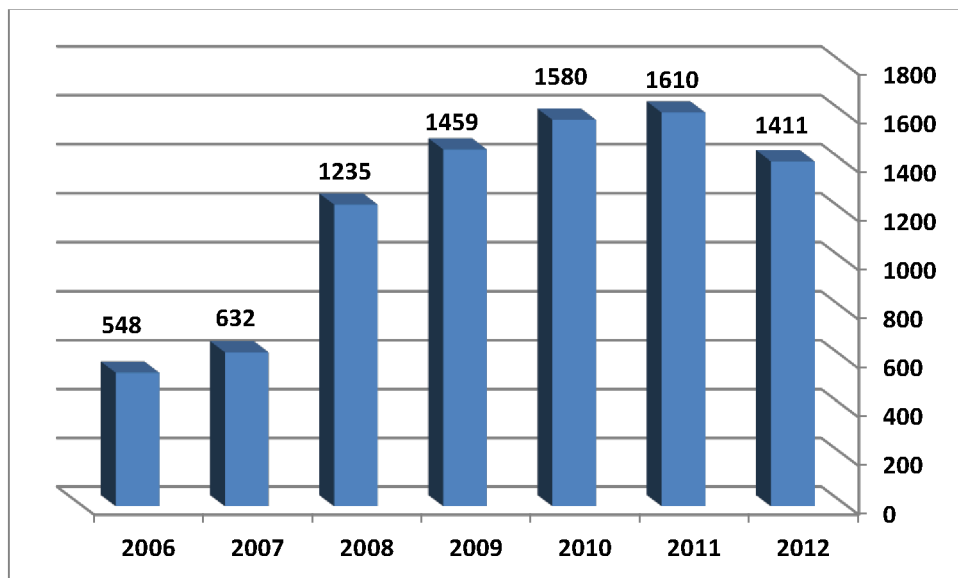


Figure 3.22 Average of direct employment³⁰⁰ in SIMP and IEIOC³⁰¹

The ratio of direct employment in SIMP and IEIOC to Iranian mining sector is presented in table 3.12.

Year	2006	2007	2008	2009	2010	2011	2012
Direct employment in SIMP and IEIOC ³⁰²	548	632	1235	1459	1580	1610	1411
Direct employment in Iranian mining sector ³⁰³	60062	66250	75458	76854	81293	84528	84922
The ratio of employment in SIMP and IEIOC to the employment in Iranian mining sector (%)	0.91	0.95	1.64	1.90	1.94	1.90	1.66

Table 3.12 Ratio of employment in SIMP and IEIOC to Iranian mining sector

The production of Iron Ore in Iran and in IEIOC is compared in table 3.13 and illustrated in figure 3.23.

³⁰⁰ Decrease in direct employment in 2012 can be attributed to termination of constructing the concentrate production plant. Usually, there are non- native workers in construction phase who leave the project after a while and the operation phase runs with less staff. However, due to new operations of plant in 2013, direct employment has increased which is illustrated in figure 3.4.

³⁰¹ SIMP, IEIOC and SIOC's Human Resources Management Departments (2013), *Internal report* (Persian)

³⁰² SIMP, IEIOC and SIOC's Human Resource Management Department (2013), *Internal report*

³⁰³ Statistical Center of Iran (2013), Access at:

http://nnt.sci.org.ir/sites/Apps/yearbook/Lists/year_book_req/Item/newifs.aspx?List=97c00882-734c-4417-831a-633d795b18ce&RootFolder=&Web=f9aca984-16ee-4860-8c00-bb43c696d32d

Iron ore production	2007	2008	2009	2010	2011	2012	2013
Iran (1000 TON) ³⁰⁴	22,378	27,300	27,435	32,220	38,260	43,497	48,693
IEIOC (1000 TON) ³⁰⁵	819	1,116	1,117	1,504	1,282	1,500	1,697
The ratio of iron ore production in IEIOC to Iran (%)	3.7	4.1	4.1	4.7	3.4	3.4	3.5
Iran iron ore production change compare to previous year (%)	---	22.0	0.5	17.4	18.7	13.7	11.9
IEIOC iron ore production change compare to previous year (%)	---	36.3	0.1	34.6	-14.7	17.0	13.1

Table 3.13 The ratio of iron ore production in Iran and IEIOC

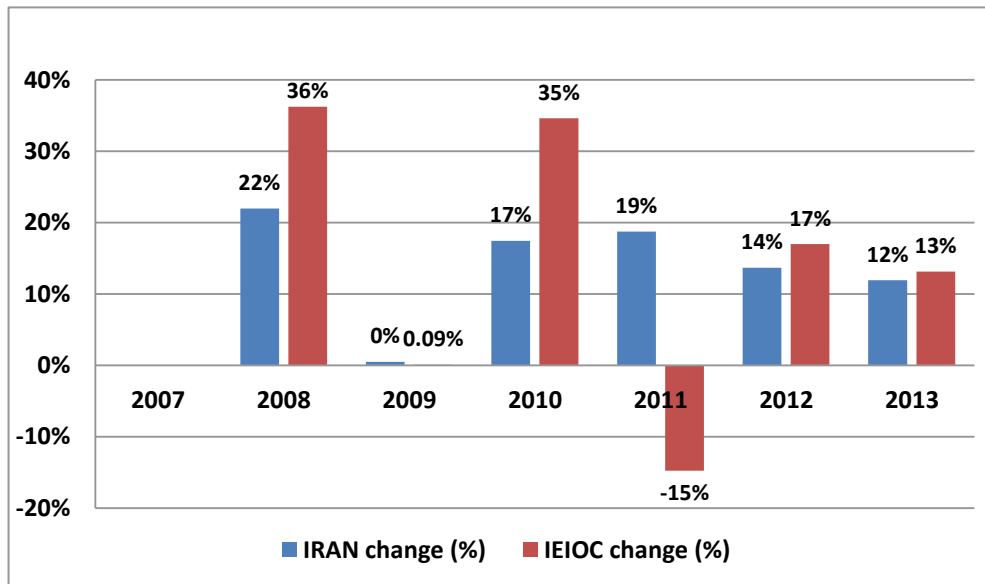


Figure 3.23 Iran and IEIOC iron ore production change compare to previous year

Figure 3.24 presents the growth of minerals added value³⁰⁶ ratios in percent in Khorasan-e-Razavi and Iran. As can be seen, the ratio has higher amounts in Khorasan Razavi, but with falls and rises. In contrary, the added value is lower in Iran but with steady trend during the years, 2005 till 2011.

³⁰⁴ IMIDRO (2013), *IMIDRO's Performance Report*, Tehran, Iran (Persian)

³⁰⁵ IEIOC board of directors summary reports to the General Assembly of shareholders (2007 to 2013), *Internal reports* (Persian)

³⁰⁶ In financial analysis of shares is to be distinguished from value added. Used as a measure of shareholder value, calculated using the formula: Added Value = Price that the product/service is sold at - cost of producing the product (Source: Investopedia)

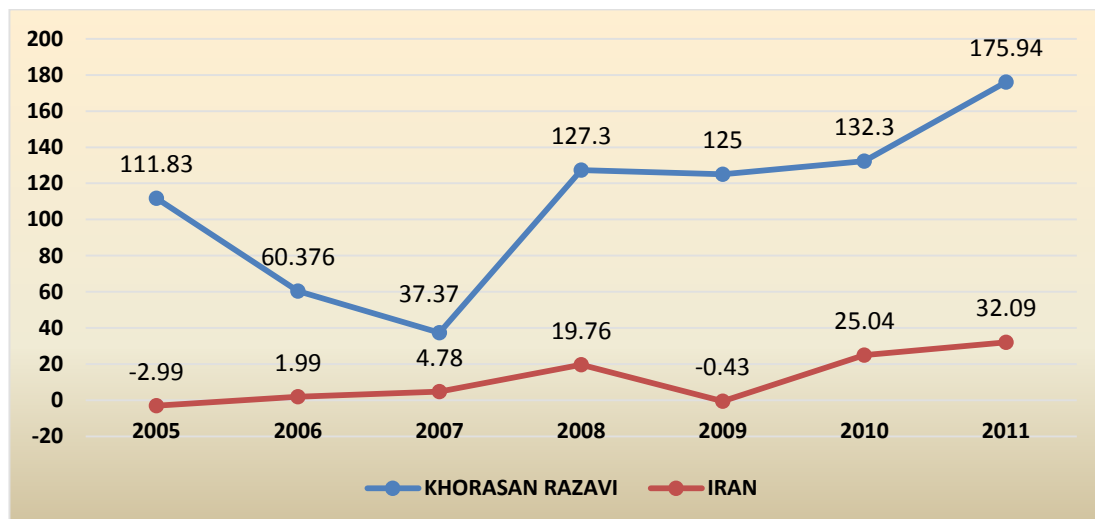


Figure 3.24 Growth of minerals added value ratio (%) in Khorasan-e-Razavi and Iran³⁰⁷

The output values³⁰⁸ of IEIOC and Iranian mining sector have been compared in table 3.14. During the studied years (2005-2012), there was an increasing trend in both parameters.

Year	2005	2006	2007	2008	2009	2010	2011	2012
IEIOC output value (BIRR) ³⁰⁹	62.759	60.592	112.148	153.284	142.736	384.754	413.315	668.073
Iran mine sector output value (BIRR) ³¹⁰	17118.4	23011.1	31249.3	36386.4	36589.2	50971	66927.8	102485.5
The ratio between IEIOC and Iran (%)	0.37	0.26	0.36	0.42	0.39	0.75	0.62	0.65

Table 3.14 Comparison between output value of IEIOC and Iran mine sector

³⁰⁷ Deputy of Mashhad Municipal Development, Access at:

https://amar.mashhad.ir/portal_content/16925-%D8%A7%D8%B7%D9%84%D8%A7%D8%B9%D8%A7%D8%AA-%D8%A2%D9%85%D8%A7%D8%B1%DB%8C-%D8%B4%D9%87%D8%B1-%D9%85%D8%B4%D9%87%D8%AF.html

³⁰⁸ Output Value is an economic concept used in national accounts. It is equal to the value of net output represents or the total value of sales by producing enterprises. (Source: CBI)

³⁰⁹ IEIOC board of directors summary reports to the General Assembly of shareholders (2005 to 2012), *Internal reports* (Persian)

³¹⁰ Statistical Center of Iran, 2013, Access at:

http://nnt.sci.org.ir/sites/Apps/yearbook/Lists/year_book_req/Item/newifs.aspx?List=97c00882-734c-4417-831a-633d795b18ce&RootFolder=&Web=f9aca984-16ee-4860-8c00-bb43c696d32d

The ratio of Sangan income to the share of mining sector in Iran`s GDP³¹¹ during the years 2005-2012 is tabulated below (table 3.15). This amount had falls and rises during the mentioned period and had the highest share in the year 2010.

According to all examined statistics, it can be deducted that IEIOC had a favorable economic influence both on the region and also on national economics. There are fluctuations in some parameters which are mostly due to economic instability and variations in national and international demand.

Year	2005	2006	2007	2008	2009	2010	2011	2012
Iran GDP (1000BIRR) ³¹²	1,993	2,407	3,139	3,743	3,893	4,741	6,245	7,091
The share of mining sector in Iran`s GDP (%) ³¹³	0.7	0.7	0.8	0.7	0.7	0.8	0.8	1
The share of mining sector in Iran`s GDP (BIRR) ³¹⁴	13,956	16,856	25,117	26,203	27,256	37,931	49,966	70,914
IEIOC income (BIRR) ³¹⁵	62.759	60.592	112.148	153.284	142.736	384.754	413.315	668.073
The ratio of IEIOC income to the share of mining sector in Iran`s GDP (%)	0.45	0.36	0.45	0.58	0.52	1.01	0.83	0.94

Table 3.15 The ratio of IEIOC income to the share of mining sector in Iran`s GDP

³¹¹ Gross domestic product (GDP) is defined by OECD as "an aggregate measure of production equal to the sum of the gross values added of all resident institutional units engaged in production (plus any taxes, and minus any subsidies, on products not included in the value of their outputs) (Source: World Bank)

³¹² Central Bank of Iran (CBI) (2013), *Annual report* (Persian),
Access at: http://www.cbi.ir/category/EconomicReport_fa.aspx

³¹³ Central Bank of Iran (CBI) (2013), *Annual report* (Persian),
Access at: http://www.cbi.ir/category/EconomicReport_fa.aspx

³¹⁴ The numbers in this row is obtained by multiplying the percentage share of mining sector in total GDP.

³¹⁵ IEIOC board of directors summary reports to the General Assembly of shareholders (2005 to 2013), *Internal reports* (Persian)

3.1.3.3 Economic effects of mining on development degree of Khaf County

Generally, there are various definitions and methods for development and its measurement. In 2012, a study has reviewed the development degree in Sangam district and its rural districts namely Khaf (in Markazi District), Salami and Zoonan Plain (Figure 3.25).

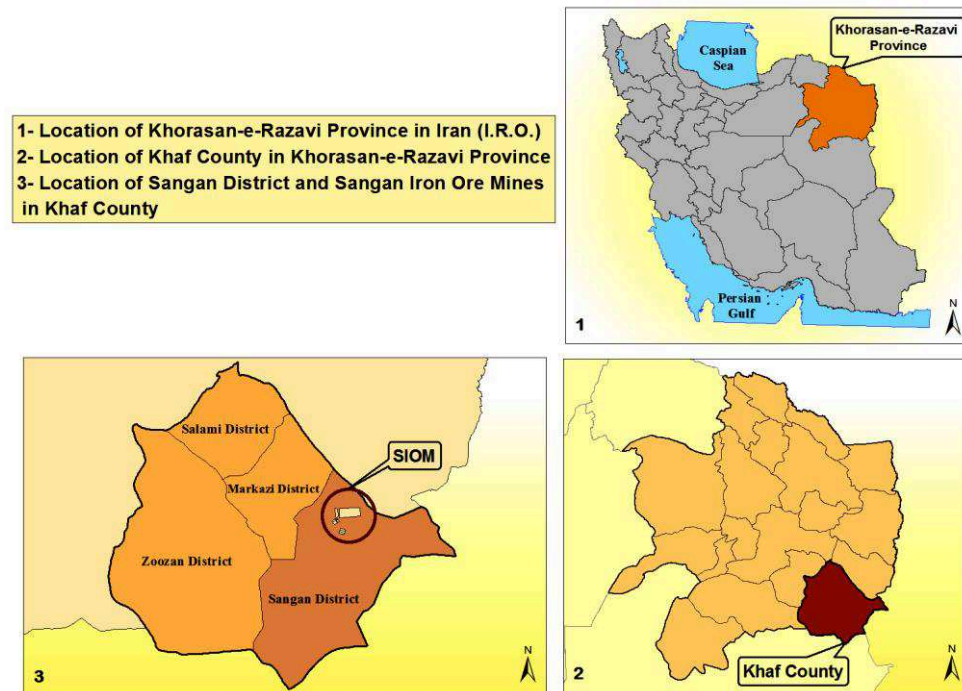


Figure 3.25 SIOM and neighbor rural districts

Development is defined in this study as:

- I. Having enough income for providing the family's basic needs including home, food, clothes, safety and health requirements.
- II. Having a job not only for monetary needs, but also as a factor of increasing life expectancy and self-confidence in residents of the region.
- III. Having access to education facilities and improving the rate of literacy in society.

As a rule of thumb, mining activities affect above- mentioned issues in tangible ways, so that it can pave the way to have a better developed region in future. To quantify the development degree in Sangam region, 24 indicators were selected from 4 classes of factors (6 from each) including communication, education, building and housing, and health and care. Numerical taxonomy method was utilized to rank the 4

rural districts on the basis of each indicator. This method aims to create a taxonomy using numeric algorithms like cluster analysis.

According to the results, rural districts in vicinity of Sangam mining operations (Sangan and Khaf) have higher degree of development in comparison to Salami and Zoozan. Table 3.16 shows the results based on factor classes and rural districts.

Part	Education		Health and Care		Building and Housing		Communications	
	Degree	Rank	Degree	Rank	Degree	Rank	Degree	Rank
Khaf	0.319	2	0.289	1	0.389	1	0.344	1
Sangan	0.282	1	0.454	2	0.562	2	0.486	2
Salami	0.416	3	0.525	3	0.621	3	0.534	3
Zoozan plain	0.489	4	0.613	4	0.687	4	0.870	4

Table 3.16 Development degree and rank in different parts of SIOM area (according to 2011 statistics)³¹⁶

Results show along with increase in mining operations, the whole County is faced with higher rate of development. In the case of education, the development degree varies from 0.282 in Sangan (the highest degree) to 0.489 in Zoozan plain (the lowest degree). In fact, the development degree in Sangan is 2.34 times more than Zoozan plain. Consequently, development degrees of Sangan and Khaf, which are close to the mine, are more than Salami and Zoozan plain. Also, higher population density and suitable geographic location are other factors that influence the speed of development. These two factors were also contributing to development degree in education section; while, in communication section, geographic location is more impressive. Population density, geographic location and also income are important factors that determine the degree of development in building and housing section. In sum, it can be deducted that infrastructures and services are improved along with mining operations, so that districts in vicinity of mine site are provided with better facilities and situations; in fact the positive influence of SIOM on economic growth of the region cannot be neglected.

³¹⁶ A. Tavakoliroodi (2012), *Security, political and economic effects of mining activities in SIOM*, Published by Taybad Azad University (Persian)

Chapter 4

Sustainable Strategic Management in Iranian Mining Sector

4 Sustainable strategic management in Iranian mining sector

4.1 Introduction into strategic management and strategic planning

The establishment of strategies, the making of plans, and the implementation of those strategies and plans are key management decision-making processes in any kind of enterprise. The strategic decision-making process takes place, in some forms or other, in most kinds of organizations. The process may be formalized and systematic. Or it may be informal, opportunistic and ad hoc in nature. The formulation of strategies and plans is a prime responsibility of entrepreneurs in small to medium-sized businesses (or “SMEs”); and of leaders, chief executives, presidents, directors, and managers in private and public companies. Business planning and the formulation of strategy is also a prime responsibility of managers and administrators in such public institution and government agencies, institutions etc.³¹⁷.

4.1.1 Definition

Strategic management is concerned with the character and direction of the enterprise as a whole. It is concerned with basic decisions about what the enterprise is now, and what it is to be in the future. It determines the purpose of the enterprise. It provides the framework for decisions about people, leadership, customers or clients, risk, finance, resources, products, systems, technologies, location, competition, and time. It determines what the enterprise should be capable of achieving, and what it will not choose to do. It will determine whether and how the organization will add value, and what form that added value should take. Strategic management is also concerned with management planning and decision-making for the medium to long-term future. It is concerned with the anticipation of that future, and with the establishment of a vision or view of how the enterprise should develop into the future that it must face³¹⁸.

The process of strategic management is used to establish missions, objectives, and strategies for the organization. Statements of mission specify what the enterprise is about, what its values are, and what its purpose is to be. Objectives are statements of

³¹⁷ R. Jones (2002), *Fundamentals of strategic and tactical business planning*, Prepared for the 2002 MAST Program (Rodney Jones: Associate professor at Kansas State University)

³¹⁸ T. Morden (2007), *Principles of strategic management*, Third Edition, Ashgate Publishing Ltd., ISBN: 978-0-7546-4474-3, p.14

the major goals that the organization is aiming to achieve. Objectives specify or quantify the targets towards which leadership, effort, investment, and willpower are to be directed. Strategies are the means or the “game-plan” by which enterprise mission is put into practice, and objectives achieved. The identification of mission, objectives, and strategy depend on understanding the basic nature and purpose of the enterprise. The process of strategic management and business planning therefore requires us to understand what the nature of the business is³¹⁹.

4.1.2 The strategic management process

The concept of strategic management is illustrated in Figure 4.1. It has four component processes. These are³²⁰:

- Strategic analysis and planning
- Strategy formulation and strategic decision-making
- Strategic choice
- Strategy implementation

³¹⁹ T. Morden (2007), *Principles of strategic management*, Third Edition, Ashgate Publishing Ltd., ISBN: 978-0-7546-4474-3, p.15

³²⁰ T. Morden (2007), *Principles of strategic management*, Third Edition. Ashgate Publishing Ltd., ISBN: 978-0-7546-4474-3, p.17

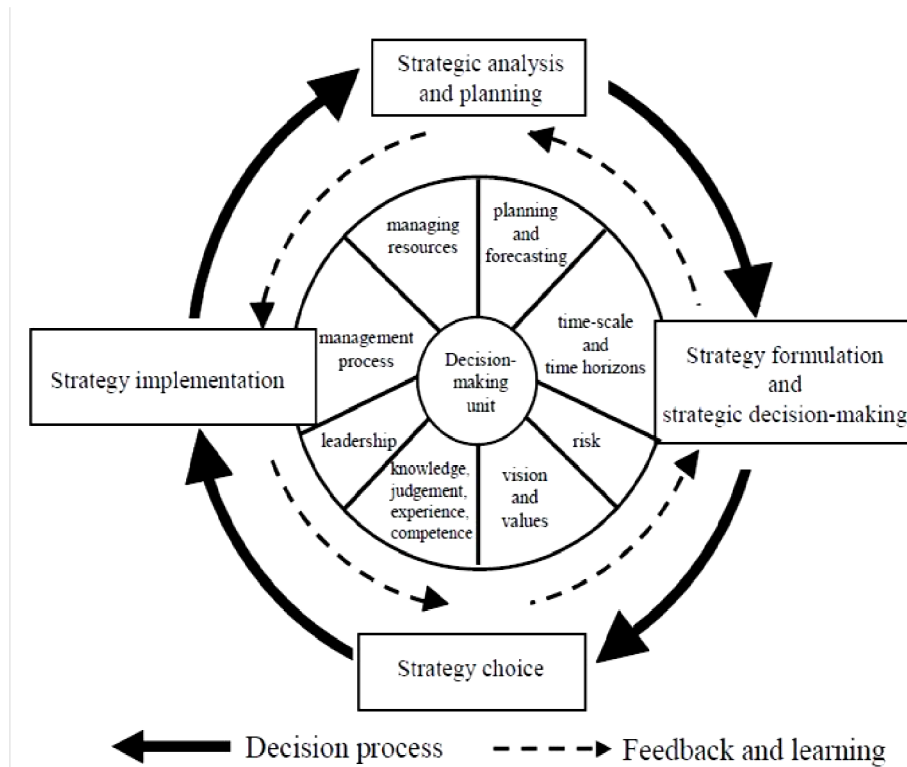


Figure 4.26 The strategic management process³²¹

The four elements of the approach to the study and practice of strategic management and business planning described are inter-related and inter-acting. Each informs and influences the other, for instance through the processes of communication, feedback, learning, and the accumulation by individuals and organizations of knowledge, judgment, experience, and competence. At the same time, decisions about strategic choice cannot be taken without careful thought as to their implementation. Strategies or plans that cannot with any degree of certainty be implemented, or for which the necessary finance or resources are unavailable, are not realistically likely to be selected. Strategic choice must be feasible as well as appropriate to the requirements of the situation³²².

4.1.2.1 Strategic analysis and planning

Strategic analysis is a process by which the enterprise examines its own internal or corporate characteristics and capabilities; and identifies the most important features of the external environment within which it must operate. Strategic analysis is used

³²¹ T. Morden (2007), *Principles of strategic management*, Third Edition. Ashgate Publishing Ltd., ISBN: 978-0-7546-4474-3, p. 17

³²² T. Morden (2007), *Principles of strategic management*, Third Edition. Ashgate Publishing Ltd., ISBN: 978-0-7546-4474-3, p. 21

to inform the processes of strategy formulation, strategic decision-making, and strategic choice described in following sections. The planning process is used to inform and to structure the processes of strategy formulation, strategic decision-making, strategic choice, and strategy implementation.

4.1.2.2 Strategy formulation and strategic decision-making

Processes of strategy formulation and strategic decision-making are used to establish enterprise mission, objectives, and strategy. Mission, objectives, and strategy will be driven from the vision and values of the enterprise, of its leaders, of its decision-makers, and of its stakeholders. The enterprise will have to decide how to formulate its strategies and plans; to decide who is to be involved in this process; and to decide how to make decisions about the allocation of finance and resources that are required to put these strategies and plans into operation. Decision-makers will have to know how to identify and describe the alternative courses of action that are likely to be available to the enterprise, given the findings of the process of strategic analysis and business planning.

4.1.2.3 Strategy choice

The process of strategy choice is used to identify the alternative courses of action that given its available resources, its capability, its willpower, and its sources of comparative or competitive advantage, are likely to be available to the enterprise (i) over the time scale and time horizon to which it operates; and given (ii) its attitude to risk. Decision-makers will have to select those strategies from the alternatives they have identified that they consider will best or most effectively enable the enterprise to fulfill the mission and achieve the objectives it has formulated for itself (or which have instead been laid down for it).

4.1.2.4 Strategy implementation

The process of putting the enterprise's chosen strategies and plans into practice takes place within the internal context and constraints of the people, the leadership, the structure, the resources, the capability, and the culture of the organization. Strategy implementation also takes place within the context and constraints of the external, political, and competitive environments. The implementation of strategic choice will in addition take place within the context of those people and organizations external to

the enterprise but with whom it has any form of operational, partnership, supply or trading relationship. Strategy implementation will depend on the nature of the knowledge, technology, and competence resources available to the enterprise. It will also depend specifically on the nature of decisions about financial and competition strategy.

4.1.3 The strategic analysis and planning tools

Methods and tools are keys to ensuring that consistency and an appropriate level of rigor is applied to the analysis. The aim of the analytical tool is to sharpen the focus of the analysis and to ensure a methodical, balanced approach. All analytical tools rely on historical and backward looking data to extrapolate future assumptions. It is important to exercise caution when interpreting strategic analysis results. Otherwise the analysis may be unduly influenced by preconceptions or pressures within the organization which seek to validate a particular strategic assumption. One of the key skills of a strategic analyst is in understanding which analytical tools or techniques are most appropriate to the objectives of the analysis. Below is an overview of some of the more commonly used strategic analysis tools³²³.

4.1.3.1 PESTLE analysis³²⁴

PESTLE analysis is a scan of the external macro-environment in which an organization exists. It can be used for evaluating market growth or decline, and as such the position, potential and direction for a business. In seeking to gather and interpret information about changes in the wider environment, PESTLE is a commonly used tool. It highlights the importance of identifying trends and anticipating changes in a variety of environments:

- Political
- Economic
- Social
- Technological

³²³ R. James (2012), *How to do strategic planning: a guide for small and Diaspora NGOs*, Common Ground Initiative, p. 2, Access at:

<http://www.intrac.org/data/files/resources/729/Strategic-Planning-A-PLP-Toolkit-INTRAC.pdf>

³²⁴ R. James (2012), *How to do strategic planning: a guide for small and Diaspora NGOs*, Common Ground Initiative, p. 10, Access at:

<http://www.intrac.org/data/files/resources/729/Strategic-Planning-A-PLP-Toolkit-INTRAC.pdf>

- Legal
- Environmental

4.1.3.2 Porter's five forces

Porter's five forces of competitive position analysis were developed in 1979 by Michael E. Porter of Harvard Business School as a simple framework for assessing and evaluating the competitive strength and position of a business organization. This theory is based on the concept that there are five forces which determine the competitive intensity and attractiveness of a market (Figure 4.2). Porter's five forces help to identify where power lies in a business situation. This is useful both in understanding the strength of an organization's current competitive position, and the strength of a position that an organization may look to move into. By understanding where power lies, the theory can also be used to identify areas of strength, to improve weaknesses and to avoid mistakes³²⁵.

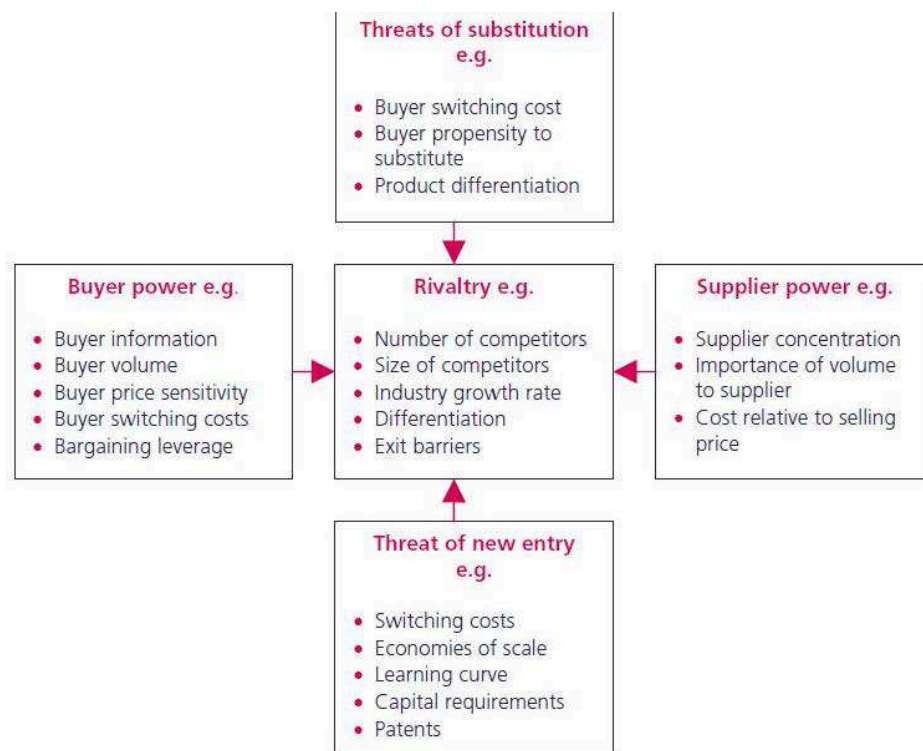


Figure 4.27 Porter's five forces diagram³²⁶

³²⁵ M. E. Porter (2008), *The Five Competitive Forces that Shape Strategy*, Harvard Business Review, January 2008, p. 86-104

³²⁶ J. Downey (2007), *Strategic Analysis Tools, Topic Gateway Series*, No. 34/ 2007, p.16, Access at: <http://www.cimaglobal.com>

4.1.3.3 The balanced scorecard³²⁷

The Balanced Scorecard (BSC) is a strategic approach and performance measurement analysis tool that enables organizations to translate a company's vision, mission, and strategy into implementation (Figure 4.3). The BSC operates from 4 basic perspectives:

- I. Financial
- II. Customer
- III. Business Process
- IV. Learning and Growth

This enables an organization to monitor their present performance and analyze their position to perform in the future.

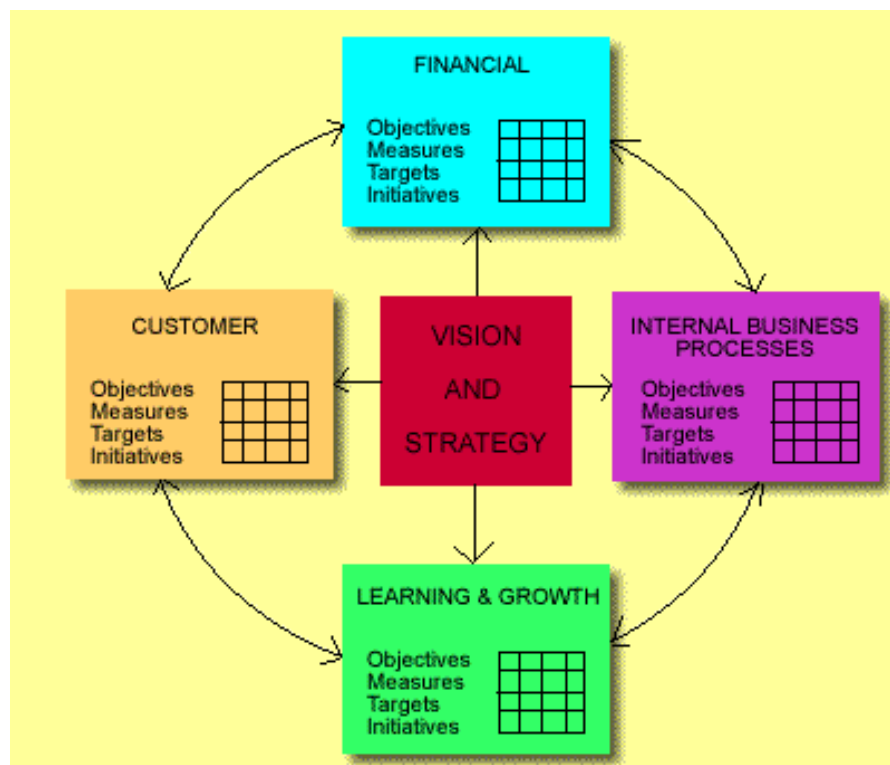


Figure 4.28 Balanced scorecard (BSC)

³²⁷ Balanced scorecard institute, *Balanced Scorecard Basics*, Access at: <http://balancedscorecard.org/Resources/About-the-Balanced-Scorecard>

4.1.3.4 SWOT analysis³²⁸

A SWOT analysis is a simple but widely used tool that helps in understanding the strengths, weaknesses, opportunities and threats involved in a project or business activity. It starts by defining the objective of the project or business activity and identifies the internal and external factors that are important to achieving that objective. Strengths and weaknesses are usually internal to the organization, while opportunities and threats are usually external. Often these are plotted on a simple 2x2 matrix (Table 4.1). When using SWOT analysis, it should be ensured that:

- Only specific, verifiable statements are used.
- Internal and external factors are prioritized so that time is spent concentrating on the most significant factors. This should include a risk assessment to ensure that high risk or high impact threats and opportunities are clearly identified and are dealt with in priority order.
- Issues identified are retained for later in the strategy formation process.
- The analysis is pitched at the project or business activity level rather than at a total company level, which may be less actionable.

³²⁸ Mindtools (2007), *SWOT analysis: discover new opportunities, Manage and eliminate threats*, Access at: www.mindtools.com/pages/article/newTMC_05.htm

<p style="text-align: center;">The Organization</p>	<p style="text-align: center;"><u>Strengths- S</u></p> <ul style="list-style-type: none"> • Capabilities? • Resources, assets, people? • Geographical location? • Price, values, quality? • Experience, knowledge, data? 	<p style="text-align: center;"><u>Weaknesses- W</u></p> <ul style="list-style-type: none"> • Known vulnerabilities? • Gaps in capabilities? • Financials? • Accreditation, etc.? • Commitment, leadership?
<p style="text-align: center;"><u>Opportunities- O</u></p> <ul style="list-style-type: none"> • Market developments? • Global influences? • Information and research? • Industry trends? • Export, import? 	<p style="text-align: center;"><u>SO Strategies</u> Leverage strengths to maximize opportunities = Attacking Strategy</p>	<p style="text-align: center;"><u>WO Strategies</u> Counter weaknesses through exploiting opportunities = Build Strengths for Attacking Strategy</p>
<p style="text-align: center;"><u>Threats- T</u></p> <ul style="list-style-type: none"> • Political effects? • Environmental effects? • Market demand? • Vital contracts and partners? • Loss of key staff? 	<p style="text-align: center;"><u>ST Strategies</u> Leverage strengths to minimize threats = Defensive Strategy</p>	<p style="text-align: center;"><u>WT Strategies</u> Counter weaknesses and threats = Build Strengths for Defensive Strategy</p>

Table 4.1 SWOT analysis matrix³²⁹

Since IMIDRO uses SWOT tool to conduct its annual strategic analysis, this tool will also be used in this research to define the strategies for SIOM.

³²⁹ Mindtools (2007), *SWOT analysis: discover new opportunities, Manage and eliminate threats*, Access at: www.mindtools.com/pages/article/newTMC_05.htm

4.2 Sustainable development in strategic management

4.2.1 Terminology and theoretical considerations

The research for Strategic Sustainable Development (FSSD³³⁰) is a process that incorporates methods, tools, and concepts into a shared, structured overview. The framework and methods, tools and concepts can help decision makers determine the problem out of the system. The numbers of international participants in this research include leading experts and the prominent pioneers of methods, tools, and concepts for sustainable development are growing. In the following section, the theory for the FSSD is developed, put it into an operational methodology, analyzed in relation to existing methods, tools and concepts³³¹.

Forecasting is a common method used in decision-making. It consists of projecting current trends into the future to predict and solve problems. Thus, forecasting may leads to ‘path dependencies’ and may not be a suitable method when planning for novel objectives. In contrast, back casting, begins by defining the objective clearly and then asking — “what shall we do today (and subsequently) to achieve the objective?” For the FSSD, the term back casting is used simply to envision a situation in the future and then explore pathways to reach it. Semantically, one is “back casting” from that imagined situation in the future to the present (not vice versa, i.e. “forecasting” from present trends to predict the future)³³².

Back casting occurs in different ways and for different purposes, none of which are in conflict with the definition above. One typical way is to develop a scenario, for example an image of “a defined sustainable energy system.” Then, one considers various step-by-step routes to attain that system, for example, by modeling multidimensional aspects such as energy potentials, learning curves, costs, consumption of areas, etc. This can also be an explorative exercise used to collect

³³⁰ The framework for strategic sustainable development

³³¹ <http://www.alliance-ssd.org/framework-for-strategic-sustainable-development-fssd/>, The Alliance for Strategic Sustainable Development (www.alliance-ssd.org) here presents a program to employ and develop further a unifying Framework for Strategic Sustainable Development (FSSD).

³³² M. Robèrt (2005), *Backcasting and econometrics for sustainable planning – Information technology and individual preferences of travel*. Journal of Cleaner Production 13/2005, p. 841-851

data and for learning. In actual planning, one may re-assess the planning, as well as the envisioned scenario, as the plan unfolds in the real world³³³.

“Planning towards scenarios” without clear understanding of the basic principles or underlying conditions that frame the objective (in this case sustainability) has at least four potential shortcomings³³⁴:

1. It may be difficult for large groups to agree on relatively detailed descriptions of a desirable distant future.
2. Given technological and cultural revolution, it may be unwise or unrealistic to lock into overly specific assumptions about the future too soon.
3. It is difficult to know whether any given scenario is truly sustainable or not.
4. It is difficult to compare one set of scenario based-plans with another set.

To counter these problems, another approach has been systematically developed. The FSSD, with its basic principles of sustainability, emerges from a process of consensus building among scientists, policy makers, and business leaders.

4.2.2 Sustainability principles³³⁵

In the sustainable society, nature is not subject to systematically increasing:

1. concentrations of substances extracted from the Earth’s crust (such as fossil carbon or metals),
2. concentrations of substances produced by society (such as nitrogen compounds, CFC’s, and endocrine disrupters),
3. degradation by physical means (such as large scale clear-cutting of forests and over-fishing),

³³³ K. H. Robèrt (2002), *Sustainable Management of Materials – Applying Backcasting from Principles of Sustainability*, Proceedings from Materials Science for Future Sustainable Technologies, September 17- 20, 2002, University of Augsburg, Inst. of Physics, Germany

³³⁴ M. Robèrt (2005), *Backcasting and econometrics for sustainable planning – Information technology and individual preferences of travel*. Journal of Cleaner Production 13/2005, p. 841-851

³³⁵ K. H. Robèrt (2002), “*Integrating Sustainability into Business Strategy and Operations: Applying The Natural Step Approach and Framework and Backcasting from Principles of Sustainability*,” in SisselWaage, Editor Re-Shaping Business through Nature, Genius, and Compassion, Sheffield, U.K.: Greenleaf Publishing

4. Moreover, in such a (sustainable) society, people are not subject to conditions that systematically undermine their capacity to meet their needs (such as from the abuse of political and economic power).

These four principles were derived by asking “by what primary mechanisms, upstream at the level of first approximation in chains of causality, do human activities set off downstream social and ecological impacts that will destroy this system?” The answer revealed how myriads of downstream impacts are rooted in a few upstream errors of societal design and operation. Thereafter a “not” was inserted into each category to form the above first order sustainability principles. These are also called “The Natural Step (TNS) System Conditions.”. This set of principles comes as close as possible to meeting criteria for planning; that is, that planning criteria be “necessary”, “sufficient”, “general”, “concrete”, and “distinct”.

4.2.3 Framework for strategic sustainable development

An appropriate analogy to guide sustainable development is chess, where a premature steering towards an exact position of pieces on the chessboard (a “scenario”) is a mediocre, and perhaps impossible, way of playing. As long as the goal is distant in complex systems, it is the principles of the objectives—checkmate or sustainability—and not an exact picture of how those principles will be fulfilled that guide a strategic player. Within a given system the objective of the planning and the process by which the objective is approached, should be differentiated. The FSSD is thus comprised of five specific levels³³⁶:

(i) The Systems level. The system’s major overall functions are described, in this case we describe : the biosphere with its human society, our knowledge of stocks, flows, biogeochemical cycles, biodiversity and resilience, and the basic relationships between human practices and their impacts. The description must be sufficient to inform the subsequent levels. To apply an analogy, in chess, the systems level contains the game rules, the pieces, and the playing board.

(ii) The Purpose level. In this case, the definition of the objective is specified as sustainability. Returning to the game analogy, the purpose is to checkmate one’s

³³⁶ S. Hallstedt, H. Ny, K. H. Robèrt and G. Broman (2010), *An approach to assessing sustainability integration in strategic decision systems*, Journal of Cleaner Production 18/2010, p. 703–712

opponent within the constraints of the game (level 1). This can happen in an almost uncountable number of combinations, all complying with the basic principles of checkmate. The next level requires the second level.

(iii) The Strategic level. The principles of how to approach the objective strategically is specified. This implies a step-by-step approach that ensures that financial, social, and ecological resources continue to feed the process. In chess, good moves serve as strategic steps to checkmate. Tradeoffs are selected from their capacity to serve as platforms towards complying with principles of success (level 2), rather than as choices between inherent evils.

(iv) The Actions level. Every action that could lead strategically towards the objective is informed.

(v) The Tools level. Tools are often required to monitor the (iv) actions to ensure that they are chosen (iii) strategically to arrive at the (ii) objective in the (i) system. Examples in sustainable development include indicators, management systems, and life cycle assessments.

4.3 Framework for sustainable strategic management in Iran

4.3.1 Sustainable development in Iran according to international scale

A recent environmental indexes report by the United Nations Environment Program ranked Iran 117th place among 133 countries³³⁷. This ranking puts Iran in the top 30 most polluted countries of the world. Iran faces a plethora of environmental issues: urban air pollution, deforestation, desertification, oil pollution in the Persian Gulf, biodiversity, threats to the Caspian Sea, wetland loss, soil degradation, water supply issues, and water pollution from raw sewage and industrial waste. Iran's sustainable development is tied to its obligations under international environmental agreements, assistance from UN agencies, and Global Environment Facility (GEF) Initiatives³³⁸.

Table 4.2 provides some important international rankings of Iran to have an idea of the general status of different parts of the country.

³³⁷ United Nations Environment Program (2012), *Annual Report 2011*, p. 64, ISBN: 975-92-807-3323-5, Access at: http://www.unep.org/gc/gc27/docs/UNEP_ANNUAL_REPORT_2012.pdf

³³⁸ Iran Rooyan, Iran: international environmental agreements fact sheet, Access at: <http://iranrooyan.org>, (Founded in 2010, Iran Rooyan (Persian for growth or development) is a non-political, non-religious, non-governmental organization. Iran Rooyan promotes the full and equal participation of women in the social, civil, and political spheres of Iran, and maintains that a strong and vibrant society must include the voices and contributions of women. Iran Rooyan is composed of individuals with backgrounds in law, medicine, journalism, advocacy, and public policy, international relations, psychology and information technology).

Category	Name	Rank	Out of	Source	Notes	Year
Agriculture	Arable land as % of total land area	131	207	World Bank	30% of land area is arable (16,100,000 hectares)	2012
	Permanent cropland as % of total land area	106	195	World Bank	0.23 hectares arable land per person	2012
Communication and information technology	Mobile phones in use	20	56	United Nations	52,000,000 Mobile phone users; 69.3% of population use mobile phones	2010
	E-government readiness	102	193	United Nations	Measure of a country's e-government capabilities	2010
	Investment commitments in telecommunications (total for period shown)	33	134	World Bank	3,102.80 million dollars investment commitments in telecommunication projects with private participation (total for period shown)	2006-13
Demographics	Birth rate	96	195	United Nations	20.3 Births per 1000 population/Year	2005-10
	Population	17	223	United Nations	Population of 74,196,000 or Approximately 1.09% of the world's population	2009
	Population growth rate	96	230	United Nations	Population growth rate of 1.35%	2005-10
Economy	GDP (PPP) ³³⁹	18	193	World Bank	GDP (PPP)= 843.86 billion dollars	2009
	GDP (nominal) per capita	73	170	World Bank	GDP (nominal) per capita= \$5,441; Iran's GDP (nominal) per capita will reach US \$32,676 by 2050	2008
	Unemployment rate	75	World	United Nations	Unemployment rate of 11.3%; Ranked from highest unemployment rate to lowest	2009
Education	Adult literacy rate	47	World	United Nations	91% of adult population (age 15 & above) is literate; Total illiteracy rate of 6.2% of population in 2002 improving from 52.5% in 1976. Total literacy rate (age 6 & above): 92.7% in 2002; & School leaving age	2011
	Book titles published per year	7	World	Book titles published per country per year	65,000 Book titles published annually	2010
Energy	Energy intensity	1	World	International Energy Agency	2.5 times the Middle Eastern average in 2010; 14,120 tons of oil equivalent/\$1 million of GDP in 2006	2010
	Proven natural gas reserves	1	209	CIA World Fact book	Total proven reserves of 33.1 trillion cubic meters or 15.8% of the world's total reserves	2012
	Energy development index	2	64	International Energy Agency	Index measures a country's per capita energy consumption, use of modern fuels & population's access to electricity	2011
Environment and ecology	Happy planet index	81	178	New Economics Foundation	Happy planet index is a measure of the environmental efficiency of supporting citizens well-being; Iran's index: 47.23	2009
	Environmental performance index	78	153	Yale University/Columbia University	Iran's index=60.0	2010
	Internal renewable freshwater resources per capita	111	179	World Bank	1,659 cubic meter internal renewable freshwater resources per capita	2013
	Carbon dioxide emissions	42	198	World Bank	7.7 metric tons carbon dioxide emissions per capita	2010
Health	Health expenditure per capita (US \$)	80	188	World Bank	490 US \$ health expenditure per capita in 2012	2012
	Quality-of-life index	150	194	Economist Intelligence Unit	Survey was done indirectly &/or by estimations	2010
	Sustainable society index	97	World	SSI rankings for 2010	Sustainable Society Index measures three dimensions of human, environmental and economic well-being;	2010
Minerals industries	World's largest petroleum companies	2	World	Energy Intelligence	The Iranian government owned corporation of NIOC after Aramco which is the world's second largest petroleum company.	2008
	World's largest mining companies	23	World	World Bank	Iran's national mining corporation (IMIDRO) is the world's 23rd largest mining company with 0.6% of the world's total mining production.	2007
	Iron ore production	8	World	US Geological Survey	Annual production of 33 million tones	2009
	Industrial production growth rate	28	161	CIA World Fact book	Industrial growth rate of 4.0% annually; Alternatively put at 7.4% by Iranian government	2009

Table 4.2 International rankings of Iran

³³⁹ Gross domestic product (GDP) based on purchasing power parity (PPP)

4.3.1.1 International standards

This part provides a brief overview of the environmental issues of concern to Iran, the International Environmental Agreements to which Iran is a party, and relevant contacts within the government pertinent to the international agreements. Currently, Iran is party to the International Multilateral Environmental Agreements (MEA) listed below:

- **Convention on Biological Diversity (Biodiversity).** The objective of this convention is to conserve biological diversity, to sustainably use its components, and to ensure the fair and equitable sharing of the benefits arising out of the utilization of genetic resources³⁴⁰.
- **The Cartagena Protocol on Biosafety to the Convention on Biological Diversity.** On 29 January 2000, the Conference of the Parties to the Convention on Biological Diversity adopted a supplementary agreement to the Convention known as the Cartagena Protocol on Biosafety. The Protocol seeks to protect biological diversity from the potential risks posed by living modified organisms resulting from modern biotechnology. The Protocol contains reference to a precautionary and reaffirms the precaution language in Principle 15 of the Rio Declaration on Environment and Development. I.R. of Iran has signed this protocol on April 2001 and has presented more than 25 reports on national measures by February 2015³⁴¹.
- **United Nations Framework Convention on Climate Change (Climate Change, UNFCCC).** This convention aims to stabilize greenhouse gas concentrations in the atmosphere at a level that will prevent dangerous human interference with the climate system. In 1992 the UNFCCC was adopted as the basis for a global response to the problem³⁴².
- **Kyoto Protocol to the United Nations Framework Convention on Climate Change (Kyoto Protocol).** The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change. The major feature of the Kyoto Protocol

³⁴⁰ *Convention on Biological Diversity*, www.cbd.int/

³⁴¹ *The Cartagena protocol on Biosafety*, <https://bch.cbd.int/protocol>

³⁴² *United Nations Framework Convention on Climate Change*, www.unfccc.int/

is that it sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas (GHG) emissions.

- **United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa (Desertification).** This Convention aims to combat desertification and mitigate the effects of drought through national action programs that incorporate long-term strategies supported by international cooperation and partnership arrangements. Desertification is the degradation of dry lands. It involves the loss of biological or economic productivity and complexity in croplands, pastures, and woodlands³⁴³.
- **Convention on the International Trade in Endangered Species of Wild Flora and Fauna, Endangered Species Act (CITES).** CITES works to protect certain endangered species from overexploitation by means of a system of import/export permits. As an international agreement, its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. Annually, international wildlife trade is estimated to be worth billions of dollars and to include hundreds of millions of plant and animal specimens³⁴⁴.
- **Basel Convention on the Transboundary Shipment of Hazardous Waste (Basel Convention).** The Basel Convention strives to reduce transboundary movements of wastes subject to the Convention to a minimum consistent with the environmentally sound and efficient management of such wastes; to minimize the amount and toxicity of wastes generated and ensure their environmentally sound management as closely as possible to the source of generation; and to assist LDCs (least developed countries) in environmentally sound management of the hazardous and other wastes they generate³⁴⁵.
- **Montreal Protocol on Substances That Deplete the Ozone Layer (Montreal Protocol).** The Montreal Protocol works to control the emissions of substances that deplete the ozone layer. As a landmark

³⁴³ *United Nations Convention to Combat Desertification.* www.unccd.int/

³⁴⁴ *Convention on International Trade in Endangered Species of Wild Fauna and Flora,* www.cities.org/

³⁴⁵ *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal,* www.Basel.int/

international agreement designed to protect the stratospheric ozone layer, the treaty was originally signed in 1987 and substantially amended in 1990 and 1992. The Montreal Protocol stipulates that the production and consumption of compounds that deplete ozone in the stratosphere--chlorofluorocarbons (CFCs), halons, carbon tetrachloride, and methyl chloroform--are to be phased out by 2000 (2005 for methyl chloroform).

- **Protocol of 1978 Relating to the International Convention for the Prevention of Pollution From Ships, 1973 (Ship Pollution, MARPOL).** The objective of this Protocol is to preserve the marine environment through the complete elimination of pollution by oil and other harmful substances and the minimization of accidental discharge of such substances. The MARPOL Convention is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes.
- **Convention on Wetlands of International Importance Especially as Waterfowl Habitat (RAMSAR).** RAMSAR works to stem the progressive encroachment on and loss of wetlands now and in the future, recognizing the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value. The Convention on Wetlands (Ramsar, Iran, 1971) -- called the "Ramsar Convention" -- is an intergovernmental treaty that embodies the commitments of its member countries to maintain the ecological character of their Wetlands of International Importance and to plan for the "wise use", or sustainable use, of all of the wetlands in their territories³⁴⁶.
- **Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (Environmental Modification).** This Convention prohibits the military or other hostile use of environmental modification techniques in order to further world peace and trust among nations. This is a Multilateral agreement with 48 signatories prohibiting the hostile use of "environmental modification techniques" (any technique for changing -- through the deliberate manipulation of natural processes -- the dynamics, composition or

³⁴⁶ *Ramsar Convention on Wetlands*, www.ramsar.org/

structure of the Earth, including its biota, lithosphere, hydrosphere and atmosphere, or of outer space) with widespread and long-lasting effects.

- **United Nations Convention on the Law of the Sea (LOS, Law of the Sea).** LOS works to set up a comprehensive new legal regime for the sea and oceans; to include rules concerning environmental standards as well as enforcement provisions dealing with pollution of the marine environment. Navigational rights, territorial sea limits, economic jurisdiction, legal status of resources on the seabed beyond the limits of national jurisdiction, passage of ships through narrow straits, conservation and management of living marine resources, protection of the marine environment, a marine research regime and, a more unique feature, a binding procedure for settlement of disputes between States - these are among the important features of the treaty.
- **Convention on Fishing and Conservation of Living Resources of the High Seas (Marine Life Conservation).** This Convention aims to solve the problems involved in the conservation of living resources of the high seas. The development of modern technology has resulted in the overexploitation of resources in the high seas. No MEA Focal Point in Iran is provided specifically for the Marine Life Conservation Convention.

4.3.1.2 The extent of environmental problem

The scope of the environmental problems in Iran is vast, and research remains ongoing to determine the extent to which the government and NGOs are participating in the international environmental arena. It is clear; however, that Iran's environment is currently in a state of crisis. In 2009, Iran's own Department of the Environment (DOE) declared that it is one of the 10 most environmentally destructive countries in the world³⁴⁷. Tehran's population of over 12 million inhabitants, with 1.5 million tons of air pollutants produced annually, its destruction of the city's green areas from urbanization and industrialization, combined with its geography and altitude has become one of the most polluted cities in the world³⁴⁸.

³⁴⁷ Payvand Iran News, (2010), *Iran Environment in Grave Danger*, Access at: <http://www.payvand.com/news/10/apr/1289.html>

³⁴⁸ Green Party of Iran. *Iran Environmental Issues*, April 2000, Access at: <http://www.iran-e-sabz.org/news/iranenv.html>

In November 2010, Tehran's air pollution was at levels requiring the government to shut down schools, universities and government offices in order to protect public health. Health officials say "the thick haze has led to a 30 percent spike in hospitalizations from respiratory illness in recent days. According to a recent World Bank study, heavy pollution has cost the Iranian economy \$3.3 billion since March 2010³⁴⁹. Furthermore, the country is struggling with issues of population growth, deforestation, desertification, oil pollution in the Persian Gulf, wetland losses from drought, desalination, pollution of water sources, and considerable environmental degradation in the Caspian Sea³⁵⁰.

This continued decline of the state of the environment over many years has brought numerous health problems to the people of Iran, at great cost to the government. The World Bank estimates losses inflicted on Iran's economy as a result of deaths caused by air pollution at \$640 million, which is equal to 5.1 trillion Rials or 0.57 percent of the GDP. Diseases resulting from air pollution are inflicting losses estimated at \$260 million per year or 2.1 trillion Rials or 0.23 percent of the GDP on Iran's economy. While statistics on the cost of environmental degradation vary, it is clear the cost is immense³⁵¹.

*4.3.1.3 Policy and legislative context*³⁵²

The Islamic Republic of Iran has signed five important international documents including Agenda 21, the United Nations (UN) Millennium Declaration, the World Summit on the Information Society (WSIS) Declaration of Principles, and the WSIS Action Plan and Tunis Commitment.

The above documents create a framework of new concepts in understanding development and prosperity and insist on a wide spectrum of commitments in the fields of human rights, good governance and democracy. In accordance with these documents, each country agrees to fight poverty and to pave the way for and accelerate a dynamic economy. They also pledge to change consumption patterns,

³⁴⁹ J. Collins (2010), *On our Radar: Air Pollution Paralyzes Tehran*, New York Times, 3 Dec. 2010, Access at: <http://green.blogs.nytimes.com/2010/12/03/on-our-radar-air-pollution-paralyzes-tehran/>

³⁵⁰ Iran Rooyan, (2012), *Iran: international environmental agreements fact sheet*, Access at: <http://iranrooyan.org/wp-content/uploads/2012/02/Iran-EIA-Factsheet-3.pdf>

³⁵¹ Iran Rooyan, (2012), *Iran: international environmental agreements fact sheet*, Access at: <http://iranrooyan.org/wp-content/uploads/2012/02/Iran-EIA-Factsheet-3.pdf>

³⁵² Global information society watch (gisw), 2010, Iran, Access at: [www. Arsehsevom.net](http://www.Arsehsevom.net)

stabilizing the world's population at an acceptable level, improve health, provide shelter, integrate environment and development, protect the atmosphere, protect jungles, and limit desertification, amongst other things.

In the social field, empowering women, youth and children, the participation of indigenous people in processes, the participation of NGOs, paying attention to laborers and recognizing their unions are all important.

In the field of information and communications technologies (ICTs), with relation to WSIS (phases one and two), the following commitments are considered:

- Equal and free access for all.
- Widening access to global knowledge in relation to health and hygiene.
- Using ICTs to combat poverty and support indigenous products.
- Reducing the digital and gender gap by increasing the participation of women, and protecting children.
- ICT capacity building for all, especially for the youth and older women (highlighting permanent systems for E-learning and education).
- Digitalizing historical and heritage data.
- An emphasis on governmental collaboration with NGOs and the private institutions (i.e. on multi-stakeholder partnerships).
- The growth of small and medium-sized enterprises (SMEs).

4.3.2 Sustainable development in Iran according to religious concerns

Further to what has been discussed above about sustainable development concepts from a legislative point of view, in this part, that concepts are examined from religious aspect. As the dominant religion in Iran is Islam (Islam is the religions of 98% of Iranians. 89% of Iranians are Shi'a and 9% are Sunni), hence Quran has been chosen as the main sources to find out the position of environment and its exploitation in Islamic ethics.

4.3.2.1 Islam and the environment

It has often been observed that Islam cannot ordinarily be described as a religion and that it prescribes a lifestyle that goes beyond the performance of rituals. The word for religion (dm) is found in the Quran (anglicized spelling: Koran; this is Islam's sacred

text. Din in essence describes an integrated code of behavior which deals with personal hygiene, at one end of the spectrum, to our relationships with the natural order at the other. It provides a holistic approach to existence; it does not differentiate between the sacred and the secular and neither does it place a distinction between the world of mankind and the world of nature. However, this Islamic mode of expression is now severely attenuated, having been swept aside by the forces of history, into a domain which treats the natural world exclusively as an exploitable resource³⁵³. Islamic jurisprudence contains regulations concerning the conservation and allocation of scarce water resources; it has rules for the conservation of land with special zones of graded use; it has special rules for the establishment of rangelands, wetlands, green belts and also wildlife protection and conservation. Much of the traditional institutions and laws associated with sound environmental practice in Islam have fallen into disuse in course of time³⁵⁴.

4.3.2.2 *A glance at basics*

Islam is the name of the religion discussed in this contribution. A Muslim is a follower of Islam. The word Islam literally means submission or surrender, and a Muslim is one who surrenders his will to the will of God. The roots of Islamic environmental practice are to be found in the Quran and the guidance (Sunnah) of Prophet Muhammad. According to Islamic ethics, Prophet Muhammad is the last of the Prophets and is usually referred to by Muslims as the Messenger of God (Rasulullah). Over the centuries, Islamic practice has been elaborated by a succession of scholars and jurists responding to real problems experienced by the growing community of Muslims in various parts of the world. The Islamic worldview is based on the belief in the existence of an all-powerful creator who is the same God (Allah in Arabic) of the other monotheistic faiths, Judaism and Christianity³⁵⁵. Muslims learn from the Quran that God created the universe and every single atom and molecule it contains and that the laws of creation include the elements of order,

³⁵³ F. M Khalid (2002), *Islam and the Environment*, in *Encyclopedia of global environmental change*, Vol. 5: Social and economic dimensions of global environmental change, ed. Peter Timmerman, p. 332-339, John Wiley and Sons Ltd, Chichester, ISBN 0-471-97796-9

³⁵⁴ M. A. Jamil (1999), *A study on environmental issues with reference to the Quran and the Sunna*, Translated by: Dr. Lahcen Haddad. Publications of the Islamic education, scientific and cultural organization (ISESCO), Kingdom of Morocco, ISBN 9981-26-186-6

³⁵⁵ F. M Khalid (2002), *Islam and the Environment*, in *Encyclopedia of global environmental change*, Vol. 5: Social and economic dimensions of global environmental change, ed. Peter Timmerman, p. 332-339, John Wiley and Sons Ltd, Chichester, ISBN 0-471-97796-9

balance and proportion: "He created everything and determined it most exactly" (25:2)³⁵⁶ and "It is He Who appointed the sun to give radiance and the moon to give light, assigning it in phases ... Allah did not create these things except with truth. We [GOD] make the signs clear for people who know" (10:5)³⁵⁷.

4.3.2.3 *A general introduction to Islam's attitude towards the conception of the universe, nature, natural resources and the relation between man and nature*³⁵⁸

I. Whatever God has created in this universe was created in due proportion and measure both quantitatively and qualitatively. God says "Verily, all things have we created by measure³⁵⁹" and says "Everything to Him is measured³⁶⁰". God says, "...And produced therein all kinds of things in due balance³⁶¹". In the universe there is diversity and variety of forms, colors and functions. In the universe and its various elements there is fulfillment of man's interests and evidence of The Creator's greatness; He is who ascertains and determines all things, and there is not a thing He has created but celebrates and declares His praise. "He is who has spread out the earth for you and enables you to go about therein by roads (and channels) and has sent down water from the sky. With it have we produced diverse pairs of plants each separate from the others. Eat (for yourselves) and pasture your cattle; verily, in this are signs for men endowed with understanding³⁶²". Man is part of this universe, whose elements are complementary to one another in an integrated whole. However, man is a distinct part of the universe and has a special position among the other parts of the universe. The relation between man and the universe, as defined and clarified in the Quran is as follows:

- a. A relationship of utilization, development and subjugation for man's benefit and for the fulfillment of his interests.

³⁵⁶ The Holy Quran, Surat Al-Furqan, Verse 2

³⁵⁷ The Holy Quran, Surat Yunus, Verse 5

³⁵⁸ A. A. Bagader, A. T. E. El-Sabbagh, M. A. Al-Glayand, and M. Y. I. Samarrai (1994), *Environmental protection in Islam*, IUCN environmental policy and law paper, second revised edition, published by IUCN Switzerland and UK, ISBN: 2-88032-088-7, p.13, Access at: http://cmsdata.iucn.org/downloads/eplp_020reven.pdf

³⁵⁹ The Holy Quran, Surat Al-Qamar, Verse 49

³⁶⁰ The Holy Quran, Surat Al-Ra'd, Verse 8

³⁶¹ The Holy Quran, Surat Al-Hijr, Verse 19

³⁶² The Holy Quran, Surat Taha, Verse 53

- b. A relationship of meditation on, and consideration and contemplation of, the universe and what it contains.
- II. God's wisdom has ordained to grant man's inheritance on earth. Therefore, in addition to being part of the earth and part of the universe, man is also the executor of God's injunctions and commands. Man has been granted inheritance to manage and utilize the earth for his benefit, and for the fulfillment of his interests. He, therefore, has to keep, maintain and preserve it honestly, and has to act within the limits dictated by honesty.
- III. God has granted all of us the inheritance of all sources of life and resources of nature. Thus, the utilization and sustainable use of these resources is, in Islam, the right and privilege of all people. Hence, man should take every precaution to ensure the interests and rights of all others since they are equal partners on earth. Similarly, he should not regard such ownership and such use as restricted to one generation above all other generations. It is rather a joint ownership in which each generation uses and makes the best use of nature, according to its need, without disrupting or upsetting the interests of future generations. Therefore, man should not abuse, misuse or distort the natural resources as each generation is entitled to benefit from them but is not entitled to own them permanently.
- IV. The right to utilize and subjugate natural resources, which God has endowed upon man, necessarily involves a commitment on man's part to conserve them both quantitatively and qualitatively. According to Islamic Ethics, God has created all the sources of life and resources of nature so that man may realize the following objectives:
 - a. Contemplation and worship;
 - b. Inhabitation and construction;
 - c. Utilization;
 - d. Enjoyment and appreciation of beauty.
- V. It follows that man should not distort the environment because it must remain permanently suitable for human life and settlement. Nor should he use natural resources irrationally or in such a way as to destroy living resources or spoil their habitats and food bases.

VI. The attitude of Islam to the environment, the sources of life and the resources of nature is a positive attitude in as much as it is based on protection and prohibition of abuse and destruction; it is also based on construction and development. This is clear in the idea of revival and restoration or recovery of lands through agriculture, cultivation and construction. God says, "It is He who hath produced you from the earth and settled you therein"³⁶³.

4.3.2.4 *Protection and conservation of all basic natural resources*

God's wisdom, as Muslims believe, has ordained that some creatures shall serve others. Followers of Islam perceive God's providence and wisdom everywhere in the universe, attesting to His greatness, omnipotence and omniscience as "The Wise Maker". They believe that God's wisdom has also ordained that all creatures shall be in the service of mankind. The Quran has made it clear that each known or unknown creature in the universe performs two major functions: a social function in the service of mankind and a religious function in so far as it evidences The Maker's omnipresence, wisdom, omniscience and omnipotence³⁶⁴. The following is a description of the basic natural elements:

A. Water

God created water as the source and origin of life. God says, "We made from water every living thing"³⁶⁵. Plants, animals and man all depend on water for life and existence. Without it, their lives would cease to exist or continue. God says, "Behold! In the rain which God sends down from the skies, and the life which he gives therewith to an earth that is dead..."³⁶⁶. "And He also says, "It is He who sent down rain from the skies; with it we produce vegetation of all kinds"³⁶⁷. In addition to this vital function, water has another socio-religious function to perform which is purgation of the body and clothes from all dirt, impurities and defilement so that man may encounter God clean, pure and purged. God has also shown us other functions of sea and ocean water. It represents a suitable biotope for many organisms and

³⁶³ The Holy Quran, Surat Hud, Verse 61

³⁶⁴ F. Khalid (2010), *Islam and the environment ethics and practice*, the 15th general conference on The Environment in Islam, Amman, 27-29 September
Access at: <http://www.ammanmessage.com/EnvConference/018.pdf>

³⁶⁵ The Holy Quran, Surat Al-Anbya, Verse 61

³⁶⁶ The Holy Quran, Surat Al- Baqarah, Verse 164

³⁶⁷ The Holy Quran, Surat Al-An`am, Verse 99

creatures which play vital roles in the development of this world and the perpetuation of life.

Conservation of this vital element is undoubtedly the basis for the preservation and continuation of life in its various forms whether vegetative, animal or human. Whatever fulfills and helps to achieve the basic necessities is itself a necessity. Therefore, any attempt at marring the vital and social functions of this element, whether by spoiling or polluting it with any material that would make it an unsuitable environment for some living organism or any such attempts to mar its function as the source of life, will necessarily lead to a complete halt or cessation of life itself. The juristic rule is "what leads to the forbidden is itself forbidden". Owing to the importance of this vital element as the main source of life, God made its use the privilege of all human beings, without discrimination. From Islamic point of view, all mankind is entitled to use it without monopoly, compulsion, coercion, corruption or abuse. God said, "And tell them that the water is to be divided between them³⁶⁸".

B. Air

This element is no less important than water for the perpetuation and preservation of life. The air may also have other functions which man does not perceive or which are not of immediate interest to him. Referring to the Quran, God sends the winds as a sign of mercy, benevolence and good omen. Likewise, the Quran attaches a vital importance and a great function to the winds namely that of pollination. God said, "And we send the fecundating winds³⁶⁹". Winds are also clear evidence of God's omnipotence, bounty, provision and perfection. He also said, "Behold! In the creation of the heavens and the earth; in the alternation of the Night and the Day; in the sailing of the ships through the Ocean for the profit of mankind; in the rain which He sends down from the skies, and the life which He gives therewith to an earth that is dead; in the beasts of all kinds that He scatters through the earth, in the change of the winds, and the clouds which they trail like their slaves between the sky and the earth; — here indeed are signs for a people who are wise³⁷⁰".

³⁶⁸ The Holy Quran, Surat Al- Qamar, Verse 28

³⁶⁹ The Holy Quran, Surat Al- Hijr, Verse 22

³⁷⁰ The Holy Quran, Surat Al- Baqarah, Verse 164

Since the air performs all these vital and social functions, it follows that its conservation, pure and unpolluted, is an integral part of the conservation of life itself which is one of the main objectives of Islamic jurisprudence (Shariah). The juristic rule is "what fulfills and satisfies necessities is itself a necessity". Therefore, any attempt at polluting it or marring its function or even spoiling it is considered an attempt at hindering God's wisdom and creation. This equally hinders and cripples man's role in the development of this world.

C. Plants and animals

No one can doubt the importance, great use and benefit of plants and animals for mankind. In addition, the Quran mentions the aesthetic and decorative functions of these creatures in addition to their other functions and, since peace of mind is one of the Islamic requirements which should be fully satisfied. God in creating all plants and animals provides pleasure and enjoyment to man so as to satisfy his peace of mind, a factor which is essential for man's proper functioning and full performance. The Quran also mentions other functions which these creatures perform and which man may not perceive, namely the mandatory functions of worshipping God, declaring His praise and bowing down to Him. God said, "Seest thou not that to God bow down in worship all things that are in the heavens and on the earth — the sun, the moon, the stars, the hills, the trees, the animals ..." ³⁷¹ and He says, "Whatever beings there are in the heavens and the earth do prostrate themselves to God — with good will or in spite of themselves ³⁷²".

Islam emphasizes all measures for the survival and perpetuation of these creatures so that they can fully perform the functions assigned to them, for He considers them living communities, exactly like mankind. God says "There is not an animal (that lives) on the earth, or a being that flies on its wings, but (forms part of) communities like you ³⁷³".

Islam looks upon these creatures in two ways:

³⁷¹ The Holy Quran, Surat Al- Haj, Verse 18

³⁷² The Holy Quran, Surat Al-Ra`d, Verse 15

³⁷³ The Holy Quran, Surat Al-An`am, Verse 38

- As living creatures in themselves attesting to God's wisdom and omnipotence;
- As creatures subjected in the service of man and playing a vital part in the development of this world.

Hence the necessity of conserving and developing them both for their own sake and for the benefit of mankind is clear.

4.3.2.5 Islamic principles and institutions governing the protection and conservation of the environment

As the Muslim interaction with the environment evolved, it manifested into a range of rules and institutions. The following is a brief summary of how **the Islam** developed in this area over the past 1400 years³⁷⁴.

Legislative principles

- [1]. Allah is the sole owner of the earth and everything in it. People hold land on usufruct - that is for its utility value only. There is a restricted right to public property.
- [2]. Abuse of rights is prohibited and penalized.
- [3]. There are rights to the benefits derived from natural resources held in common.
- [4]. Scarce resource utilization is controlled.
- [5]. The common welfare is protected.
- [6]. Benefits are protected and detriments are either reduced or eliminated.

Institutions

- [1]. People who reclaim or revive land (*ihya'almawat*) have a right to its ownership.
- [2]. Land grants (*iqta'*) may be made by the state for reclamation and development.

³⁷⁴ F. Khalid (2010), *Islam and the environment ethics and practice*, the 15th general conference on The Environment in Islam, Amman, 27-29 September
Access at: <http://www.ammanmessage.com/EnvConference/018.pdf>

- [3]. Land may be leased (*ijara*) for its usufruct by the state for its reclamation and development.
- [4]. Special reserves (*hima*) may be established by the state for use as conservation zones.
- [5]. The state may establish inviolable zones (*harim*) where use is prohibited or restricted. Every settlement has a right to create such zones managed by the people and where use is severely restricted. Additionally, it is permitted to establish these zones adjacent to sources of water and other utilities like roads and places of public resort.
- [6]. Mecca and Medina are known as the Two Inviolable Sanctuaries (*al-haramain*) where trees cannot be cut down and animals are protected from harm within their boundaries. They serve as examples of best practice.
- [7]. Charitable endowments (*awqaf*) may be established with specific conservation objectives.

4.3.2.6 General rules for protecting the environment from harm

Islamic jurisprudence includes many rules that serve as the foundation of many regulations and laws concerning sustainable development. For example³⁷⁵:

- **“Do no harm”**: This means that a human being may not cause harm to himself or to others. And he may not sustain harm as a result of the acts of others. Each person is entitled to use water for drinking and personal purposes, but may not pollute or waste it. Each environmental right has a corresponding environmental duty.
- **“Warding off evil takes precedence over bringing benefits”**: If an act that a person intends to do brings benefits but could also cause major harm to others, such an act is forbidden in Islam. For example, if a state dumps chemical waste in the oceans, it gains benefits, but causes harm to sea life and humans. Therefore, such an act is forbidden.

³⁷⁵ M. Nouh (2011), *Sustainable Development in Muslim Context*, Access at: http://www.earthcharterinaction.org/invent/images/uploads/11%20Manuscrip_Muhammad.pdf

- **“Sustaining personal harm to ward off public harm”**: the damage resulting from avoiding the frequent use of pesticides and relying on biological rather than chemical resistance is much less than the damage inflicted on many creatures as a result of polluting the soil with chemicals, adversely affecting human beings and animals as well as killing micro-organisms in the soil that are needed for its fertility.
- **“Harm shall be removed”**: The causes of harm must be removed. When ships dump waste in the sea, they pollute and destroy sea life and disturb the environment balance.

The entity causing harm must take all necessary measures to remove the adverse effects of its acts, because they destroy the earth. God pledged to severely torture those who do mischief on the Earth. This warning causes people to control their acts and bear responsibility for them.

4.3.2.7 *General rules for not wasting the earth’s resources*

A further important Islamic principle related to the environment is the Islamic prohibition concerning thoughtless consumption; that is, wastefulness and extravagance. Wastefulness is not only the thoughtless consumption of natural resources; it is at the same time disrespectful towards God, the Creator and Owner of all the bounties- according to Islamic beliefs. For this reason, in Islam, eating and drinking of licit food is lawful, but wastefulness is forbidden. At this age of science and technology than at any other, it has been widely proven that the world’s resources are limited. Extravagance and over-consumption will affect not only the current generation, but forthcoming generations. Therefore human beings are compelled to be aware and sensitive concerning this matter³⁷⁶. In the Holy Quran, God says: “Verily we have created all things in proportion and measure”³⁷⁷.

³⁷⁶ I. Ozdemir (2002), *An Islamic Approach to the Environment*, Access at: http://www.crescentlife.com/spirituality/islamic_approach_to_environment.htm (Ibrahim Ozdemir is a professor at the Divinity School of Ankara University, Turkey. He received his Ph.D. degree from the Middle East Technical University, Graduate School of Social Sciences. Presently, He is a Visiting Luce Professor of Abrahamic Religions at University of Hartford & Hartford Seminary. His major interests are Islamic Ethics, environmental philosophy and environmental ethics. He is an interfaith and environmental activist. He contributes regularly to a host of Western and Islamic scholarly journals).

³⁷⁷ The Holy Quran, Surat Al- Qamar, Verse 49

Considering limited resources in the Earth, careful preservation of the Earth's balance is a human obligation. The science of ecology shows that the universe contains extremely sensitive ecosystems and balances and that man, according to Islamic ethics, has therefore to maintain these ecological systems. Modern man only came to realize the environmental problems with the help of ecology when the problems became apparent, whereas the Quran draws our attention to this balance in particular, which everyone is now trying to maintain. The obligation of maintaining this balance, which is in fact man's work, whom God created on "the best of patterns," and who is His vicegerent or deputy on earth. No Muslim is therefore allowed to spoil the universe's balance, nor any Muslim can look on indifferently while other's spoil it³⁷⁸.

Islam permits utilization of the environment, but this should not be arbitrary. Wastefulness and extravagance are prohibited by God: "O children of Adam! Wear your beautiful apparel at every time and place of prayer; eat and drink, but waste not by excess, for God loves not the wasters"³⁷⁹.

The eating and drinking in this verse refer to utilizing the resources necessary for the continuation of our lives. This should not be uncontrolled. The elements that support life should be conserved so that they can be utilized continuously. More than this, such conservation should be unselfish. That is, it should not only have human interests in view. Thus, while utilizing the world's bounties, the Muslim should not do so with an unconstrained and irresponsible approach to consumption. On the contrary, he is obliged to base all such actions and the measure of his consumption on Islamic economic principles. Every passing day it is becoming better understood that the world's resources are limited. The following commands of the Quran are striking at a time feasible development and economic models are being widely discussed³⁸⁰: "Those who, when they spend, are not extravagant and not niggardly, but hold a just [balance] between those extremes"³⁸¹.

³⁷⁸ F. Khalid (2010), *Islam and the environment ethics and practice*, the 15th general conference on The Environment in Islam, Amman, 27-29 September

Access at: <http://www.ammanmessage.com/EnvConference/018.pdf>

³⁷⁹ The Holy Quran, Surat Al- A'raf, Verse 31

³⁸⁰ I. Ozdemir (2002), *An Islamic Approach to the Environment*,

Access at: http://www.crescentlife.com/spirituality/islamic_approach_to_environment.htm

³⁸¹ The Holy Quran, Surat Al- Furqan, Verse 67

The Quran commands us to eat and drink, but waste not by excess, for God loves not the wasters³⁸² so that we become accustomed to avoiding wastefulness and extravagance in our daily consumption of food and drink. It frequently points out that frugality and consuming what one has without being over-lavished is the measure of what God loves³⁸³.

4.3.2.8 Conclusion

According to Islamic Ethics, the rights to benefit from nature are connected to obligation and maintenance or preservation of the resource. A lot of environmental destruction is caused by people's lack of knowledge of what their Creator demands of them. People especially those in Islamic countries need to understand that the conservation of the natural environment is a religious responsibility required by the GOD³⁸⁴. Allah has stated. "And do good as Allah has been good to you. And do not seek to cause corruption in the earth. Allah does not love the corrupters³⁸⁵". Islam maintains that God is the absolute creator and sustainer of the universe and the resources within, all elements of nature and the associated resource. Allah said "nay, we let them and their forebears enjoy the good things of life, until they outlive their prosperity. Can they not see that we visit the land under their control and gradually curtail its boundaries all around them? Is it, then, they who will prevail?³⁸⁶". Islam advocates that "environmental disruption of any kind must be avoided for two reasons. First, it is an ethical command of Islamic jurisprudence and law and second, it is essential for protecting the public interest and universal common good of all mankind".

Environmental awareness and the protection of natural resources are an integral part of Islamic beliefs. Muslims have to utilize natural resources in a sustainable manner in order to ensure that Allah's Bounties to continue.

³⁸² The Holy Quran, Surat Al- A`raf, Verse 31

³⁸³ G. B. Muhammad, R. Sh. Kazemi and A. Ahmed (2010), *The Holy Quran and the Environment*, The royal AAL Al- Bayt Institute for Islamic Thought, Jordan, Book 6, ISBN: 978-9957- 428- 38-9

³⁸⁴ U. A. Umar and M. F. Khamidi (2013), *Green and sustainable development in an Islamic perspective*, Access at:

http://www.researchgate.net/profile/Usman_Aminu_Umar/publication/233996739_GREEN_AND_SUSTAINABLE_DEVELOPMENT_IN_AN_ISLAMIC_PERSPECTIVE

³⁸⁵ The Holy Quran, Surat Al- Qasas, Verse 77

³⁸⁶ The Holy Quran, Surat Anbiyaa, Verse 44

4.3.3 Sustainable development according to national agreements and regulations in Iranian mining sector

To evaluate the status of sustainable development in laws and regulations of the Islamic Republic of Iran, following Persian sources have been reviewed: the general policies of the Regime, the constitution, the Five-Year Development Plans of the country, mines Act, regulations on mining Act, laws and regulations on mining engineering organization, mining safety regulations, environmental preservation and improvement Act, the statutes of the insurance Fund's investment in mining activities and statues of Mine and Industry Bank from the perspective of the principles of sustainable development.

4.3.3.1 The general policies of the Islamic Republic of Iran

General policies of the system are a set of strategies and political measures determined to achieve the goal-oriented values and goals of the constitution. The policies are apart from government orders in the way that court rulings have no right to invoke them. Iran Islamic Council Parliament is also responsible for legislation within the policies³⁸⁷.

General policies of the Islamic Republic of Iran for participation in the cooperative sector were issued by the supreme leader³⁸⁸ of the country³⁸⁹, including: economic security, energy, water resources, mining, natural resources, transportation, prevention and mitigation of natural hazards and disasters, legal security, the fight against drugs , telecommunication, general policies of Article 44³⁹⁰ of the Iranian

³⁸⁷ <http://www.ensani.ir/fa/content/221479/default.aspx>

³⁸⁸ Ayatollah Seyyed Ali Khamenei is a Shia Cleric and the second and current (2016) Supreme Leader of Iran since 1989.

³⁸⁹ <http://parliran.ir/index.aspx?siteid=1&pageid=3367>

³⁹⁰ Article 44 of Constitution of Islamic Republic of Iran states: The economy of the Islamic Republic of Iran is to consist of three sectors: state, cooperative, and private, and is to be based on systematic and sound planning. The state sector is to include all large-scale and mother industries, foreign trade, major minerals, banking, insurance, power generation, dams and large-scale irrigation networks, radio and television, post, telegraph and telephone services, aviation, shipping, roads, railroads and the like; all these will be publicly owned and administered by the State. The cooperative sector is to include cooperative companies and enterprises concerned with production and distribution, in urban and rural areas, in accordance with Islamic criteria. The private sector consists of those activities concerned with agriculture, animal husbandry, industry, trade, and services that supplement the economic activities of the state and cooperative sectors. Ownership in each of these three sectors is protected by the laws of the Islamic Republic, in so far as this ownership is in conformity with the other articles of this chapter, does not go beyond the bounds of Islamic law, contributes to the economic growth and progress of the country, and does not harm society. The [precise] scope of each of these sectors, as well as the regulations and conditions governing their operation, will be specified by law.

constitution³⁹¹, the general policies of the five-year economic, social and cultural development plan, Islamic Republic of Iran vision in 1404 Hijri, etc.

Table 4.3 shows typical examples of these policies referring to the principles of sustainable development.

³⁹¹ The general policies pertaining to article 44 of the constitution of the Islamic Republic of Iran is available under: <http://www.princeton.edu/irandataportal/laws/labor-civilsociety/principle-44-policies/>

Title	Description	Date of Approval
General policies of the Third Five-Year Economic, Social and Cultural Plan	Economic: 8. No preference for governmental and public sector which have economic activities rather than the private institutions and cooperatives in the enjoyment of privileges and access to information	May, 22, 1999
General Policies of Regime on Economic security	2. The purpose of investment security is promoting the general welfare and prosperity which is predisposing economic justice and eliminates poverty in the country. Tax laws and regulations and other matters that may aid that goal are the mandatory duty of the government and parliament.	February, 1, 2001
General Policies of Regime on Energy	b. General policies of other energy sources 1. Diversification of country energy sources and use it in compliance with environmental issues and trying to increase the share of renewable energy with the priority of the water energy	February, 1, 2001
General Policies of Regime on Water Resources	1. Creating a comprehensive system to manage the entire water cycle, based on the principles of sustainable development and land use planning in the basins of the Country 3. Increasing the level of water harvesting and minimize normal and abnormal water losses in the country in any way possible	February, 1, 2001
General Policies of Regime on Mining	2. Foster creativity and innovation, access to new technologies, promotion of education and training level of human resources and deepen the research and development of basic, economic, engineering, environmental and marine geology for utilization of the country minerals reserves	February, 1, 2001
General Policies of Regime on Natural Resources	1. Establishing a national commitment to renewable natural resource restoration, development of suitable vegetation for protection and increased productivity, acceleration of the production of these resources, promoting the public culture and people's participation in this field 3. Reform exploitation of natural resources and harness of these resources unsustainability factors and efforts to maintain and develop them	February, 1, 2001
Vision of the Islamic Republic of Iran in 1404 Hijri	Iranian society on the horizon of this vision will have features such as: - Having the health, welfare and food security, social security, equal opportunities, appropriate distribution of income, strong family foundation, free from poverty, corruption, discrimination and benefited from a favorable environment	November, 4, 2003
General Policies of the Fourth Development Plan of the Islamic Republic of Iran	12. Trying to create social justice and equal opportunity, and promotion of indicators such as education, health, food security, increase in per capita income and combat with corruption 19. Land use planning is based on the following principles: - Promote social justice and regional balance - Environmental protection and restoration of natural resources	December, 2, 2003
General Policies of Article 44 of the Islamic Republic of Iran Constitution	- Expansion of public ownership in order to secure social justice - Promoting the general level of employment	May, 22, 2005
General Policies of Employment	3. Creating sustainable employment opportunities with emphasis on the use of technology development and knowledge based economy and future predicting of their changes in the national and global level	July, 19, 2011
General Policies on Land Use Planning	h. Preservation, restoration and optimal utilization of capitals, renewable natural resources and environmental protection in development plans	December, 12, 2011
General Policies on Agriculture	1. Sustainable agricultural development with conservation of basic natural resources and preservation and empowerment of the human resource	December, 19, 2012

Table 4.3 Examples of the attention of the general policies of the Islamic Republic of Iran according to the principles of sustainable development³⁹²

³⁹² The General Policies of the Regime, Legal vice Presidency, Deputy Editor, expurgate and publish rules and regulations, June 2013, ISBN:978-600-6747-55-2 (Persian)

4.3.3.2 *Constitution of the Islamic Republic of Iran*

The constitution of a country is the highest legal document and it is a base for setting other rules and regulations. The constitution is in fact the political principle, structure, hierarchy, status and power of the government of a country and determines and ensures the rights of citizens. No law shall be inconsistent with the constitution. Constitution of “Mashrooteh” was the first constitution of Iran, which was signed on Sunday, December, 30, 1906 by “Mozafar-al-Din Shah Qajar- the Persian king”. Subsequently, the amendments to the constitution was prepared and passed by the Parliament and Mohammad Ali Shah Qajar the Persian king signed it on Monday, October, 7, 1907. The Act and its amendments were the Iranian constitution until 1978 when the monarchy was abolished in Iran. The Constitution of the Islamic Republic of Iran was prepared after the Islamic revolution in 1978 and it was recognized after receiving the majority of votes in the referendum on Friday & Saturday, March, 30 & 31, 1979. The law was revised in 1989 and in the referendum on Friday, July, 28, 1989 Iranian constitution was approved by a majority of the Iranian people³⁹³.

Some specific items of the basic principles of the constitution of Islamic Republic of Iran related to the basis of sustainable development (in the case of social, economic and environmental) will be mentioned below³⁹⁴:

A. Social

Article 19: All people of Iran, whatever the ethnic group or tribe to which they belong, enjoy equal rights; and color, race, language do not bestow any privilege.

Article 30: The Government is obliged to provide free of charge educational facilities for all up to the end of high school and to expand free facilities for higher education up to the limit of the self-sufficiency.

B. Economic

Article 43: The economy of the Islamic Republic of Iran, with its objectives of achieving the economic independence of the society, uprooting poverty and deprivation, and fulfilling human needs in the process of development while preserving human liberty, is based on the following criteria:

³⁹³ <http://en.parliran.ir>

³⁹⁴ Constitution of the Islamic Republic of Iran, Access at: <http://www.alaviandassociates.com/documents/constitution.pdf>

1. The provision of basic necessities for all citizens including housing, food, clothing, hygiene, medical treatment, education, and the necessary facilities for the establishment of a family;
2. The utilization of sciences and technologies and training skilled personnel with respect to the needs for development and promotion of country's economy

C. Environmental

Article 50: The preservation of the environment, in which the present as well as the future generations have a right to flourishing social existence, is regarded as a public duty in the Islamic Republic of Iran. Economic and other activities that inevitably involve pollution of the environment or cause irreparable damage to it are therefore forbidden.

4.3.3.3 Rules, regulations, special laws and statutes relating to mining

In this regard, several sources were studied in Persian, related issues to sustainable development principles were extracted from and the most important ones are mentioned below:

A. Mining Act (passed by the Islamic Consultative Assembly on May, 17, 1998)

In order to achieve sustainable development in the mining sector, the government is obliged to establish "Mining Activities Investment Insurance Fund" at the Ministry of Mines and Metals for the compensation of part or all of the probable damages arising from the failure of exploration and existing investments, in accordance with the statute which will be approved by the Board of Ministers and if necessary the government offer State's share of the required credits in annual budget every year with respect to production policies³⁹⁵.

B. Bylaw Mining Act (Approved by the ex-Ministry of Mines and Metals on February, 10, 1999)

Article 63: Implementing each step of exploration and exploitation requires compliance with environmental regulations.

Article 64: In the implementation of the commitments and assignments of the operation license holders', the Ministry of Mines and Metals will supervise mining operations based on Mining Act; it's Bylaw and issued instructions. Supervision and monitoring of mining operations includes all regulatory affairs that lead to health and

³⁹⁵ A. R. Mirzaei (2011), *Margin Reticulum of Rules and Regulations for Mines*, Behnami publications, Tehran, ISBN: 978-600-5380-31-6 (Persian)

safety of employees and miners, compliance with approved plan, fulfillment of the license holders' obligations, controlling the performance of technical responsible, preservation of mineral reserves, mineral reserves exploitation and other items that make good performance of Mining Act and it's Bylaw as well as observance of safety and protection in the mines³⁹⁶.

C. The law of Iranian Mining Engineering Organization (approved by the Ministry of Industries and Mines in 2003)

Article 2: The objectives and tasks of mining engineering organization include:

Making laws in order to ensure observance of the principles of safety, health, suitable productivity, environmental protection and economic efficiency and supervision of its implementation³⁹⁷.

D. Mine Safety Regulations Act of 2001

Article 8: Observance of all rules and regulations adopted by the Supreme Technical Protection Council on the technical safety tips related to accessories, goods and mining equipment are indispensable.

Article 18: Subject to Article 92 of the Labor Law of the Islamic Republic of Iran, the medical and health examination of employees is mandatory in mines.

Article 24: According to the regulations of individual protection approved by the Supreme Technical Protection Council, all miners entering the mines- depending on type and condition of work- must be equipped with proper personal protective equipment³⁹⁸.

E. Environmental Conditions of Mining Activity (Implementing Directive No. 59/581 / T 23806 H dated on February, 10, 1999 the rules of procedure of paragraph "c" of Article 104 of the Third Development Plan)

Article 3: The licensing of exploration and exploitation of minerals in new wildlife refuges and new protected areas is subject to agreement between the Department of

³⁹⁶ A. Agha Nabati and Sh. Shariati (2007), *The Complete Set of Rules and Regulations of Iran Mining Sector and Mineral Industries*, Education Centre and Industrial Research of Iran, ISBN: 978-964-2841-14-1 (Persian)

³⁹⁷ Ministry of Industry and Minerals (2003), *Law and Executive Regulations of Mining Engineering, Mine Safety Supervision Bureau, Act of 2003* (Persian)

³⁹⁸ Ministry of Industry and Mines (2001), *Law and Executive Regulations of Mining Engineering, Mine Safety Supervision Bureau, Act of 2001* (Persian)

Environment and the Ministry of Industries and Mines, compliant with the provisions of the Law on the protection and improvement of the environment (Act of 1974) and conducting environmental assessments based on environmental impact assessment models and this regulations.

Article 4: The Ministry of Industry and Mines is required to inquiry from the Department of Environment for following point. DOE is required to respond the inquiry within one month. Later than this time, it will be inferred as agreement:

A: Issuance of all licenses for exploration

B: Extending the operation license of mines within the areas under supervision of the Iranian Department of Environment³⁹⁹

C: Issuance of operation license for the mines which do not need to be explored

Article 6: The licensee shall operate and commit to repair the exploration or exploitation area at the end of their respective licenses.

Article 7: The operator is required to comply with all the rules and regulations and environmental standards in the country⁴⁰⁰.

F. Environmental Conditions of Mining Activity (passed by the Council of Ministers on April, 10, 2005)

Article 2: Issuance, renewal and extension of licenses for exploration of class one mines are prohibited in following places: national parks and natural monuments and national wetlands referred to Ramsar Convention (February 1971) and those of wildlife refuges and protected areas referred to the paragraph "a " of agreement between the Ministry of industries and Mines and the Department of Environment (dated on October, 13, 1975) and preserved rivers, open pit mines in the area of forests and pastures and within the range of areas approved as municipal.⁴⁰¹.

G. Statute of Mining Activities Investment Insurance Fund

Article 4: The Fund aims to achieve sustainable development in the mining sector and to compensate all or part of the damages caused by the failure of exploration and existing investments.

³⁹⁹ These areas include: national parks, protected areas, wildlife refuges and natural heritage sites.

⁴⁰⁰ A. Agha Nabati and Sh. Shariati (2007), *The Complete Set of Rules and Regulations of Iran Mining Sector and Mineral Industries*, Education Centre and Industrial Research of Iran, ISBN: 978-964-2841-14-1 (Persian)

⁴⁰¹ A. R. Mirzaei (2011), *Margin Reticulum of Rules and Regulations for Mines*, Behnami publications, Tehran, ISBN: 978-600-5380-31-6 (Persian)

H. Statute of the Bank of Industry and Mine

Article 4: The purpose of the Bank-as a business agency-is using the banking operations capabilities-investing in the direction of the country's economic development, providing the perfect platform for the presence and participation of non-governmental organizations with the use of all facilities including the appropriate tools, processes and institutions in the field of new technologies, industries, mines and related services⁴⁰².

4.3.3.4 Environmental protection and improvement law (approval on June, 18, 1974 and amendments on July, 19, 1992

The law was approved on June, 18, 1974 and subsequently its amendments were approved on July, 19, 1992. Its three main and important articles related to research topic are as follows:

Article 1: Protection and recovery and rehabilitation of the environment and prevention and prohibition of any form of pollution and any malicious actions that disturb the balance and proportion of the environment as well as all matters relating to wild animals and aquatic animals of domestic water are the responsibilities of the Department of Environment.

Article 3: A) Issuing any licenses for mineral exploration and exploitation of natural areas as national parks, national wildlife refuges and protected areas has been designated, subject to the approval of the Supreme Environmental Protection Council.

Article 9: Any action that causes environmental pollution is prohibited. Environmental pollution means distribution or mixing of foreign substances into water, air, soil, or ground to the extent which its physical, chemical or biological quality is harmful to human, other living creatures, plants or monuments and buildings⁴⁰³.

⁴⁰² A. Agha Nabati and Sh. Shariati (2007), *The Complete Set of Rules and Regulations of Iran Mining Sector and Mineral Industries*, Education Centre and Industrial Research of Iran, ISBN: 978-964-2841-14-1 (Persian)

⁴⁰³ A. Agha Nabati and Sh. Shariati (2007), *The Complete Set of Rules and Regulations of Iran Mining Sector and Mineral Industries*, Education Centre and Industrial Research of Iran, ISBN: 978-964-2841-14-1

4.3.3.5 Rules and regulations of the first to fifth five-year development plans of the Islamic Republic of Iran

For many years, medium-term economic planning has played an important role in Iranian economic life. Before the Iranian revolution, the government designed and implemented several five-year and seven-year economic plans, focusing on private and public institutions' interactions, their investment requirements, structural reforms, and stabilization policies to achieve sustainable economic growth. With the emergence of the Islamic Republic of Iran in 1979, followed by an end to the eight-year war with Iraq, the government concentrated on constructing and carrying out medium-term economic plans.

The Islamic Republic carried out its first five-year economic plan (FYDP), approved by the Parliament on 31 January 1990, focusing on the reconstruction of damaged infrastructures. The plan also aimed at tackling the inefficient public organizations and the reluctant private institutions, both suffering from rapidly changing economic policies and uncertainty. After a one-year delay from the end of the first FYDP, the authorities initiated the second FYDP in 1996. Nevertheless, the plan remained impractical and was only partially implemented. The unsuccessful first and second FYDPs prompted the 3rd FYDP to strengthen the initial but necessary structural reforms, including promotion of the private institution, development of private domestic and international banks and insurance companies, and substitution of tariffs for quantitative trade restrictions. The 4th FYDP was comprehensive, contained abundant quantitative targets, and constituted the first of the four pillars of a 20-year economic and social vision to significantly upgrade Iranian economic, political, and social international status. The 4th FYDP underscored a smaller government role in the economy, drew attention to enterprise privatization, and stressed more reliance on market forces. After the 4th FYDP, the government deliberated on a 5th FYDP with many targets that were much less quantitative. This was really only a compilation of wishes and desires⁴⁰⁴.

⁴⁰⁴ R. Ghasimi (2012), *The Iranian Economy under Its 4th and 5th Five Year Development Plans*, Journal of Money and Economy, Vol. 7(1)/2012, p. 161-186, Access at: <http://muftah.org/the-iranian-economy-under-the-countrys-4th-and-5th-five-year-development-plans/#.VJftqcCCA>

Due to comprehensiveness of these plans, this part of the dissertation only presents a number of significant rules in the first to the fifth five-year plans about the economic, social and cultural development of the Islamic Republic of Iran and administrative regulations concerning the principles of sustainable development. It is notable that the simultaneous consideration of environmental, social and economic consideration concerns separately from each individual consideration. This means that cases are not common, i.e. none of the five items are repeated in other cases.

The numbers of these cases are tabulated in table 4.4 in four categories; namely: environmental considerations, social considerations, economic considerations, and simultaneous consideration of aforementioned three considerations.

Description	cases
Environmental considerations	35
Social considerations	12
Economic considerations	10
Simultaneous consideration of environmental, social and economic	5

Table 4.4 Number of socio-eco-environmental considerations in the first till the fifth FYDPs in Iran

To be more precise, the cases were categorized according to the number of the plan, mentioned in. As can be seen in table 4.5, the first FYDP with 2 cases, and the fourth FYDP with 25 cases have respectively the lowest and the highest number of cases among all FYDPs.

Considerations	Number of cases in plan				
	first	second	third	fourth	fifth
Environmental	2	3	6	16	8
Social	----	----	1	6	5
Economic	----	----	4	1	5
Environmental, social and economic simultaneous	----	1	2	2	----
Total	2	4	13	25	18

Table 4.5 Number of each socio-eco-environmental considerations in the first till the fifth FYDPs in Iran

Figure 4.4 shows the share of each consideration in each FYDP. Environmental considerations with 35 cases have the highest number, while socio-eco-environmental with 5 has the lowest.

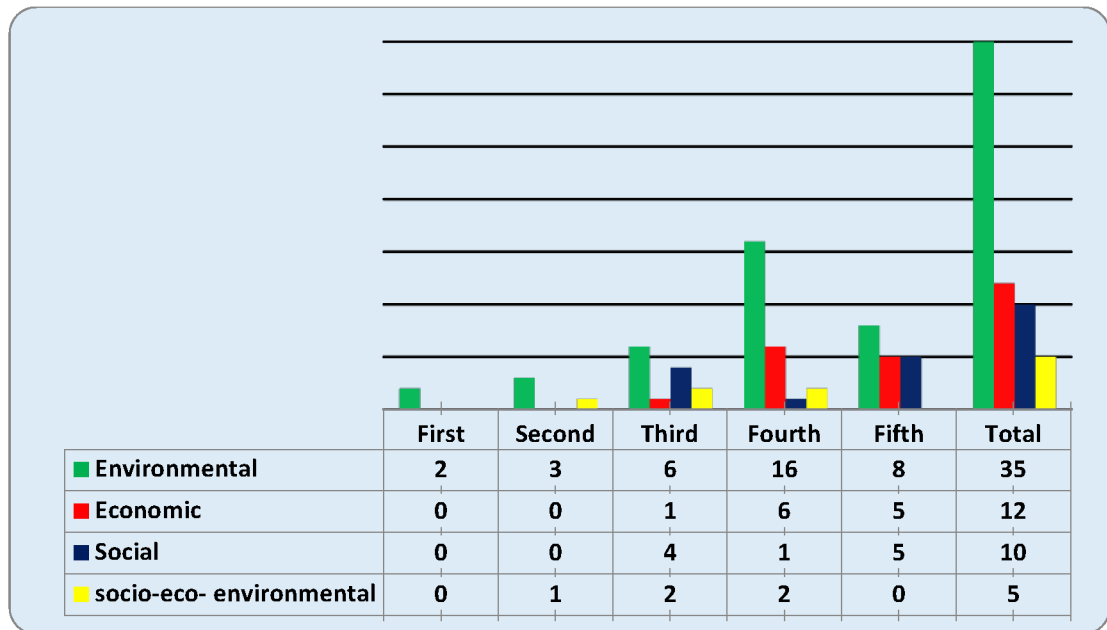


Figure 4.29 The number of significant rules related to sustainable development in the Iranian first to fifth FYDP

Regarding the status of sustainable development in Iranian rules and regulations, it can be deduced from tables 1 and 2 that the number of environmental considerations at the first to fifth five-year development plans for economic, social and cultural development rules of the Islamic Republic of Iran and the relevant administrative regulations are greater than the social and economic considerations. Economic and social cases do not have much difference. Most of the considerations to the principles of sustainable development have also been in the fourth plan. In the first and the second plans, a number of considerations to the principles of sustainable development are less than ten percent of the total amount. This is despite the fact that more than 90% of considerations to the principles of sustainable development are related to the third, fourth and fifth plans⁴⁰⁵.

The main reason is the development of new management approaches according to the principles of sustainable development in the late nineties. After the war with Iraq, the Iranian government was busy about a decade (from 1989 to 1999) to rebuild the destructions caused by the war. So the priorities of the government authorities at that time (which is known as the construction period) were mainly focused on the

⁴⁰⁵ J. Kretschmann and R. Amiri (2015), *Sustainable Mining Management in Iran based on Islam and Iranian Laws and Regulations*, in Proceedings of Fifth Aachen International Mining Symposia (AIMS), Mineral Resources and Mine Development, Aachen, Germany, ISBN: 978-3-941277-22-9, p. 265-278

improvement of the country's infrastructure. After that period, coinciding with the start of the third development plan, the considerations and approaches to the principles of sustainable development have been clearly increased by the government.

Although sustainable development has been considered in Iranian rules and regulations, more attention needs to be paid to this issue while ratifying new regulations (especially in the sixth FYDP and its by-laws) along with the adoption of international approaches.

As it can be seen in appendix 1 the clear rules and regulations attention of the First to the Fifth Five-Year Plan for Economic, Social and Cultural Development of the Islamic Republic of Iran⁴⁰⁶ to the principles of sustainable development has been inserted into separate programs.

4.4 Basic documents for strategic development in Iranian mining sector

Two documents were chosen as the main sources to describe the framework for strategic development in Iranian Mining Sector, which can be considered as fundamental for improvement and development of the country's mining sector.

4.4.1 Iranian mine sector strategic document

Proportional to governance in the third Millennium, new management approaches, especially strategic management is inevitable in the mining sector as the main tool for efficient use of natural, human and financial sources⁴⁰⁷. Ministry of Industry, Mine and Trade of Iran (MIMT) with cooperation of different stakeholders including management, mining and economic experts has initiated the "The Country Mining Sector Strategy Project" by Tarbiat-e-Modarres University based on general and future policies of the Ministry⁴⁰⁸. The project's output was the Country Mine Sector

⁴⁰⁶ H. Tabibi Tavakoli (2011), *The complete Set of rules and regulations in First till Fifth Five- year Development Plans*, Ferdowsi Publications, ISBN: 974-964-8347-45-6 (Persian)

⁴⁰⁷ Tarbiat-e-Modarres University (2012), *The Country Mining Sector Strategy Document*, Ministry of Industry, Mine and Trade, p.1(Persian)

⁴⁰⁸ Tarbiat-e-Modarres University (2012), *The Country Mining Sector Strategy Document*, Ministry of Industry, Mine and Trade, p.3 (Persian)

Strategy Document (CMSSD) which included certain principals related to sustainable development such as⁴⁰⁹:

- I. The importance of protecting the finite and non-renewable mineral resources and reserves of the country
- II. The importance of human resource protection against the risks of mining activities
- III. The importance of minimizing negative environmental impacts of mining activities
- IV. The importance of maximizing the positive impacts of mining activities on local communities
- V. The importance of increasing the social advantages of the mining sector and the general acceptance of national benefits of mining activities
- VI. The importance of empowering the private institution and controlling the monopolies
- VII. The importance of existing role of Iranian mining and mineral industries in the international scale
- VIII. The necessity of separating the governmental affairs from operational affairs in mining activities

Essential issues for preparation of CMSSD are explained in international and national level in this document, too⁴¹⁰.

The CMSSD includes three chapters that its schematic diagram is shown in figure 4.5.

⁴⁰⁹ Tarbiat-e-Modarres University (2012), *The Country Mining Sector Strategy Document*, Ministry of Industry, Mine and Trade, p 4 (Persian)

⁴¹⁰ Tarbiat-e-Modarres University (2012), *The Country Mining Sector Strategy Document*, Ministry of Industry, Mine and Trade, p.5 (Persian)

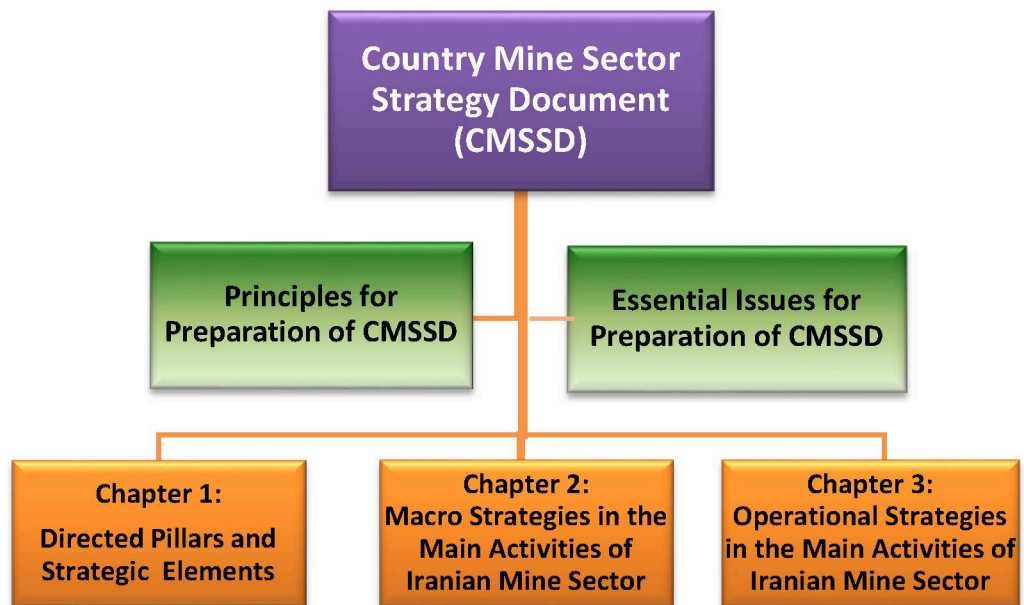


Figure 4.30 Schematic diagram of CMSSD

(Adopted from the Country Mine Sector Strategy Document)

4.4.1.1 Directed pillars and strategic elements

This part of CMSSD which contains vision, mission, values, strategic subjects and strategic objective zones has been summarized in table 4.6. It is notable that sustainable development is mentioned in the vision on the horizon of 2025 as well as in certain strategic topics.

Item	Description
Vision on the horizon of 2025	The mining sector in the horizon of 2025 ⁴¹¹ is a basic part of the country's industrial development which benefits from the world-class level of human resources and efficient technology, attractive for investment, competitive, active in the mineral global value chain based on <i>sustainable development</i> considerations.
Mission	The mining sector is responsible for production of a national database of earth science, identification of resources and deposits, reserves exploration, optimal and protective extraction of mines, the development of raw materials processing, supply of raw materials for mineral industries and other related industries in the country, increasing the public's welfare and national wealth.
Values	<ul style="list-style-type: none"> • Participation in national wealth development • Competitive production and competitiveness • Progress based on science and knowledge • Cooperation on international scale • Preservation of resources and mineral reserves • Protecting the health and development of human resources • Environmental Protection • Respecting the rights of local communities • Respecting the rights of stakeholders
Strategic subjects	<ul style="list-style-type: none"> • International relationships and interactions • Business environment • Productivity • Supply and support • <i>Sustainable development</i>
Strategic objectives zones	<ul style="list-style-type: none"> • Investment • Globalization • Management system • Human resources • Technology • Physical infrastructure • Health, safety and environment (HSE) • Regional development

Table 4.6 Core elements and strategic elements of CMSSD⁴¹²

⁴¹¹ According to the “horizon document”, which was prepared by the Expediency Council and ratified by the Leader in November 2003, Iran aims to be the leading country in economy, science, and technology in the region by 2025, inspiring the region and the world with its constructive and effective interactions in international relationships.

⁴¹² Tarbiat-e-Modarres University (2012), *The Country Mining Sector Strategy Document*, Ministry of Industry, Mine and Trade, p. 11-16 (Persian)

4.4.1.2 Macro strategies in the main activities of the country mine sector

In this section, citing a series of studies carried out during the "Country Mine Sector Strategy Preparation Project", with an emphasis on data collection obtained from the analysis of the strengths, weaknesses, opportunities and threats in each part of the study areas, macro strategies were defined and composed in line with the vision, mission and objectives. This chapter has two main parts⁴¹³:

- Macro strategies of the country mine sector in the framework of four main activities include exploration, exploitation, mining industries and trade
- Obligation of implementation and execution of the mining sector strategies as the major needs to realize the mining sector's strategic plan

4.4.1.3 Operational strategies in the main activities of country mine sector

After designing and defining the macro strategy for each one of the main activities of the mining sector in the third chapter of the above mentioned document the operational aspects in implementing the guidelines have also been developed. The definition and implementation guidelines are intended to emphasize the points of interest and recognized strategic gaps in terms of results comprised the strengths, weaknesses, opportunities and threats of the mine sector⁴¹⁴.

4.4.2 IMIDRO's strategy documents

The first strategic plan of IMIDRO was prepared in 2004. This plan was updated once in 2010 and then in 2013. The main objectives and strategies of these documents will be mentioned hereinafter.

4.4.2.1 IMIDRO's first strategic plan

IMIDRO, under the framework of its legal responsibilities as the tenure of subset governmental companies and with the aims of their promotion, formulated the first strategic plan for the period 2004 till 2009. This plan was in complete conformity with the third national development plan and also general policies of the fourth

⁴¹³ Tarbiat-e-Modarres University (2012), *The Country Mining Sector Strategy Document*, Ministry of Industry, Mine and Trade, p. 19 (Persian)

⁴¹⁴ Tarbiat-e-Modarres University (2012), *The Country Mining Sector Strategy Document*, Ministry of Industry, Mine and Trade, p. 61

national development plan. The main objectives of the plan were determined as follows⁴¹⁵:

- Competitive mines and minerals industries in domestic and global markets
- Reaching sustainable growth of the mines and minerals industry
- Increasing the share of world production and exports of mineral products and basic metals
- Supplying the domestic market demand for mineral products and basic metals
- *Paying attention to the environmental considerations and conservation of natural resources in the mining and mineral industry activities*

The last object is clearly related to sustainable development principles. Based on the SWOT model and the main objectives, the following strategies were identified in 2004 which are mentioned in table 4.7.

⁴¹⁵ Iranian Mines and Mining Industries Development and Renovation Organization (2004), *IMIDRO's Strategic Plan, Internal report*, p. 12 (Persian)

Strategies based on	Description
Strengths and Opportunities (SO)	<ul style="list-style-type: none"> • Transferring national industries and mines to private sector • Pricing metal products in metal exchange • Investing in development and renovation projects according to the country's competitive advantage
Weaknesses and Opportunities (WO)	<ul style="list-style-type: none"> • Strengthening industry innovation • Improving production abilities • Paying special attention to human resource management • Improving FDI⁴¹⁶
Strengths and Threats (ST)	<ul style="list-style-type: none"> • Business support and development of exports • Empowering the private institution • Developing competitive structure and avoiding excessive competition
Weaknesses and Threats (WT)	<ul style="list-style-type: none"> • Strategic marketing • Emphasizing on research and development • Improving the quality and variety of products • <i>Optimizing and saving water and energy consumption and paying attention to the environmental considerations</i>⁴¹⁷ • Transportation⁴¹⁸

Table 4.7 IMIDRO's strategies at the first strategic plan⁴¹⁹

4.4.2.2 IMIDRO's second strategic plan

Due to some modifications in general policies, scope of works and ownership of subsidiary companies, IMIDRO's First Strategic Plan was updated in 2008 in compliance with new aims, strategies, policies and plans of the government. In preparation of the second strategic plan, at first, IMIDRO's dimensions are divided into three different businesses as follows⁴²⁰:

- PART 1: Empowering mines and mineral industries section
- PART 2: Development and renovation of mines and mineral industries
- PART 3: Strategic leadership of companies

⁴¹⁶ Foreign Direct Investment (FDI)

⁴¹⁷ This strategy is clearly related to sustainable development principles, too.

⁴¹⁸ By transportation strategy, it is meant that road transportation shall be substituted by railways and sea transportation. It also includes utilizing modern technologies to reduce the costs, benefiting from facilities of private sector and more research and development regarding this section.

⁴¹⁹ Iranian Mines and Mining Industries Development and Renovation Organization (2004), *IMIDRO's Strategic Plan, Internal report*, p. 13 (Persian)

⁴²⁰ Iranian Mines and Mining Industries Development and Renovation Organization (2004), *IMIDRO's Strategic Plan, Internal report* (Persian)

For each of above mentioned parts, vision, mission and strategic objectives were then defined and the analysis of strengths, weaknesses, opportunities and threats based on SWOT model was performed. Finally, IMIDRO's new strategies in each part were separately determined which is totally summarized in table 4.8.

Strategies based on	part	Description
Strengths and Opportunities (SO)	1	Development and empowerment of the market
	2	Creation of competitive advantage in the country with defining development and renovation projects
	3	Strategic marketing and market development
Weaknesses and Opportunities (WO)	1	Development of human resources
	1	Development of bases and infrastructures
	2	Empowerment of financial supply capability and investor attraction in projects
	3	Empowerment of production abilities and increasing competitiveness
Strengths and Threats (ST)	1	Empowerment of financial capability and investment in development
	2	Empowerment of projects execution abilities
	3	Development of efficient human resources
	3	Development of subsidiary companies cooperation to increase synergy
Weaknesses and Threats (WT)	1	Improvement of production abilities
	1	Localization of technology and research development
	2	Improvement of completed projects operation
	3	Optimized management of assets and resources

Table 4.8 IMIDRO's strategies at the second strategic plan⁴²¹

4.4.2.3 IMIDRO's third strategic plan

After the presidential election in 2013 and the start of a new government in Iran, the new IMIDRO's chairman of the board and CEO declared the necessity of revising the strategy. It was stated that according to external factors like changes in regulations, changes in economic conditions and internal factors like structural changes, changes in assets, the strategy should be modified in accordance with new conditions⁴²². In 2014, IMIDRO's chairman of the board announced again that in the

⁴²¹ Iranian Mines and Mining Industries Development and Renovation Organization (2008), *IMIDRO's Strategic Plan, Internal report* (Persian)

⁴²² GOSTARESH, Iranian newspaper, *IMIDRO's strategic plan will be revised*, published on 2013/09/23 (Persian)

direction of eleventh government policy, IMIDRO's new strategic guidelines developed and will be operational for a period of four years⁴²³. The main reasons for changing the IMIDRO's strategic plan are as follows⁴²⁴:

- Modification of policies according to the new Industry, Mine and Trade Minister's approaches
- Changes in sanctions' conditions and supply of the materials, technology and marketing
- Execution of the second phase of systemized subsidies in mining sector
- Changing the country industrial development strategy document

In table 4.9, vision, mission, values and macro strategies of IMIDRO's third strategic plan are presented briefly. As can be seen, sustainable development of mine and mineral industries sector is clearly mentioned in the IMIDRO's vision and all the values of the IMIDRO's third strategic plan are in the line with sustainable development principles.

⁴²³ Donya-e-Eqtesad, Iranian newspaper, *Preparation of IMIDRO's new strategy for four-year period*, published on 2014/02/17(Persian)

⁴²⁴ Public Relations of IMIDRO publications, *IMIDRO's Performance Report*, 1393(2012-2013), p. 68- 69 (Persian)

Item	Description
Vision ⁴²⁵	Leader and pioneer in the <i>sustainable development</i> and evolution of mine and mineral industries sector and competitiveness in the world value chains
Mission ⁴²⁶	IMIDRO is steering development, empowerment and competitiveness of mine and mining industries sector and converting its resources and products to sustainable wealth of the country.
Values ⁴²⁷	<ul style="list-style-type: none"> • Protecting the rights, dignity and social justice • Paying attention to the health and safety of employees • Respecting the rights of all stakeholders and customers • Paying attention to deprived areas, job creation and commitment to the rights of local communities • Protecting the environment, heritage and non-renewable resources and the rights of future generations • Commitment to professional ethics and respect for the copyrights • Clear informing and response
Macro Strategies ⁴²⁸	<ul style="list-style-type: none"> • Development of mine and mining industries activities with competitive edge in less developed areas • Increasing investment in building mine and mining industries chain units with high risk and modern technologies • Development of overseas mining activities and mining industries with the aim of completing value chain • Expanding modern methods of financing in implementing of development projects • Boosting productivity, synergy and competitiveness in mine and mining industries sector • Promotion of knowledge, applied researches and technologies needed for mine and mining industries sector • Expansion of private institutions' investment in mine and mining industries activities and related infrastructures • Development of human resources in mine and mining industries sector • Strategic marketing and boosting exports of products and technical-engineering services

Table 4.9 IMIDRO's vision, mission, values and macro strategies in third strategic plan

⁴²⁵ IMIDRO's Board of Director Approval, Number H-912/3-5, Dated: 17, May, 2014

⁴²⁶ http://imidro.gov.ir/general_content/395-Mission.html

⁴²⁷ IMIDRO's Board of Director Approval, Number H-912/3-5, Dated: 17, May, 2014

⁴²⁸ http://imidro.gov.ir/general_content/1639-Strategy.html

4.5 Stakeholder model for SIOM

In this section of the research, the stakeholder model for SIOM will be presented. A conceptual flow diagram which contains the steps of the related analysis is shown in figure 4.6.

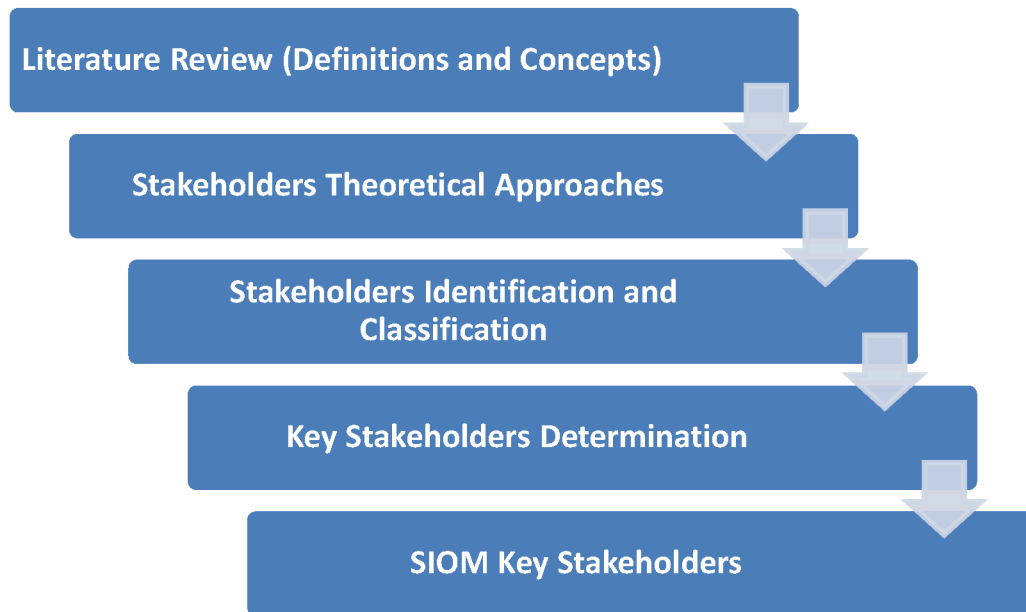


Figure 4.31 SIOM Stakeholders Analysis Flow Diagram

4.5.1 Literature review (definitions and concepts)

Stakeholders were used to be known as manufacturers and final consumers of the product but in modern approaches, stockholders are those who their knowledge, skills and expectations are effective for the success of an organization. Generally, stakeholders are individuals and groups that are depended on the organization for the achievement of some of their goals or needs and the organization is mutually depended on them and affected by them, too. Stakeholders are people or groups which are affected by organization's activities and can be booster or hinder of an organization's success. Stakeholder may be the winner or loser and can be part of decision makers, users and consumers of the organization⁴²⁹.

⁴²⁹ Tarbiat-e-Modarres University (2012), *Mine Sector Stakeholders Analysis*, The Country Mining Sector Strategy Document Project, Ministry of Industry, Mine and Trade of Iran (Persian)

Freeman defines stakeholders as groups or individuals who are able to affect or be affected by the achievement of organizational goals⁴³⁰. According to another definition, stakeholders are those individuals, groups, communities, organizations, associations or authorities whose interests may be positively or negatively affected by a proposal or activity and/or who are concerned with a proposal or activity and its consequences⁴³¹.

Stakeholders can be divided into two groups⁴³²:

- I. Internal: internal stakeholders have the main role to achieve the internal goals of the organization.
- II. External: external stakeholders include individuals and groups whose organizational goals` realization requires their cooperation.

Freeman divides stakeholders into two phases, namely the primary stakeholders and secondary stakeholders. Primary stakeholders are those directly related to the company such as customers, investors, employees, suppliers and communities, while secondary stakeholders are not directly related such as media, government, competitors, consumer organizations and other related groups⁴³³.

4.5.2 Stakeholders theoretical approaches

Generally, there are three approaches in stakeholders' theory which will be mentioned briefly in the following⁴³⁴:

- A. Shareholder value approach:** In this approach, all activities of the organization shall be in accordance with the requirements and needs of shareholder. Other stakeholders can only be considered when their

⁴³⁰ R. E. Freeman (1984), *Strategic Management: A stakeholder approach*, Boston: Pitman, ISBN 0-273-01913-9

⁴³¹ Consultative Forum on Mining and the Environment (2002), *Participation Guidelines for Stakeholders in the Mining Industry*, published by the Chamber of Mines of South Africa, Marshalltown, (First Edition, 2002), ISBN: 0-620-29332-2, p. 1

⁴³² Tarbiat-e-Modarres University (December 2012), *Mine Sector Stakeholders Analysis*, The Country Mining Sector Strategy Document Project, Ministry of Industry, Mine and Trade of Iran, p.3 (Persian)

⁴³³ R. Rudy Irawan, U. Sumarwan, B. Suharjo and S. Djohar (2014), *Stakeholder management: conflict and interest in tin mining industry Indonesia (case study Bangka Belitung province)*, European Scientific Journal, vol. 10 (25)/2014, ISSN: 1857-7881

⁴³⁴ Tarbiat-e-Modarres University (2012), *Mine Sector Stakeholders Analysis*, The Country Mining Sector Strategy Document Project, Ministry of Industry, Mine and Trade of Iran, p. 4-5 (Persian)

needs and requirements are in accordance with the needs and requirements of the shareholders and owners.

B. Stakeholder value approach: In the stakeholder value approach, the social responsibilities of organizations are considered. In this approach, if the economic goals of the organization are in conflict with the values based on social responsibility, the goals should be changed so that priority will be based on this responsibility.

C. Managerial approach: In management approach or intermediate approach, stakeholder's value is not inconsistent with shareholder's value. In this approach, the organization and its stakeholders can have benefit in the long-term survival when they pay attention to social responsibility as their priority. This approach argues that the stakeholders should be managed and considers stakeholder management as the base movement towards efficient and effective organizations. In stakeholder analysis and management, stakeholders should be recognized and classified and their clear demands and expectations must be considered in terms of the formulation of objectives and strategies. The stakeholder management is critical for any business which is related to the long-term organization strategic decisions. In its stakeholder management theory; popular management knowledge theorist, Freeman, suggests the issue of corporate social responsibility (due to the voluntary social goals) alongside economic goals. The activities of such organizations will create value for groups other than the shareholders. The groups are stakeholders.

4.5.3 Stakeholders identification and classification

The first step in stakeholder analysis is identification of the people who are affected by work, who have influence or power over it, or have an interest in its successful or unsuccessful conclusions. Although stakeholders may be both organizations and people, but it is necessary to communicate with people ultimately and make sure that the correct individual stakeholders within a stakeholder organization have been identified.

The second step will be stakeholder classification which can be localized for each country based on its governance situations, governmental structure and local community's conditions. Different main stakeholder groups in Iranian mine sector have been identified and classified as follows⁴³⁵:

- Society: National community, surrounding communities, public nongovernmental organizations and agencies and the media
- Main markets: International and domestic manufacturers and applicants, domestic and international trade associations, manufacturers and applicants of minerals and mining industries
- Supporting markets: Owners of exploration business, both foreign and domestic investors, mining traders, mining exchange and international and domestic trade organizations
- Supply part: providing finance, insurance, machinery, equipment, materials, technical services and infrastructures
- Human resources: Engineers, foreign and domestic technicians and skilled workers, professional managers in the mining sector and labor organizations
- Professional organizations of mine sector: Domestic and international organizations and professional associations, universities and research centers
- Governance: Related institutions in legislative, judicial and executive branches of the country

4.5.4 Key stakeholders determination

Key stakeholders or key players are stakeholders who are strongly affected by activities and changes in the mining sector and a lot of gains or losses are found for them by these changes. This group of stakeholders has the ability to influence and affect. They will be identified in both general and private environments in the process of mining sector development⁴³⁶. According to the mentioned category, the

⁴³⁵ Tarbiat-e-Modarres University (2012), *Mine Sector Stakeholders Analysis*, The Country Mining Sector Strategy Document Project, Ministry of Industry, Mine and Trade of Iran, p.13 (Persian)

⁴³⁶ Tarbiat-e-Modarres University (2012), *Mine Sector Stakeholders Analysis*, The Country Mining Sector Strategy Document Project, Ministry of Industry, Mine and Trade of Iran, p.18 (Persian)

list of key stakeholders in the Iranian mining sector in both general and private environments is shown in table 4.10.

Environment	Stakeholder
<p style="text-align: center;">General (External)</p>	<ul style="list-style-type: none"> • National Society • Surrounding communities • Governance regulator and supervisor institutions • Institutions related to the environment, natural resources and cultural heritage in government • Governmental institutions providing physical infrastructure • Foreign investors
<p style="text-align: center;">Private (Internal)</p>	<ul style="list-style-type: none"> • Governmental specialized institutions in mine sector • Exploration business owners • Investors and domestic manufacturers of mineral products • Domestic owners of mines and mining industries businesses and their associations • Domestic manufacturers of machineries and specialized equipment for mining • Domestic expert and skilled human resources (engineers, technicians and skilled workers) • Local organizations and professional associations in the mine sector

Table 4.10 Key stakeholders in Iranian mining sector^{۴۳۷}

4.5.5 SIOM key stakeholders

In strategic planning, identification of key stakeholders in order to consider their expectations for the related objectives and strategies determinations is important⁴³⁸. If the strategy is based on correct understanding of key stakeholders and their expectations, implementation, monitoring and evaluation of strategies becomes easier and implementing corrective actions will be faster based on the results of monitoring and evaluation. Considering all the above descriptions, key stakeholders of the research area that have an impact on the SIOM and play role in the success or failures of the set objectives were considered in both general and private environments. The outcome based on a basic model is shown in figure 4.7.

⁴³⁷ Tarbiat-e-Modarres University (2012), *Mine Sector Stakeholders Analysis*, The Country Mining Sector Strategy Document Project, Ministry of Industry, Mine and Trade of Iran, p.19 (Persian)

⁴³⁸ Tarbiat-e-Modarres University (2012), *Mine Sector Stakeholders Analysis*, The Country Mining Sector Strategy Document Project, Ministry of Industry, Mine and Trade of Iran, p.38 (Persian)

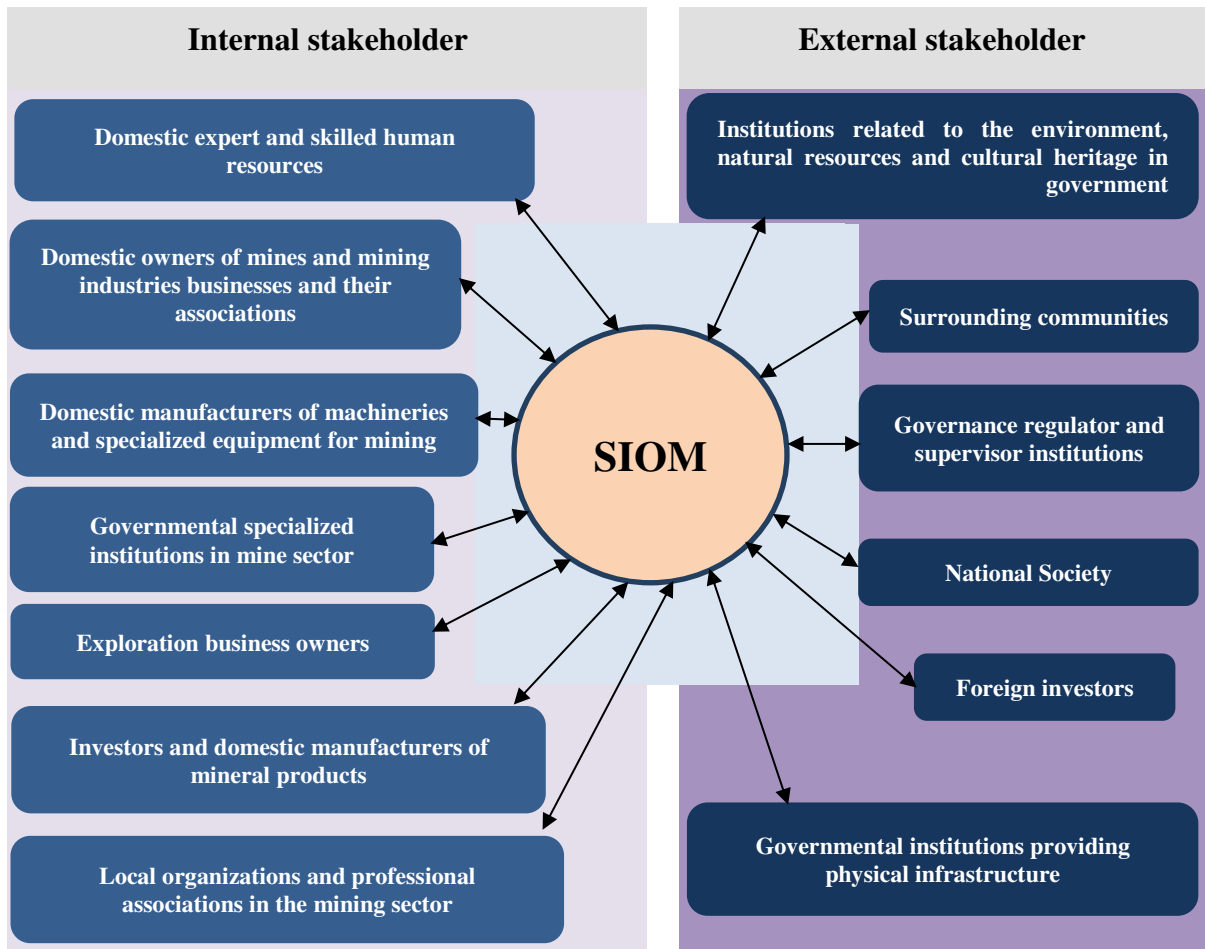


Figure 4.32 Stakeholders basic model for SIOM

Also, based on the above basic model and according to specific conditions governing the scope of this research, SIOM key stakeholders separated in different groups were detected in both general and private environments which are shown in table 4.11.

Environment	Stakeholders groups	SIOM key stakeholders
General (External)	National Society	➤ The Government of the Islamic Republic of Iran
	Surrounding communities of SIOM	➤ Local communities of Khaf County ➤ Local communities and other Counties near Sangan iron ore mines including Taibad, Roshtkhar, Ghaen, Torbat-e-Heydariyeh and Torbat-e-Jaam
	Governance regulator and supervisor institutions	➤ Khorasan-e-Razavi provincial governorship ➤ Governorship of Khaf County ➤ Audit Court of Khorasan-e-Razavi Province ➤ Inspection organization of Khorasan-e-Razavi Province
	Institutions related to the environment, natural resources and cultural heritage in government	➤ General Administration of Environmental Protection of Khorasan-e-Razavi Province ➤ Forest Range and Watershed Organization of Khorasan-e-Razavi Province ➤ Agriculture Organization of Khorasan-e-Razavi Province - Land affairs ➤ Administration of Cultural Heritage, Handicrafts and Tourism Organization of Khorasan-e-Razavi Province
	Governmental institutions providing physical infrastructure	➤ Khorasan-e-Razavi Water and Wastewater Company ➤ Gas Company of Khorasan-e-Razavi Province ➤ Khorasan-e-Razavi Road and Urban Development Organization ➤ Regional Electricity Company of Khorasan-e-Razavi Province
	Foreign investors	➤ Companies and foreign banks (for example: Mediobanca from Italy)
Private (Internal)	Governmental specialized institutions in mine sector	➤ Ministry of Industry, Mine and Trade ➤ Iranian Mines and Mining Industries Development and Renovation Organization (IMIDRO) ➤ Industry, Mine and Trade Organization of Khorasan-e-Razavi Province
	Exploration business owners	➤ Geological Survey of Iran ➤ IMIDRO Exploration Management ➤ Contractors and consultants in the field of iron ore exploration
	Investors and domestic manufacturers of mineral products	➤ Banks, stock market and investment holdings (for example Bank-e-Melli of Iran and Parsian Investment Company) ➤ Iran Central Iron Ore Company ➤ Chadormalu Mining and Industrial Company ➤ Gol-e-Gohar Mining and Industrial Company ➤ Jalal Abad Iron Ore Complex ➤ Companies producing placer iron ore in Sangan ➤ Other governmental and private producers of iron ore
	Domestic owners of mines and mining industries businesses and their associations	➤ Contractors working in Sangan iron ore mines ➤ Consultants working in Sangan iron ore mines ➤ Companies supplying equipment and spare parts needed in Sangan ➤ Commercial companies active in buying and selling iron ore ➤ Main customers (such as Zobeahan Esfahan, Mobarakeh and Khuzestan Steel Plants) ➤ Iranian Society of Consulting Engineers ➤ Syndicate of Iranian Blasting Services Companies ➤ Iron Ore Producers & Exporters Association of Iran
	Domestic manufacturers of machineries and specialized equipment for mining	➤ Domestic companies manufacturing mining equipment (such as HEPCO and Tirajeh Machine) ➤ Domestic companies manufacturing equipment for the mining industries
	Domestic expert and skilled human resources	➤ Managers, engineers, technicians, skilled workers and normal workers working in Sangan iron ore mines
	Local organizations and professional associations in the mining sector	➤ Iranian Mining Engineering Organization ➤ Iran Mine House ➤ Iranian Society of Mining Engineering ➤ Iron & Steel Society of Iran ➤ Iran Chamber of Commerce, Industries, Mines & Agriculture

Table 4.11 List of SIOM key stakeholders in the general and private environments to separate different groups

4.5.6 The main expectations of key stakeholders of mining sector in relation to the sustainable development

After identifying the key stakeholders both in internal and external environment of the mining sector, the expectations of each stakeholder should be determined. This is a separate specialized process that requires a separate study and must be checked in particular.

In the process of formation of this thesis, two questionnaires were distributed among the selected statistical population in the Sangan iron ore mines area in 2012 and 2015. A set of questions have been about the expectations of the local communities from the active companies in the field of mines and mining industries in the region. The results and interpretations will be described in chapter five.

Given the importance of issues related to sustainable development in this thesis, the main expectations of the Iranian mining sector`s key stakeholders regarding sustainable development are summarized in table 4.12.

Expectations	Related S.D. principles
Effective and equitable distribution of income due to mining licenses in the country	Economic
Maximizing the mine life and optimized use of mining resources of the country	Economic
Applying the world standard level for employees` health and safety in mining operations and ensure the legal rights of the human resources in the mining sector	Environmental and Social
Considering the public rights interest in the privatization of the mines	Economic and Social
Applying the active role of human resources and mining capacity and capabilities in the sustainable development of the country	Social and Economic
Optimal use of energy and water resources in mining operations	Economic and Environmental
Optimal use of land and natural resources in mining operations	Environmental
Minimizing the environmental impact of mining activities	Environmental
Employment of skilled human resources to manage the risks and impacts of mining accidents	Environmental and Social
Paying special attention to the development of the mining sector in less developed mining areas in accordance to their capabilities	Social and Economic
Stability and transparency of legal rights of the mines surrounding communities and their guarantee	Social
Minimizing the damages of mining activities to the economic, environmental, social, local and regional situations	Economic, Environmental and Social
Getting more benefit to the surrounding communities from the economic and social benefits due to mining operations	Economic and Social

Table 4.12 Main expectations of key stakeholders of mining sector in relation to the sustainable development⁴³⁹

⁴³⁹ Tarbiat-e-Modarres University (2012), *Mine Sector Stakeholders Analysis*, The Country Mining Sector Strategy Document Project, Ministry of Industry, Mine and Trade of Iran, p.35 (Persian)

4.6 Strategy formulation for SIOM

Since SIOC as the main subsidiary of IMIDRO in SIOM is active in the field of iron ore fine and lump production and projects` implementation supervision⁴⁴⁰, the strategy preparation will be done for SIOC. *It can surely be used for Opal Parsian Sangan Company and generalized as a role model for the other development phases which are under construction by private institutions in SIOM.*

In this research a "Comprehensive Framework for Strategy formulation" is used which is shown in figure 4.8.

Initiating Stage	
Mission Determination and Corporate Mission Statement Preparation	
Input Stage	
Internal Factor Evaluation (IFE) Matrix	External Factor Evaluation (EFE) Matrix
Matching Stage	
Internal – External (IE) Analysis	SWOT Analysis
Decision Making Stage	
Quantitative Strategic Planning Matrix (QSPM)	

Figure 4.33 Comprehensive framework for SIOC strategy formulation⁴⁴¹

4.6.1 Initiating stage

In this stage the corporate mission and its statement will be determined. The corporate mission shows its existence reasons or philosophy and on the other hands declares the corporate identity. A document including the corporate mission for stakeholders` information is called "Corporate Mission Statement". So, the mission statement is a sentence or phrase, by means of it, a corporate`s aims are separated from another one. The mission statement should include products, customers, market, technology, profitability, corporate philosophy, distinctive competency, people imagination attention and employees` attention. Considering the above

⁴⁴⁰ The 2.4 MTPY iron ore concentration plant (second line) and 5 MTPY pelletizing plant projects of phase one is under construction by Opal Parsian Sangan Company which the chief of the board of this company is SIOC manager on behalf of IMIDRO.

⁴⁴¹ S. M. Aarabi (2013), *The Handbook of Strategic Planning*, Mohtasham Publications, Tehran- Iran, ISBN: 964-379-095-9, p. 8 (Persian)

mentioned items, some simple and understandable sentences are stated fluently together as the corporate mission statement⁴⁴².

According to the above mentioned process and the SIOC special conditions, the SIOC mission statement has been prepared by consulting some related experts. IMIDRO mission statement was considered as the basic model, too. So, the proposed mission statement of SIOC is as follows:

SIOC PROPOSED MISSION STATEMENT:

"Sangan Iron Ore Complex as one of the biggest iron ore producers in Iran - beside implementing, developing projects and providing technical services - is supplying raw materials for local and foreign steel making factories by using world most modern technologies with the aim of creating employment opportunities, welfare improvement, ensuring sustainable security and well-being in the sensitive and strategic area of the eastern part of Iran near the border of Afghanistan.

The existence of Sangan Iron Ore Mines - as rich and high quality iron ore reservoirs - near this complex and the government`s plan for supplying about 25 percent of the country steel industry raw materials from this area, made it very attractive target for different investors.

With attention to employees` welfare level promotion and job satisfaction parallel to their training and in order to achieve sustainable development in the area with considering the all stakeholders` rights, environmental protection (specially sustainable water consumption reduction) and creating economic development, the complex gets Social License from surrounding local communities to operate and considers corporate social responsibilities, as well.

Sangan Iron Ore Complex believes that its existence and life persistence is depended on economic growth, profitability and human resources, as the most valuable corporate resources which have the major and key role to reach the whole targets and missions."

⁴⁴² S. M. Aarabi (2013), *The Handbook of Strategic Planning*, Mohtasham Publications, Tehran- Iran, ISBN: 964-379-095-9 (Persian)

4.6.2 Input stage

At this stage, the main required data for strategic preparation is determined. The stage includes External Factor Evaluation (EFE) Matrix and Internal Factor Evaluation (IFE) Matrix.

4.6.2.1 External factors

In studying external factors, Opportunities and Threats that the corporates are face with, and task environment were identified in general to prepare suitable strategies for the use of opportunities and decrease the effects of threats. General environment includes major factors (economical, socio-cultural, technological, political-legal and universal) that affect corporate activities indirectly. Task environment contains elements or groups which affect corporate directly and are affected by the corporate mutually. Task environment includes stakeholders that corporate has a regular relation with them such as customers, suppliers, competitors, governmental institutes, local communities, etc.⁴⁴³.

After analyzing general and task environment, external strategic factors (opportunities and threats) will be extracted as shown in figure 4.9.

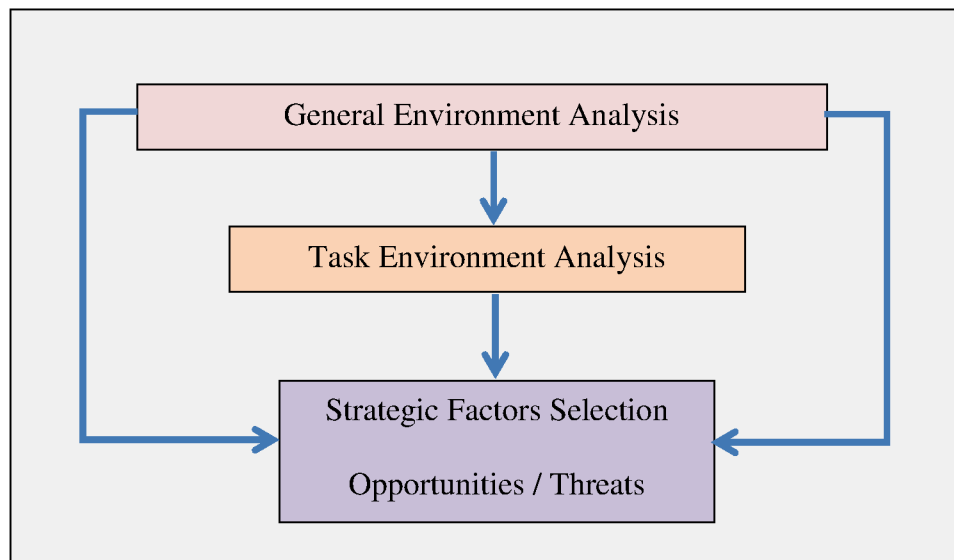


Figure 4.34 External environment studying pattern⁴⁴⁴

⁴⁴³ S. M. Aarabi (2013), *The Handbook of Strategic Planning*, Mohtasham Publications, Tehran- Iran, ISBN: 964-379-095-9 (Persian)

⁴⁴⁴ S. M. Aarabi (2013), *The Handbook of Strategic Planning*, Mohtasham Publications, Tehran- Iran, ISBN: 964-379-095-9, p. 21(Persian)

Based on the above mentioned pattern and studying the external factors in the research area, opportunities and threats identified in general and task environment by consulting some related experts are as follows:

Opportunities:

- O1: Existence of more than one billion tons of iron ore reservoirs in SIOM
- O2: Existence of the country's relatively cheap, abundant energy resources especially Khangiran gas plants of Sarakhs in Khorasan-e-Razavi Province almost near SIOM
- O3: Continued growth in demand for the SIOM products in the country (due to the existence of Khorasan steel complex and steel making projects under construction such as Sabzevar, Qaen and Torbat-e-heydariyeh near SIOM), Middle East (renovation and reconstruction of the neighbor countries including Iraq, Afghanistan, Pakistan and Syria) and Southeast Asia (due to the impending development of India)
- O4: Willingness of the private institutions to invest in SIOM (About 25% of raw materials for local steel plants will be supplied by SIOM based on the Iran Steel Master Plan)
- O5: Fluctuations in oil prices in the international market (The government is paying more attention to invest in the field of mining and mineral industry during recent years)
- O6: Absence of severe restrictions on the land use in the area (Due to a severe lack of precipitation, desert vegetation, poor pasture and forage production and poor quality of soil for agriculture around SIOM)
- O7: Recent technological advances in the field of water management such as handling, reducing water consumption and waste water recovery in the world and the possibility to use them in SIOM
- O8: Proper coordination and cooperation of local communities for implementing development projects and operation phase because of job creation and other indirect benefits related to SIOM

Threats:

- T1: lack of a comprehensive and efficient method for determining the crude iron ore price produced by IMIDRO for selling to the private institutions investors in SIOM (Based on the contracts between IMIDRO and investors, IMIDRO as the owner of SIOM will sell the crude iron ore to the investors at the first stage of crushing point i.e. gyratory crusher area for 25 years. But there was not a defined and an appropriate method for determining the crude iron ore price considering all the effective factors including grade, international price, gangues etc.)
- T2: Existence of resource nationalism and religious conflict in the region⁴⁴⁵
- T3: Existence of political sanctions and their negative impacts on access to new technologies, equipment and spare parts supply, financial transactions, investment risk, and etc.
- T4: Iran`s government subtle intervention in the iron ore pricing to support steel making plants and control steel products prices in the country
- T5: World financial crisis and the estimation of China economic growth slowdown and its chain impact on global demand especially for iron ore
- T6: Rising the prices of basic energy elements (fuels, gas and power) and subsequently increasing the price of final products in Iran during recent years
- T7: Having a common border with Afghanistan, as an insecure country with unstable political conditions (SIOM is located in eastern Iran, at latitude N34°24', longitude E60°16' and 30 km west of the Afghanistan border⁴⁴⁶)
- T8: The limitations of labor law and social security regulations for decreasing the number of inefficient and extra employees

⁴⁴⁵ Resource nationalism as a phenomenon has been seen in most mining areas worldwide and it can be seen in SIOM area as well. Main population of Khaf area are Muslims but with different opinions which separate them into two main Islamic branches called Shia and Sunni. Among these people, about 70% are the Sunni and 30% are the Shia, but the country distribution is 89% of Iranians are Shia and only 9% are Sunni. These two different thoughts basically have a lot of commons especially the same belief to Prophet Mohammad (PBUH) and Holy Quran. However, there are a few differences that sometimes cause minor problems in the region. Clearly, problems before turning into troubles need special attentions and solutions which are presented in chapter six.

⁴⁴⁶ J. Kretschmann, R. Amiri and A. Zarekar, (2013), *Realization of Sustainable Development in Iranian Mining Sector- case study: Sangan Iron Ore Mines (SIOM)*, The first International Conference on Economic Management in Mining Activities, HaNoi, VietNam, 8-9 Nov, p. 459-466

T9: Lack of airport in the region and shortage of infrastructures including water, electricity, gas and proper roads according to the ultimate goal of producing 20 MTPY of raw materials for local steel industry

After identification of opportunities and threats, according to the importance and sensitivity of each factor and comparison of these factors to each other, the importance weights are considered for factors between zero to one. The total sum of weights should not be more than one.

Then, the factors should be ranked. If the corporate opportunity is exceptional, the rank is considered 4 and if it is a normal one, the rank will be 3, whereas rank 2 is given to a normal threat and rank 1 is given to a serious one. As the factors move from exceptional opportunity toward serious threat, the ranks decrease from 4 to 1.

Finally, the score of each factor and the final score will be determined for the corporate. The score of each factor is equal with the multiplication of weight and rank. At the bottom of the EFE matrix score column, the total sum obtained from the scores will be the corporate final score due to opportunities and threats. If the EFE final score is more than 2.5, it means that the opportunities will overcome the threats and in the case of less than 2.5, it shows that the threats will overcome the opportunities⁴⁴⁷.

Based on above mentioned method, External Factor Evaluation (EFE) Matrix for SIOC has been prepared which the results are shown in table 4.13.

⁴⁴⁷ S. M. Aarabi (2013), *The Handbook of Strategic Planning*, Mohtasham Publications, Tehran- Iran, ISBN: 964-379-095-9, p. 22 (Persian)

External factors			weight	rank	score
Opportunities	O1	Existence of more than one billion tons of iron ore reservoirs in SIOM	0.12	4	0.48
	O2	Existence of the country's relatively cheap, abundant energy resources	0.06	3	0.18
	O3	Continued growth in demand for the SIOM products in the country, Middle East and Southeast Asia	0.04	3	0.12
	O4	Willingness of the private institutions to invest in SIOM	0.10	4	0.40
	O5	Fluctuations in oil prices in the international market	0.12	4	0.48
	O6	Absence of severe restrictions on the land use in the area	0.03	3	0.09
	O7	Recent technological advances in the field of water management	0.08	4	0.32
	O8	Proper coordination and cooperation of local communities	0.06	4	0.24
Threats	T1	Lack of a comprehensive and efficient method for determining the crude iron ore price	0.08	2	0.16
	T2	Existence of resource nationalism and religious conflict in the region	0.05	2	0.10
	T3	Political sanctions	0.05	1	0.05
	T4	Iran government subtle intervention in the iron ore pricing	0.05	1	0.05
	T5	World financial crisis	0.05	1	0.05
	T6	Rising the prices of basic energy elements in Iran	0.03	2	0.06
	T7	Common border with Afghanistan	0.02	2	0.04
	T8	The limitations of labor law and social security regulations	0.03	2	0.06
	T9	Lack of airport in the region and shortage of infrastructures	0.03	1	0.03
Total sum			1.00		2.43

Table 4.13 SIOC External Factor Evaluation (EFE) matrix

As it can be seen, the EFE final score has been calculated 2.43 which is less than 2.5 meaning threats may overcome the opportunities in SIOC.

4.6.2.2 Internal factors

Internal factors are related to corporate`s specific condition and unlike the external factors, they are under the control of corporate`s managers.

Among internal factors, Strengths are the factors which are considered as corporate`s advantage in comparison to the past, competitors and industry average. Strengths include skills and abilities that enable the corporate to plan and implement its strategies properly.

Besides, internal factors are considered as weaknesses which corporate aren`t able to overcome them, whereas the main competitors are able to do so. Weaknesses are also known as skills and abilities that corporate could not choose so that the strategies will not be implemented consequently.

For studying the internal factors, it is necessary to gather, classify and evaluate the operational information. These factors (strengths and weaknesses) which have the key role in corporate success should be recognized and prioritized by task approach. In task approach factors such as management, marketing, financial/accounting, production/operation, R&D, information management system and human resources are studied. Then, the most important corporate`s strengths and weaknesses will be determined and evaluated in a matrix in order to identify the corporate situation in the case of having the strengths and weaknesses in the future⁴⁴⁸.

Using the task approach and studying the internal factors in the research area, strengths and weaknesses of SIOC were identified through consulting with experts:

Strengths:

S1: IMIDRO's desire for exploration and implementation of developmental projects in cooperation with the private institutions in SIOM

S2: Existence of adequate and reliable geological and exploration basic information in SIOC technical archive

⁴⁴⁸ S. M. Aarabi (2013), *The Handbook of Strategic Planning*, Mohtasham Publications, Tehran- Iran, ISBN: 964-379-095-9, p. 27-33 (Persian)

- S3: Easy access to raw materials and security supply of crude iron ore by IMIDRO for under construction plants
- S4: Iron ore high average grade and proper process behavior and acceptance of SIOC different products in domestic and foreign markets
- S5: Existence of local empowered contractors and consultants to implement development projects and taking part in operation phase
- S6: Possibility of producing clean energies by using solar and wind due to climate of the area
- S7: Possibility of getting revenue from first iron ore concentrator plant and using the profits to implement the SIOC development projects

Weaknesses:

- W1: Lack of sufficient attention to the Research and Development (R&D) in various fields
- W2: Existence of surplus manpower and low productivity of employees engaged in unproductive and non-operational organizations
- W3: Lack of adequate responsibility and inside corporate synergies of the personnel for the SIOC development and progress
- W4: Severe water shortage due to severe droughts in the region and the country (The SIOM area faces regional aridity and suffers from low precipitation, high evaporation and low level of ground water. Water shortage is the most important problem and the main challenge for development of this mining area⁴⁴⁹).
- W5: Remoteness from seaports and major country`s steel plants (Zob-e-Ahan Esfahan, Mobarakeh and Khuzestan Steel Plants) in comparison to other competitors
- W6: Lack of adequate financial relationship between direct revenue of personals and the SIOC profit
- W7: Lack of a comprehensive Information Management System (IMS)

⁴⁴⁹ J. Kretschmann and R. Amiri (2014), *Solutions for a Sustainable Water Consumption Reduction in Sangan Iron Ore Mines in Iran*, in Proceedings of Sixth Aachen International Mining Symposia (AIMS), The Sixth International Symposium on Mineral Resources and Mine Development, Aachen, Germany, ISBN: 978-3-941277-20-5, p. 445-456

After identification of strengths and weaknesses, according to the importance and sensitivity of each factor and comparison of these factors to each other, the importance weights are considered for factors between zero to one. The total sum of weights should not be more than one as well as EFE matrix.

Then, the factors should be ranked. If the corporate strength is excellent, the rank is considered 4 and if it is a normal one, the rank will be 3. Whereas a rank 2 is given to a normal weakness and a rank 1 is given to a critical one. As the factors move from excellent strength toward critical weakness, the ranks decrease from 4 to 1.

Finally, the score of each factor and the final score will be determined for the corporate. The score of each factor is equal with the multiplication of weight and rank. At the bottom of the IFE matrix score column, the total sum obtained from the scores will be the corporate final score due to strengths and weaknesses. If the IFE final score is more than 2.5, it means that the strengths will overcome the weaknesses and in the case of less than 2.5, it shows that the weaknesses will overcome the strengths⁴⁵⁰.

Based on the above mentioned method, Internal Factor Evaluation (IFE) Matrix for SIOC has been prepared which the results are shown in table 4.14.

⁴⁵⁰ S. M. Aarabi (2013), *The Handbook of Strategic Planning*, Mohtasham Publications, Tehran- Iran, ISBN: 964-379-095-9, p. 34 (Persian)

Internal Factors			weight	rank	score
Strengths	S1	IMIDRO's desire for exploration and implementation of developmental projects in SIOM	0.12	4	0.48
	S2	Existence of adequate and reliable geological and exploration basic information	0.04	3	0.12
	S3	Easy access to raw materials and security supply of crude iron ore by IMIDRO	0.08	3	0.24
	S4	Iron ore high average grade and proper process behavior	0.10	4	0.40
	S5	Existence of local empower contractors and consultants	0.06	3	0.18
	S6	Possibility of producing clean energies by using solar and wind due to climate of the area	0.03	3	0.09
	S7	Possibility of getting revenue and using the profits for the SIOC development projects	0.10	4	0.40
Weaknesses	W1	Lack of sufficient attention to the Research and Development (R&D)	0.04	2	0.08
	W2	Existence of surplus manpower and low productivity of unproductive and non-operational employees	0.08	1	0.08
	W3	Lack of adequate responsibility and inside corporate synergies of the personnel	0.05	2	0.10
	W4	Severe water shortage due to severe droughts in the region and the country	0.12	1	0.12
	W5	Remoteness from seaports and country`s major steel plants	0.07	1	0.07
	W6	The lack of adequate financial relationship between direct revenue of personals and the SIOC profit	0.06	1	0.06
	W7	Lack of a comprehensive Information Management System (IMS)	0.05	2	0.10
Total sum			1.00		2.52

Table 4.14 SIOC Internal Factor Evaluation (IFE) matrix

The table shows that the IFE final score is 2.52 which are a bit more than 2.5 and it means the strengths may overcome the weaknesses in SIOC.

4.6.3 Matching stage

This stage includes SWOT analysis and Internal-External analysis which will be described in general and for the case of SIOC in the following.

4.6.3.1 SWOT analysis

In SWOT analysis, external and internal factors are studied so that corporate opportunities, threats, strengths and weaknesses in future are identified in order to prepare suitable strategies in case of facing them. To conduct this analysis, a SWOT matrix is used. It is one of the important tools for comparison of information about external and internal factors. Then, different kinds of possible strategies can be presented as follows⁴⁵¹:

- **SO Strategies:** In this case, internal strengths and external opportunities are compared to each other and then the suitable related strategies will be prepared. Based on these kinds of strategies, corporate tries to apply external opportunities by using internal strengths.
- **WO Strategies:** At this stage, internal weaknesses are compared to external opportunities and then the suitable related strategies will be prepared. The aim of these strategies is to improve corporate internal weaknesses by using external opportunities.
- **ST Strategies:** In this part, internal strengths are compared to external threats and then the suitable related strategies will be prepared. By applying these strategies, corporates try to decrease or eliminate the effects of external threats by using internal strengths.
- **WT Strategies:** In this manner, internal weaknesses are compared to external threats and then the suitable related strategies will be prepared. Corporate which applies these kinds of strategies have a defensive style. In this situation, the aim is to reduce internal weaknesses and avoid external threats.

⁴⁵¹ S. M. Aarabi (2013), *The Handbook of Strategic Planning*, Mohtasham Publications, Tehran- Iran, ISBN: 964-379-095-9, p. 54-55 (Persian)

Based on the above mentioned explanations and the EFE and the IFE matrixes, the SIOC SWOT matrix has been prepared by consulting some related experts as table 4.15:

		Strengths		Weaknesses	
		Internal factors	External factors		
		S1	IMIDRO's desire for exploration and implementation of developmental projects in SIOM	W1	Lack of sufficient attention to the Research and Development (R&D)
		S2	Existence of adequate and reliable geological and exploration basic information	W2	Existence of surplus manpower and low productivity of unproductive and non-operational employees
		S3	Easy access to raw materials and security supply of crude iron ore by IMIDRO	W3	Lack of adequate responsibility and inside corporate synergies of the personnel
		S4	Iron ore high average grade and proper process behavior	W4	Severe water shortage due to severe droughts in the region and the country
		S5	Existence of local empower contractors and consultants	W5	Remoteness from seaports and major country's steel plants
		S6	Possibility of producing clean energies by using solar and wind due to climate of the area	W6	The lack of adequate financial relationship between direct revenue of personals and the SIOC profit
		S7	Possibility of getting revenue and using the profits for the SIOC development projects	W7	Lack of a comprehensive Information Management System (IMS)
Opportunities		Strategies based on Strengths and Opportunities (SO)		Strategies based on Weaknesses and Opportunities (WO)	
O1	Existence of more than one billion tons of iron ore reservoirs in SIOM	SO1: Deployment of new technologies and methods for sustainable water consumption reduction SO2: Exploitation of the first iron ore concentrator plant and implementing of development projects by sell-out (divestment) or with cooperation of private sector SO3: Establishing of a public company and allocating some parts of the shares to the local people		WO1: Settlement of suitable comprehensive Information Management System (IMS) in SIOC WO2: Improvement of R&D conditions by creating motivating system with the cooperation of private sector WO3: Establishing a fund for mine rehabilitation and sustainable land development and supporting employment after mine closures	
O2	Existence of the country's relatively cheap, abundant energy resources				
O3	Continued growth in demand for the SIOM products in the country, Middle East and Southeast Asia				
O4	Willingness of the private sector to invest in SIOM				
O5	Fluctuations in oil prices in the international market				
O6	Absence of severe restrictions on the land use in the area				
O7	Recent technological advances in the field of water management				
O8	Proper coordination and cooperation of local communities				
Threats		Strategies based on Strengths and Threats (ST)		Strategies based on Weaknesses and Threats (WT)	
T1	Lack of a comprehensive and efficient method for determining the crude iron ore price	ST1: Construction of an airport in Khaf County by cooperation of governmental and private institutions' investors ST2: Defining of a comprehensive crude iron ore pricing method by considering all the effective factors ST3: Implementing of solar and wind energy producing projects ST4: Selling the SIOC products through the Iranian material and energy exchange market		WT1: Reviewing of SIOC organization chart and transferring of surplus manpower to productive and operational sections and employment of new staff with different age, birth location and religious attitude ⁴⁵² WT2: Allocating some parts of SIOC shares to personnel in order to increase the productivity WT3: Performing cultural training programs against resource nationalism and religious conflict in the region	
T2	Existence resource nationalism and religious conflict in the region				
T3	Political sanctions				
T4	Iran government subtle intervention in the iron ore pricing				
T5	World financial crisis				
T6	Rising the prices of basic energy elements in Iran				
T7	Common border with Afghanistan				
T8	The limitations of labor law and social security regulations				
T9	Lack of airport in the region and shortage of infrastructures				

Table 4.15 SIOC SWOT matrix

⁴⁵² In the U.S. they call it "Equal Employment Opportunity" and it is a federal law. Simple definition for that is to eliminate discrimination based on race, color, age, sex, national origin, religion or physical disability.

4.6.3.2 Internal-external analysis

Internal-External (IE) matrix is a tool for external and internal factors analysis at the same time. The matrix is used for determining the corporate position. For making the matrix, EFE and IFE matrixes final rates should be placed in the vertical and horizontal directions respectively. IE matrix is presented in two figures: nine squares and four squares. Since four groups of strategies (SO, ST, WO and WT) are determined for corporate based on SWOT analysis and the obtained position in IE matrix shows the emphasized area for strategies in SWOT framework, so the four squares matrixes is more suitable⁴⁵³.

Based on EFE and IFE matrixes final rates, In four squares matrix (fig. 4.10) if, the corporate falls in square I of the four-square matrix, the strategy is conservative (protection - inside support); in square II, the strategy is aggressive (growth and development); in square III, the strategy is defensive (retrenchment, divestment and liquidation) and finally in square IV, the strategy is competitive (protection - outside support)⁴⁵⁴.

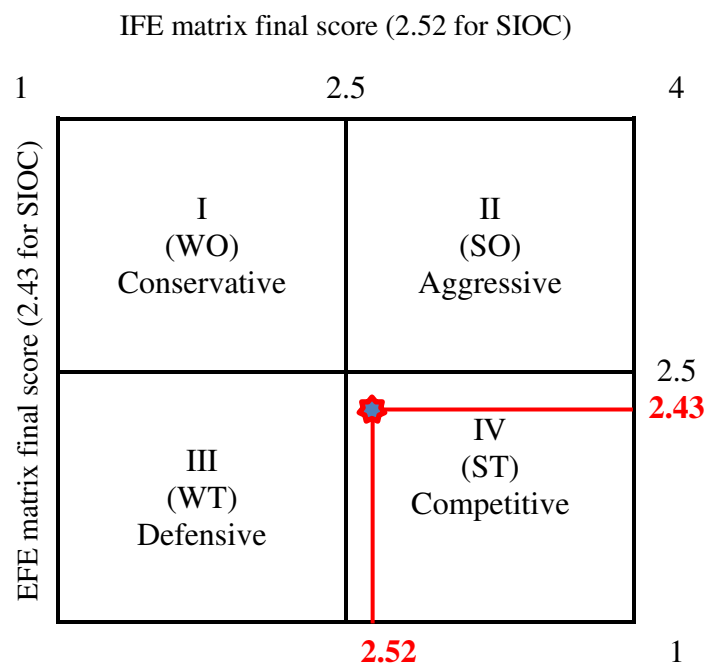


Figure 4.35 SIOC four squares internal-external matrix

⁴⁵³ S. M. Aarabi (2013), *The Handbook of Strategic Planning*, Mohtasham Publications, Tehran- Iran, ISBN: 964-379-095-9, p. 56 (Persian)

⁴⁵⁴ S. M. Aarabi (2013), *The Handbook of Strategic Planning*, Mohtasham Publications, Tehran- Iran, ISBN: 964-379-095-9, p. 57 (Persian)

Based on SIOC EFE and IFE matrixes` final scores, the SIOC position is placed in square IV, so the strategies for SIOC should be competitive (ST).

4.6.4 Decision making stage

At the final stage, identified strategies in previous stage (matching stage) are evaluated and analyzed by using Quantitative Strategic Planning Matrix (QSPM) without involving personal perceptions. This matrix illustrates relative attraction of various strategies and also presents a clear base for choosing specific strategies⁴⁵⁵.

To present QSPM of SIOC (table 4.16), six stages have been performed based on IMIDRO`s strategic plan model as follows:

- a) External major opportunities and threats and internal major strengths and weaknesses have been written in left hand side column of QSPM.
- b) The same weights of EFE and IFE matrixes have been put in weight column.
- c) ST strategies of SIOC SWOT matrix have been placed at the above row of QSPM.
- d) The factors have been ranked as 1 (without attractiveness), 2 (somewhat attractive), 3 (with reasonable attractiveness) and 4 (very attractive).
- e) Then, the score of each factor has been calculated with the multiplication of weight and rank.
- f) Finally, the total attractiveness scores for the ST strategies have been derived from the sum of the scores columns of QSPM.

ST strategies gained from SIOC SWOT matrix are as follows:

ST1: Construction of an airport in Khaf County by cooperation of governmental and private institutions` investors

ST2: Defining of a comprehensive crude iron ore pricing method by considering all the effective factors

ST3: Implementing of solar and wind energy producing projects

ST4: Selling the SIOC products through the Iranian material and energy exchange market

⁴⁵⁵ S. M. Aarabi (2013), *The Handbook of Strategic Planning*, Mohtasham Publications, Tehran- Iran, ISBN: 964-379-095-9, p. 69 (Persian)

		Success determining main factors		weight	strategy ST1		strategy ST2		strategy ST3		strategy ST4	
					rank	score	rank	score	rank	score	rank	score
External factors	Opportunities	O1	Existence of more than one billion tons of iron ore reservoirs in SIOM	0.12	4	0.48	4	0.48	3	0.36	4	0.48
		O2	Existence of the country's relatively cheap, abundant energy resources	0.06	3	0.18	2	0.12	1	0.06	2	0.12
		O3	Continued growth in demand for the SIOM products in the country, Middle East and Southeast Asia	0.04	3	0.12	4	0.16	2	0.08	4	0.16
		O4	Willingness of the private sector to invest in SIOM	0.10	4	0.4	4	0.4	3	0.3	3	0.3
		O5	Fluctuations in oil prices in the international market	0.12	2	0.24	3	0.36	3	0.36	2	0.24
		O6	Absence of severe restrictions on the land use in the area	0.03	2	0.06	1	0.03	4	0.12	1	0.03
		O7	Recent technological advances in the field of water management	0.08	1	0.08	1	0.08	1	0.08	1	0.08
		O8	Proper coordination and cooperation of local communities	0.06	2	0.12	1	0.06	2	0.12	1	0.06
	Threats	T1	Lack of a comprehensive and efficient method for determining the crude iron ore price	0.08	1	0.08	4	0.32	1	0.08	3	0.24
		T2	Existence resource nationalism and religious conflict in the region	0.05	2	0.1	2	0.1	1	0.05	1	0.05
		T3	Political sanctions	0.05	1	0.05	2	0.1	3	0.15	2	0.1
		T4	Iran government volatile intervention in the iron ore pricing	0.05	1	0.05	4	0.2	1	0.05	4	0.2
		T5	World financial crisis	0.05	1	0.05	3	0.15	2	0.1	3	0.15
		T6	Rising the prices of basic energy elements in Iran	0.03	2	0.06	4	0.12	4	0.12	2	0.06
		T7	Common border with Afghanistan	0.02	3	0.06	1	0.02	2	0.04	2	0.04
		T8	The limitations of labor law and social security regulations	0.03	2	0.06	1	0.03	2	0.06	1	0.03
T9		Lack of airport in the region and shortage of infrastructures	0.03	4	0.12	1	0.03	2	0.06	2	0.06	
weights total sum				1.00								
Internal factors	Strengths	S1	IMIDRO's desire for exploration and implementation of developmental projects in SIOM	0.12	4	0.48	3	0.36	4	0.48	1	0.12
		S2	Existence of adequate and reliable geological and exploration basic information	0.04	1	0.04	3	0.12	1	0.04	1	0.04
		S3	Easy access to raw materials and security supply of crude iron ore by IMIDRO	0.08	3	0.24	3	0.24	1	0.08	2	0.16
		S4	Iron ore high average grade and proper process behavior	0.10	2	0.2	4	0.4	2	0.2	4	0.4
		S5	Existence of local empower contractors and consultants	0.06	3	0.18	2	0.12	3	0.18	1	0.06
		S6	Possibility of producing clean energies by using solar and wind due to climate of the area	0.03	1	0.03	1	0.03	4	0.12	1	0.03
		S7	Possibility of getting revenue and using the profits for the SIOC development projects	0.10	3	0.3	1	0.1	3	0.3	3	0.3
	Weaknesses	W1	Lack of sufficient attention to the Research and Development (R&D)	0.04	1	0.04	2	0.08	3	0.12	2	0.08
		W2	Existence of surplus manpower and low productivity of unproductive and non-operational employees	0.08	1	0.08	1	0.08	1	0.08	1	0.08
		W3	Lack of adequate responsibility and inside corporate synergies of the personnel	0.05	2	0.1	2	0.1	1	0.05	1	0.05
		W4	Severe water shortage due to severe droughts in the region and the country	0.12	1	0.12	1	0.12	1	0.12	1	0.12
		W5	Remoteness from seaports and major country's steel plants	0.07	2	0.14	4	0.28	2	0.14	4	0.28
		W6	Lack of adequate financial relationship between direct revenue of personals and the SIOC profit	0.06	1	0.06	1	0.06	1	0.06	2	0.12
		W7	Lack of a comprehensive Information Management System (IMS)	0.05	2	0.1	2	0.1	2	0.1	2	0.1
Weights' total sum				1.00								
Total attractiveness scores					4.42	4.95	4.26	4.34				

Table 4.16 Quantitative Strategic Planning Matrix (QSPM) of SIOC

According to the QSPM of SIOC, the priority of ST strategies has been shown in table 4.17.

Priority	Strategy	Total Score
1	ST2: Defining a comprehensive crude iron ore pricing method by considering all the effective factors	4.95
2	ST1: Construction of an airport in Khaf County by cooperation of governmental and private institutions` investors	4.42
3	ST4: Selling the SIOC products through the Iranian material and energy exchange market	4.34
4	ST3: Implementing solar and wind energy producing projects	4.26

Table 4.17 SIOC ST strategies priority

Chapter 5

Stakeholder Surveys about SIOM, Results and Consequences

5 Stakeholder surveys about SIOM, results and consequences

5.1 Measures and results

To get useful ideas and comments about sustainable strategic management from local external and internal stakeholders in SIOM area, two questionnaires including questions about mining and mineral industries activities and their influence on local community had been prepared and distributed among residents at the zone of under direct influence of mine site around Sangan during the research period (2012-2015)⁴⁵⁶.

To get a better insight of general status of Khaf County, a brief introduction is presented in 5.1.1 using the population growth rate and literacy rate statistics. This section helps to understand the ambience of the place where respondents to questionnaires live. The most important obtained outputs from questionnaires and an analysis of them are presented in 5.1.2 and 5.1.3. The outputs of two questionnaires have been compared and analyzed in 5.1.4.

5.1.1 Statistical analysis of population growth rate and literacy rate in Khaf County in comparison to Khorasan-e-Razavi Province and Iran

In this section, some indicators in Khaf County, Khorasan-e-Razavi Province, and Iran were compared by the data of population and housing census report in 1966, 1976, 1986, 1996, 2006, and 2011.

5.1.1.1 Population Growth Rate

Population growth refers to the change in population over time, and can be quantified as the change in the number of individuals in a population using "per unit time" for measurement. Table 5.1 shows population during 6 censuses in Iran, Khorasan-e-Razavi Province and Khaf County.

⁴⁵⁶ The stakeholder analysis is focusing on external effects of SIOM and does not include internal financial results like profit, return on investment etc.

Year	Population		
	Iran	Khorasan-e-Razavi	Khaf
1966	25,078,923	2,497,381	51,957
1976	33,708,744	3,264,398	60,607
1986	49,445,010	4,086,182	90,173
1996	60,055,488	4,719,902	92,158
2006	70,495,782	5,593,079	110,378
2011	75,149,669	5,994,402	121,859

Table 5.1 Population in Iran, Khorasan-e-Razavi Province and Khaf County⁴⁵⁷

The population of Khaf County has grown from 51,957 in 1966 to 121,859 in 2011 which is a 42% increase during the period. Population trends in Khaf County are shown in figure 5.1 in 5-year intervals. As can be seen, the population of Khaf County has significantly increased from 1981 to 1986 which can be attributed to the migration of Afghans to Iran and has declined from 1991 to 1996. One of the main reasons for this decreasing can be returning back Afghans to their origin country. Since the development of mining and related projects improved the economic and social conditions in the region, the population had an increasing trend from 1996 which is in compliance with the increasing trend in the whole country.

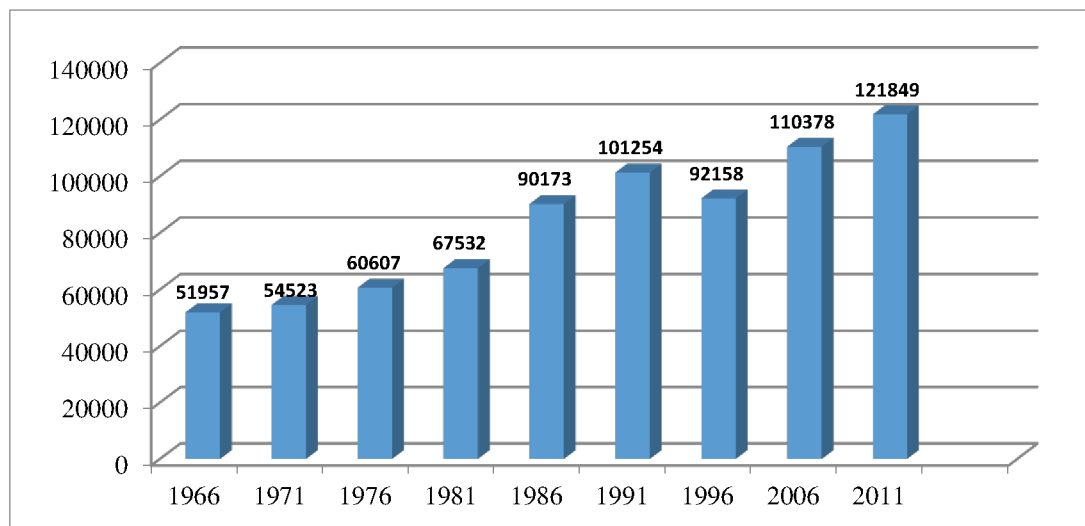


Figure 5.1 Population of Khaf County from 1966 to 2011 per each 5 years⁴⁵⁸

⁴⁵⁷ Statistical Pocketbook of the Islamic Republic of Iran, Statistical Center of Iran (SCI), 2011 <http://amar.org.ir>

⁴⁵⁸ Statistical Pocketbook of the Islamic Republic of Iran, Statistical Center of Iran (SCI), 2011 <http://amar.org.ir>

The comparison of the growth rate in Khaf County, Khorasan-e-Razavi Province and Iran is illustrated in figure 5.2.

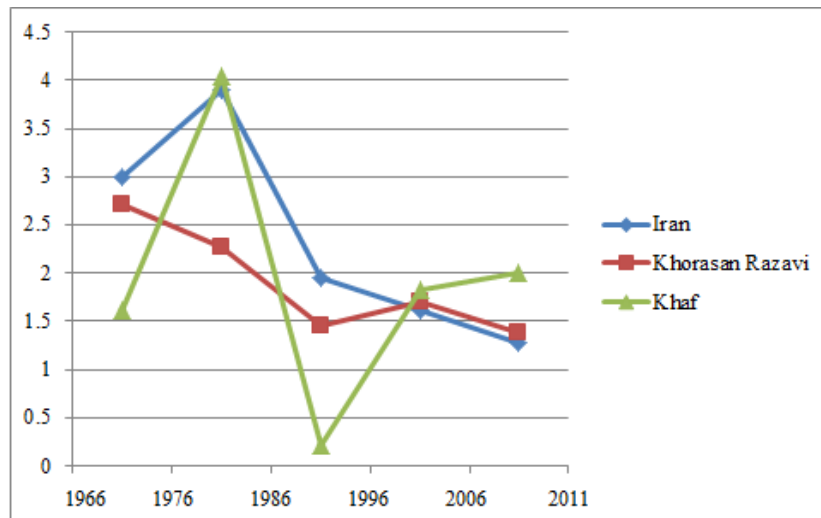


Figure 5.2 Population growth rate trend⁴⁵⁹ during 5 periods in Iran, Khorasan-e-Razavi Province and Khaf County⁴⁶⁰

During 1966 – 1976, the population growth rate increased from 3.001 to 3.9 percent in Iran while Khorasan-e-Razavi Province shows a different pattern and its growth rate has declined from 2.71 to 2.27 percent. In Khaf County, the growth rate has significantly increased from 1.62 percent in 1966 to 4.05 percent in 1976.

In 1986 the growth rate has significantly decreased in three areas. It has declined to 1.61 percent in Iran in 2006, which has increased in both Khorasan-e-Razavi Province and Khaf County and then declined to 1.28 in Iran, and Khorasan-e-Razavi Province from 1.71 percent to 1.39 percent in 2011. In Khaf County, the growth rate increased from 1.82 percent to 1.998 percent in 2011.

To know how the population in future changes, a prediction has been made using the relevant formula. Trend of population change in future helps national and local governors to plan realistically for the needs of the residents. Besides, mining industry officials in Khaf County need this projection to set doable developing strategies for the projects. Knowing the fact that population in Khaf may increase up to 220,652 by 2041 determines that more social and economic infrastructures (e.g. school, housing,

⁴⁵⁹ It should be noted that trends are depicted according to the time intervals presented in the reference. As seen in figure 5.1, the population decreased in 1996 which means a subtle fluctuation in the trend.

⁴⁶⁰ Statistical Center of Iran (SCI) (2011), *Statistical Pocketbook of the Islamic Republic of Iran*, Access at: <http://amar.org.ir>

job, transportation, sanitary facilities etc.) are required. Hence, SIOM and other private/governmental companies should include these issues in their future strategies, especially post-closure CSR activities. Table 5.2 shows the future increase in population in Iran, Khorasan-e-Razavi Province and Khaf County by 2041.

Year	Iran	Khorasan-e-Razavi	Khaf
2016	80,110,789	6,424,521	134,534
2021	85,399,426	6,885,503	148,528
2026	91,037,200	7,379,562	163,977
2031	97,047,160	7,909,072	181,033
2036	103,453,877	8,476,575	199,863
2041	110,283,543	9,084,799	220,652

Table 5.2 Future population growth in 25 years later in Iran, Khorasan-e-Razavi Province and Khaf County⁴⁶¹

5.1.1.2 Literacy rate

The literacy rate in Iran is the percentage of the population age of 6 and above who can understand, read and writes a short, simple statement on their everyday life⁴⁶². This indicator is calculated by dividing the number of literates aged 6 years and over by the corresponding age group population and multiplying the result by 100. The number of literates and the literacy rate are shown in table 5.3 in Iran, Khorasan-e-Razavi Province and Khaf County.

⁴⁶¹ The projections are research results which are based on the formula " $P_{t+n} = P_t(1+r)^n$ ", where P_{t+n} is the population in required year, P_t is the current population, r is growth rate and n the number of years for which the projected is calculated.

⁴⁶² Statistical Center of Iran (SCI) (2011), *Statistical Pocketbook of the Islamic Republic of Iran*, Access at: <http://amar.org.ir>

Area	Year	Population of 6 Years And Over	Number of Literates	Literacy Rate (%)
Iran	1966	18,843,123	5,532,353	29.36
	1976	27,112,844	12,877,075	47.49
	1986	38,708,879	15,506,666	40.05
	1996	52,294,979	41,582,277	79.51
	2006	63,920,157	54,076,453	84.60
	2011	67,681,876	57,361,682	84.75
Khorasan-e-Razavi Province	1966	1,892,307	442,971	23.40
	1976	2,604,641	1,040,267	39.93
	1986	4,081,892	1,299,698	31.84
	1996	5,210,755	4,216,031	80.91
	2006	5,020,073	4,326,540	86.18
	2011	5,335,442	4,604,741	86.30
Khaf County	1966	NA ⁴⁶³	NA	NA
	1976	NA	NA	NA
	1986	NA	NA	NA
	1996	73,973	54,411	73.55
	2006	95,137	75,123	78.96
	2011	104,031	84,216	80.95

Table 5.3 Population of 6 Years and Over and Literates and the Literacy Rate in Iran, Khorasan-e-Razavi Province and Khaf County⁴⁶⁴

The literacy rate trend in Iran, Khorasan-e-Razavi Province and Khaf County is shown in figure 5.3.

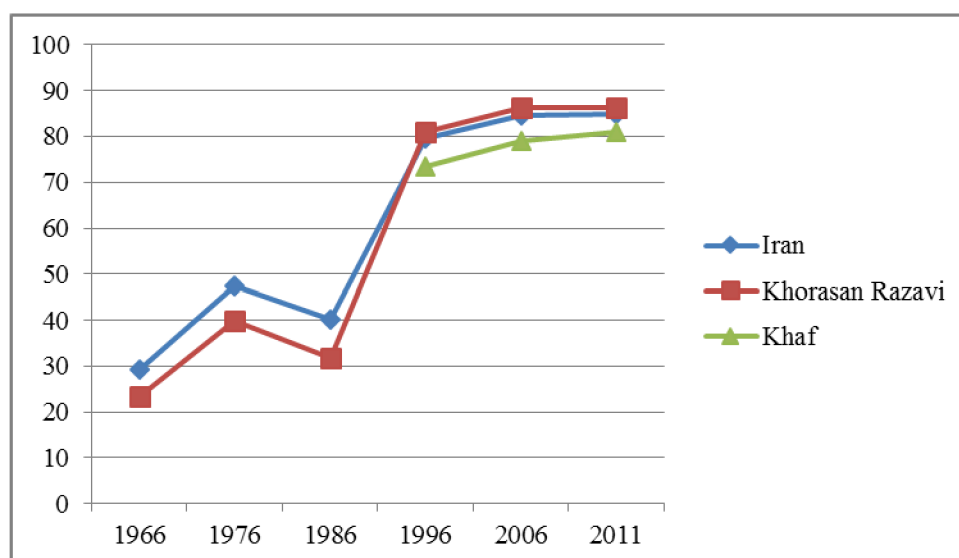


Figure 5.36 Literacy Rate Trend in Iran, Khorasan-e-Razavi Province and Khaf County

⁴⁶³ Not Available

⁴⁶⁴ Statistical Center of Iran (SCI) (2011), *Statistical Pocketbook of the Islamic Republic of Iran*, Access at: <http://amar.org.ir>

According to figure 5.3, there is an increasing trend for both Iran and Khorasan-e-Razavi Province during 1966- 1976, but the literacy rate has significantly decreased during 1976-1986 which is mainly due to the Islamic revolution, and the 8-year Iran-Iraq imposed war. Because of Literacy Movement Organization⁴⁶⁵, the literacy rate increased in Iran, Khorasan-e-Razavi and consequently in Khaf County after 1986.

5.1.2 Results of questionnaire no. 1 (QN1)

At the early stage of the research, a field research questionnaire (appendix 2) containing 21 questions related to the research topic was prepared and distributed among literate households as statistical population who live in the area around SIOM. 200 forms were filled and gathered in December 2012. The results of QN1 were statistically analyzed and the outputs were visually presented. The main aim of this measure was to draw a general picture of SIOM from local people point of view.

The degree of education (Figure 5.4) shows that more than 38% of respondents (literate households) have B.Sc. or higher degrees.

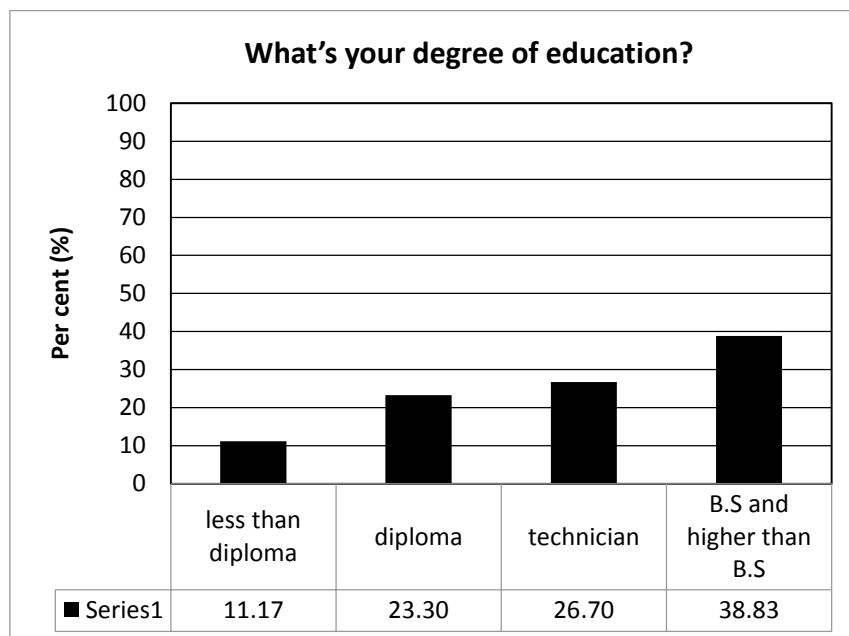


Figure 5.4 Respondents` degree of education in QN1

⁴⁶⁵ Literacy Movement Organization along with Ministry of Education works on education and training of illiterate adults, <http://www.lmoiran.ir/>

5.1.2.1 General questions⁴⁶⁶

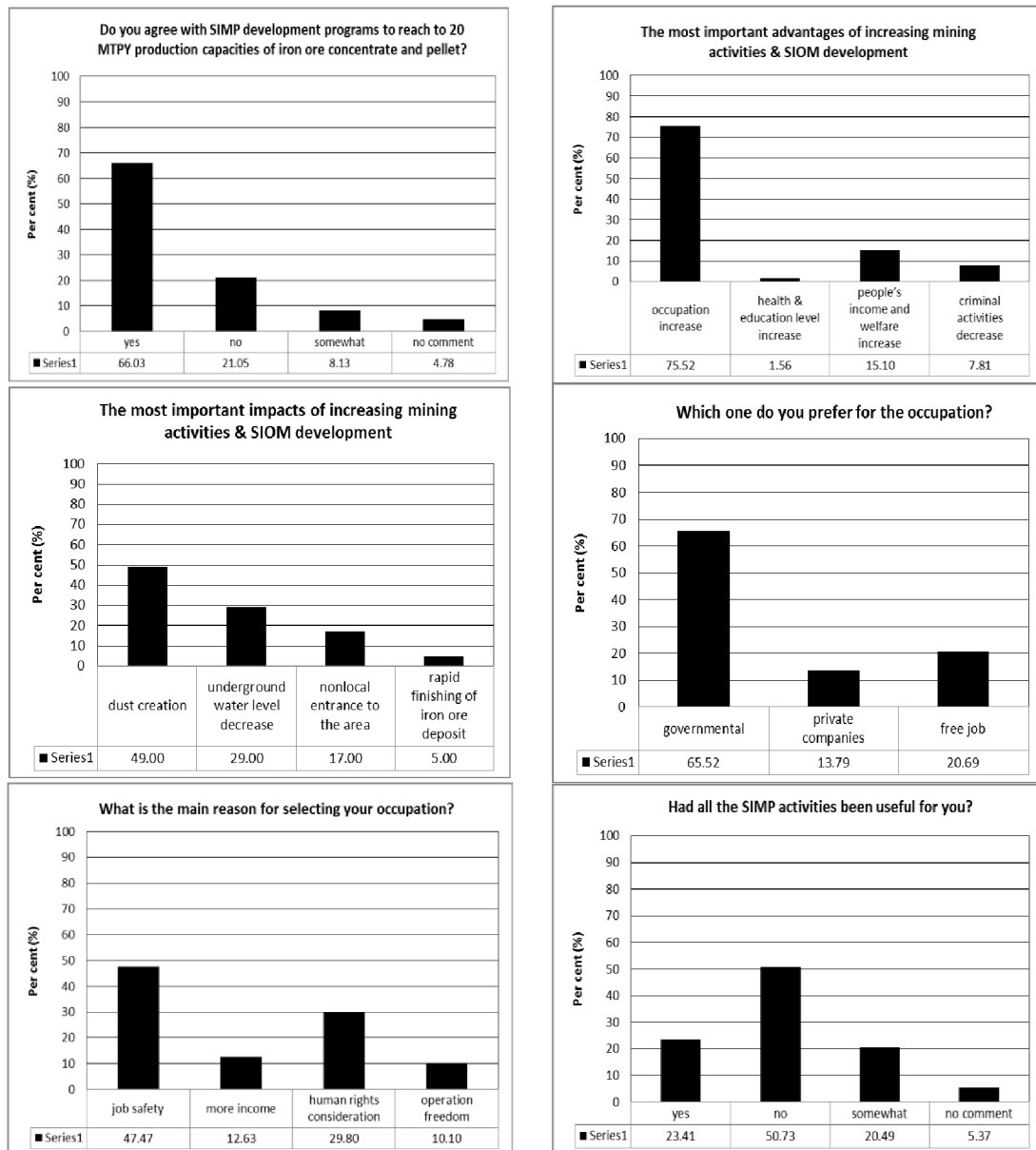


Figure 5.5 Graphs related to six general questions in QN1

As it can be seen, about 66% of the respondents agree with SIMP development programs to reach an annual production of 20 MTPY of iron ore concentrate and pellets. Obviously the majority of the people believe SIMP development will be helpful to the region.

Around 75% of the respondents believe that creating new jobs is the most important advantage of increasing mining activities. People are satisfied with employment caused by SIMP.

⁴⁶⁶ On that time, SIMP and IEIOC were active and popular in the research area; therefore the questions of QN1 were basically related to them.

49% of the respondents believe that dust formation is the most important ecological impact of increasing mining activities. This result is not related to SIMP and IEIOC activities alone, also active private mining companies in the area cause a lot of dust emissions, polluting the area consequently. This problem must be solved by the government and local authorities in Khaf County by enforcing these companies to use better dust deduction systems.

Around 51% of the respondents answered that SIMP activities have not been directly useful for them, while about 23% of them confirmed a positive impact. As the project is still in its early stages, the favorable impacts were not still tangible for the majority of the local people. However, it is expected that as SIMP develops, people change their mind and have better impressions about mining companies in the region.

5.1.2.2 Social responsibility questions

Six questions of the QN1 are directly related to the topic “social responsibility”. There are some small private companies active around SIOM for iron ore placer mining. They have both positive and negative effects on the surrounding environment and the society. As these companies create jobs, some of the local people have been involved with them. To make comparison between these private companies, SIMP and IEIOC in this regard, three questions about private companies’ social responsibilities activities are included in QN1. The responses are showed in the figure 5.6 and analyzed after that.

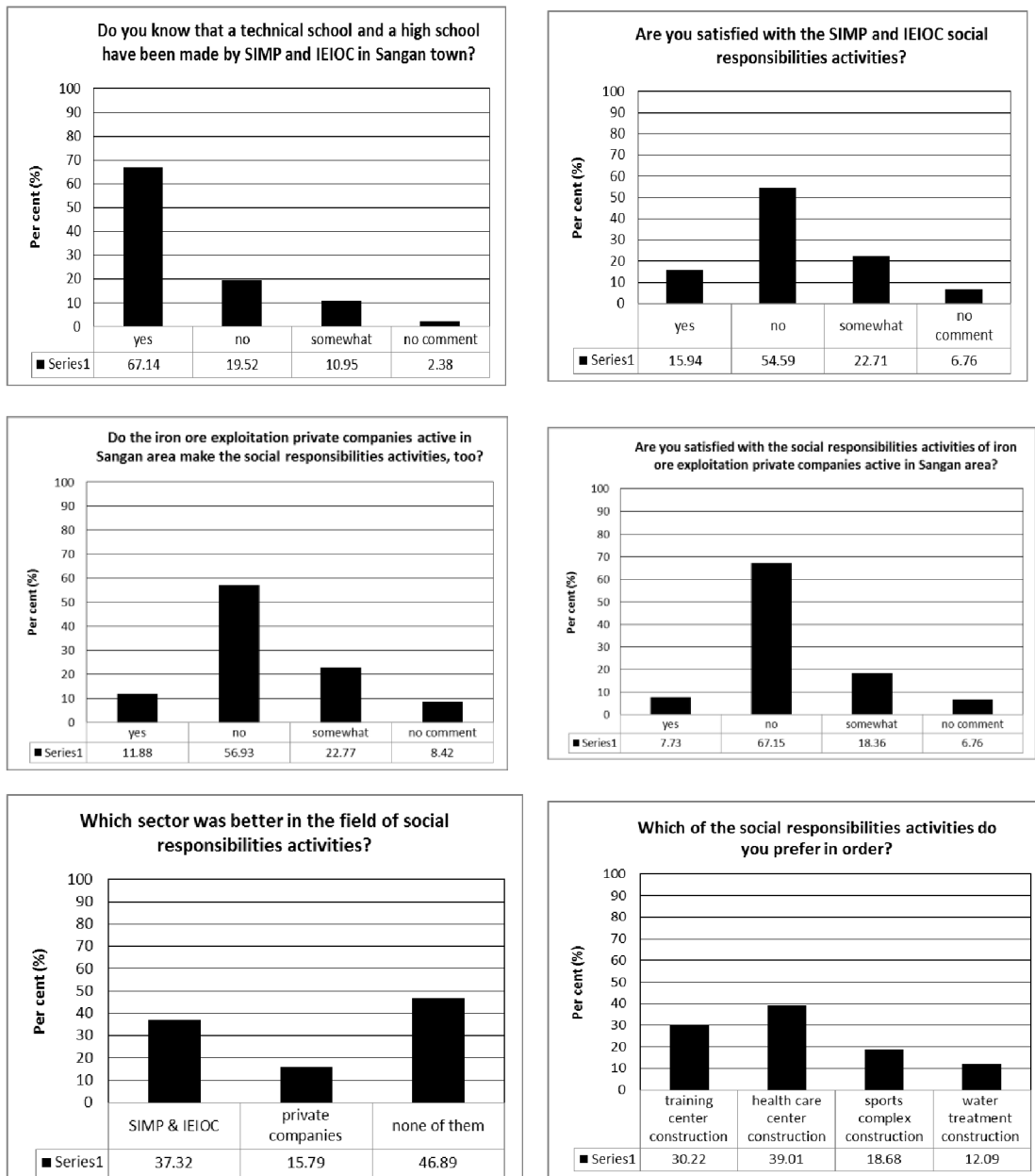


Figure 5.6 Graphs related to social responsibility questions in QN1

Approximately 67% of the respondents were aware of the construction of a new technical school and a high school for girls in Sangon by SIMP and IEIOC. However, about 55% of people were not satisfied with SIMP and IEIOC social responsibility activities (SRAs). Since there is not any concrete social development plan for this region, it seems such activities have not been based on a strategic plan developed by mutual agreement between the local community and SIMP. The assistance has been considered ad-hoc and more or less ineffective by the respondents.

Approximately 12% of the respondents believe that other private iron-ore mining companies active in Sangan area realize SRAs, but 67% of them are not satisfied with their activities. This result shows that these private companies should be encouraged by the government and local authorities in Khaf County to enforce social responsibility measures in their own activities. In this regard, a training program on benefits of SRAs for better performance will be useful for both private companies and local communities.

37% of the respondents believed that SIMP and IEIOC as state-owned companies are paying more attention to SRAs than private companies (16%). Based on former activities by SIMP and IEIOC in the mine area, it is partly reasonable. Approximately 20% have not been aware of the two main and important SRAs in Sangan (construction of a new technical school and a girl's high school).

Approximately 47% of the respondents believed that neither SIMP and IEIOC nor private companies are performing well in the field of SRAs. This is an indicator that mining companies should improve their SRAs, and/or improve their communication and dialogue about their SRAs. Almost 39% of the respondents preferred the construction of a health care center as a new SRA. 30% have voted for a new training center, 19% for a new sports complex and 12% for new water treatment facilities.

5.1.2.3 Main conclusions from QN1

Based on the results of general questions in QN1, it seems that the development of SIMP is accepted by the majority of the local people. They are aware of the direct and indirect benefits and assess the impacts of the mining activities positively⁴⁶⁷.

Based on the results of social responsibility questions in QN1, it seems that SIOM did not get a social license to operate (SLTO)⁴⁶⁸ completely. Losing a social license to operate (SLTO) is a very real and potentially very expensive risk to a business. The challenge for operators is balancing immediate stakeholder demands and the inherent value in being a socially and environmentally reliable operator with

⁴⁶⁷ J. Kretschmann and R. Amiri (2013), *The Sangan Iron Ore Mines: An example for modern mining in Iran*, in Proceedings of the Fourth International Symposium on Mineral Resources and Mine Development, Aachen, Germany, pp 517-530

⁴⁶⁸ The SLTO is an unwritten social contract. Unless a company earns that license and maintains it on the basis of good performance and community trust, there will undoubtedly be negative implications. In summary, the SLTO means that a project is accepted by a majority of its hosts, both local communities and the stakeholders of the host nation.

optimizing costs, lost production time, reputational damage and overflow impacts to other operations⁴⁶⁹. Nevertheless, regarding to the special conditions of SIOM area, the amount of SRAs in SIOM area is higher than in other mining areas in Iran. It is an ongoing measure for achieving social sustainable development⁴⁷⁰.

5.1.3 Results of questionnaire No. 2 (QN2)

In 2014, based on the research necessity, Questionnaire No. 2 (appendix 3) as the modified and improved version of QN1 was prepared and distributed among Khaf County residents for getting feedbacks and having realistic analysis for strategy development. The questioning themes include: education, satisfaction in life, infrastructures, job and income. It was distributed among 379 persons as statistical population⁴⁷¹ and results were analyzed and interpreted, accordingly. The outputs of QN2 are helpful for assessing the success or failure of the mining activities in the SIOM region, too. This questionnaire data were collected from 353 residents of Khaf city. Of these 353 persons, 59 were female and 282 were male. 12 persons did not respond to this question. 26 persons did not at all respond to the questionnaire.

5.1.3.1 Marital status and gender

Marital status and gender of the statistical population is shown in the table 5.4. Among all respondents, 72% were married and 18% were single.

⁴⁶⁹ EY's Global Mining & Metals Center (2015), *Business risks facing mining and metals 2014-2015*, P. 4, Access at: <http://www.ey.com/Publication/vwLUAssets/EY-Business-risks-facing-mining-and-metals-2014%E2%80%932015>

⁴⁷⁰ J. Kretschmann and R. Amiri (2013), *Social responsible mining in east Iran: The Sangan Iron Ore Mines*, 23rd World Mining Congress, Montreal, Canada, Canadian Institute of Mining (CIM)

⁴⁷¹ This figure is calculated according to Cochran sample size formula. Reference: W. G. Cochran, (1977), *Sampling Techniques*, 3rd Edition, New York: John Wiley & Sons, ISBN: 978-0-471-16240-7

Respondents	Number	Share
Female	59	17%
Widow or divorced	6	10%
Married	18	31%
Single	25	42%
Fiancée	10	17%
Male	282	83%
Widow or divorced	3	1%
Married	231	82%
Single	38	13%
Fiancée	10	4%
Unspecified	12	
Total married	249	72%
Total single	63	18%

Table 5.4 Marital status and gender of respondents to QN2

5.1.3.2 Degree of education

The status of all respondents' education degree is shown in figure 5.7 which shows that about 47% have a high school diploma or below. Since about 72% of the respondents are married, it indicates that education condition in this area was not so good during the last 20 years. In table 5.5, the status of education is shown by gender.

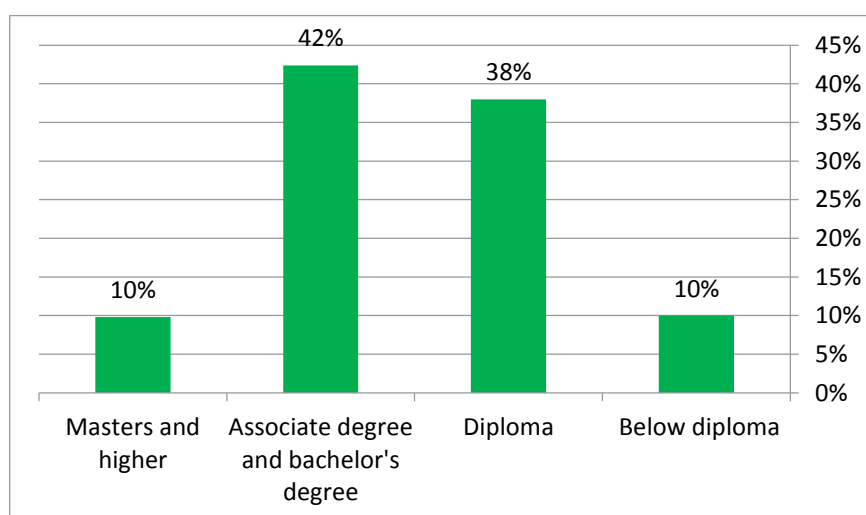


Figure 5.7 Status of all respondents' education degree in QN2

Marital Status According to Gender	Share
Female	17%
Below diploma	2%
Diploma	22%
Associate degree and bachelor's degree	55%
Masters and higher	22%
Male	82%
Below diploma	9%
Diploma	42%
Associate degree and bachelor's degree	40%
Masters and higher	7%
Unspecified	1%
Below diploma	20%
Diploma	20%
Associate degree and bachelor's degree	60%

Table 5.5 Status of education degree by gender in QN2

5.1.3.2 Population variety

Based on the results of QN2, the population of the respondents' families was not so high. As seen in table 5.6, only 27% of respondents live in the home with a population of more than five people.

The number of people living at home	Share
Above 6	9%
5 To 6	18%
3 To 4	31%
1 To 2	36%
Blank	5%

Table 5.6 Number of people living at a home together in QN2

Among the families, 59% of them have children less than 7 years which is shown in figure 5.8.

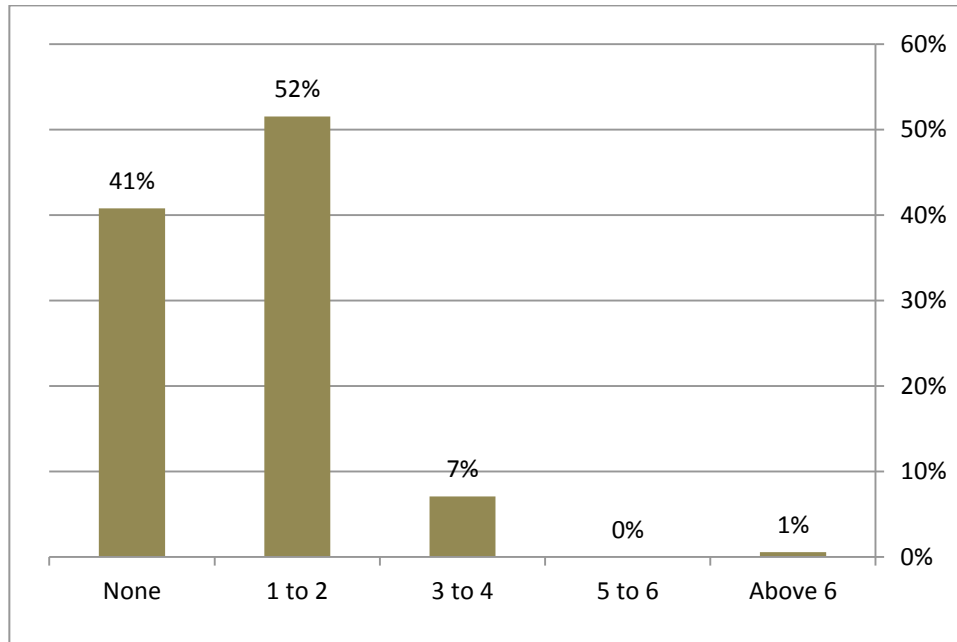


Figure 5.8 Numbers of children less than 7 years old

In figures 5.9 and 5.10, number of persons in the family aged from 7 to 18 and from 18 to 25 years is shown respectively.

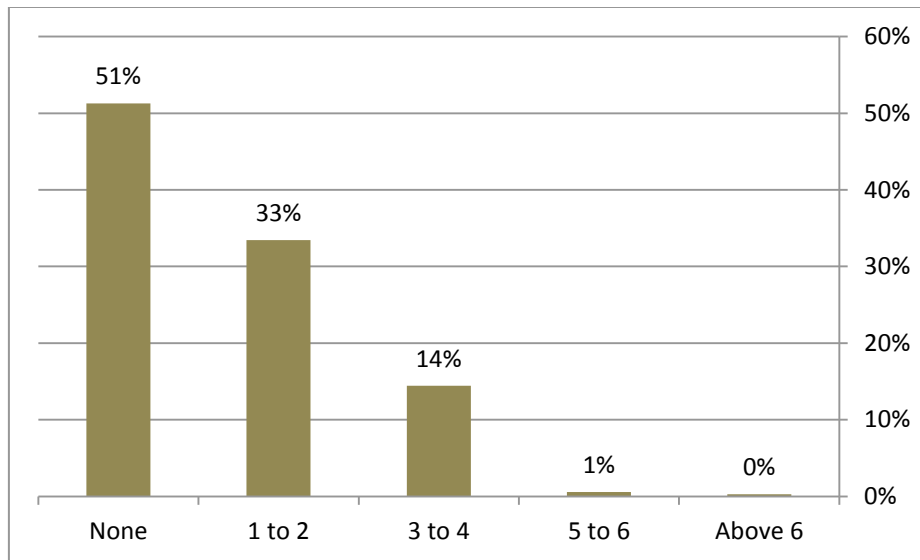


Figure 5.9 Numbers of persons in the family from 7 to 18 years old in QN2

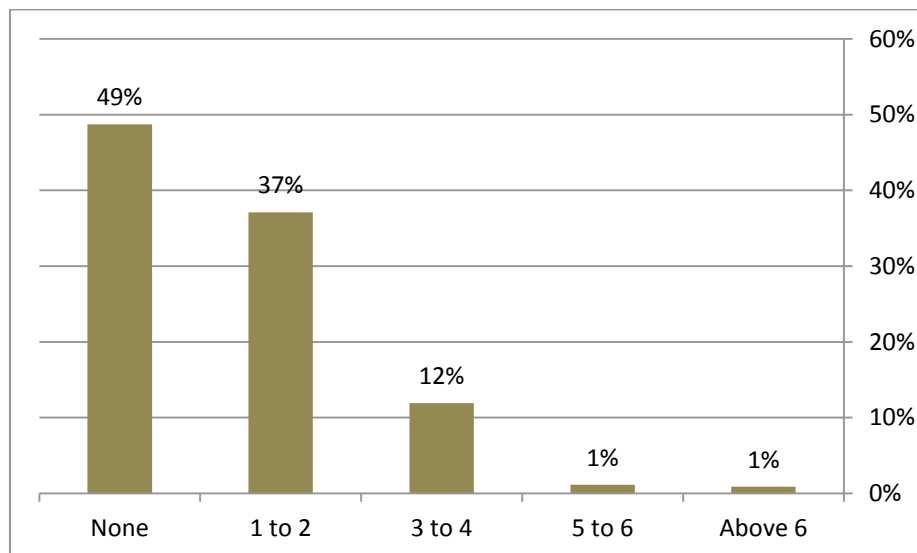


Figure 5.10 Numbers of persons in the family from 18 to 25 years old in QN2

Out of 353 people, 209 have at least one child less than 7 years. It is notable that 91 of the 179 residents, who stated that there is nobody aged 7 to 18 among their family members, had a child younger than 7 years old. Meanwhile, 92 of the 172 residents, who stated that there is nobody from 18 to 25 years old among their family members, had a child younger than 7 years. It clearly shows the young age of respondents' family members which can be generalized to Khaf County. Obviously, job creation for them in near future is a necessity which is possible by implementing SIOM development projects.

5.1.3.3 Literacy

Literacy in Iran is the ability of the population age of 6 and above who can understand, read and writes a short, simple statement on their everyday life⁴⁷². The inability to do so is called illiteracy or analphabetism. Figure 5.11 is the result of QN2 regarding this subject.

⁴⁷² Statistical Center of Iran (SCI) (2011), *Statistical Pocketbook of the Islamic Republic of Iran*, Access at: <http://amar.org.ir>

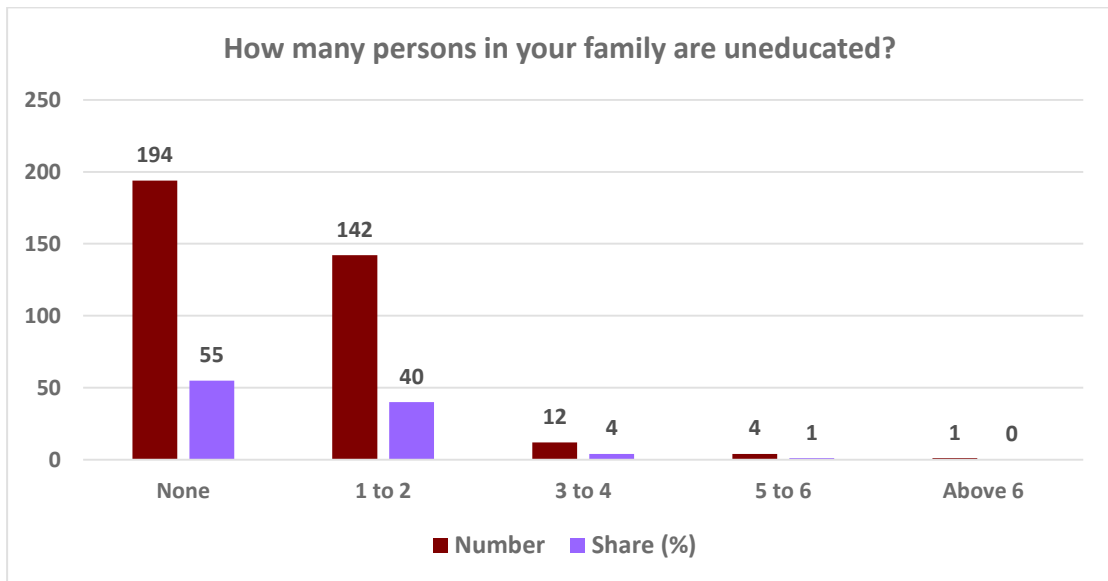


Figure 5.11 Number of uneducated (Illiterate) persons in families in QN2

It is noteworthy that of the 159 people who said at least one person in their family is uneducated, 125 people have stated that they had at least one child younger than 7 years, and only 34 of them said, despite of not having a child younger than 7 years old, they have uneducated people in the family. This shows the growth of literacy in the region which can be attributed to national literacy movements and SIMP's SRAs as the first mining project in SIOM.

5.1.3.4 Girls' high school and boys' technical school

As mentioned in chapter 3, a girls' high school and boys' technical school have been constructed by SIMP⁴⁷³ in 1992 and 2010 respectively as social responsibilities activities.

According to the results of this survey, around 68% of respondents know that girls' high school and boys' technical school were built by SIMP and IEIOC. However, 58% of them believe that the implementation of SIOM projects effects on the level of education in the region. The respondents' idea regarding SIOM projects and level of education is presented in table 5.7.

⁴⁷³ SIMP was established in 1983.

Do you think that the implementation of SIOM projects effects on the level of education?	Number	Share
Yes	203	58%
No	115	32%
No comment	35	10%

Table 5.7 Effects of SIOM projects on level of education based on QN2

5.1.3.5 University degree

Regarding the status of university education of family members, one question in QN2 was assigned to this issue. The results which are summarized in figure 5.12 show that 63% of respondents have at least one university graduated person in their families. In fact, it indicates the better education condition for the new generation. Although the situation is the same in the whole country, SIOM might have a special motivating role for youth in the area to get their higher degrees. In other words, SIOM seems like an opportunity for youth to get employed so that they are motivated to continue their studies.

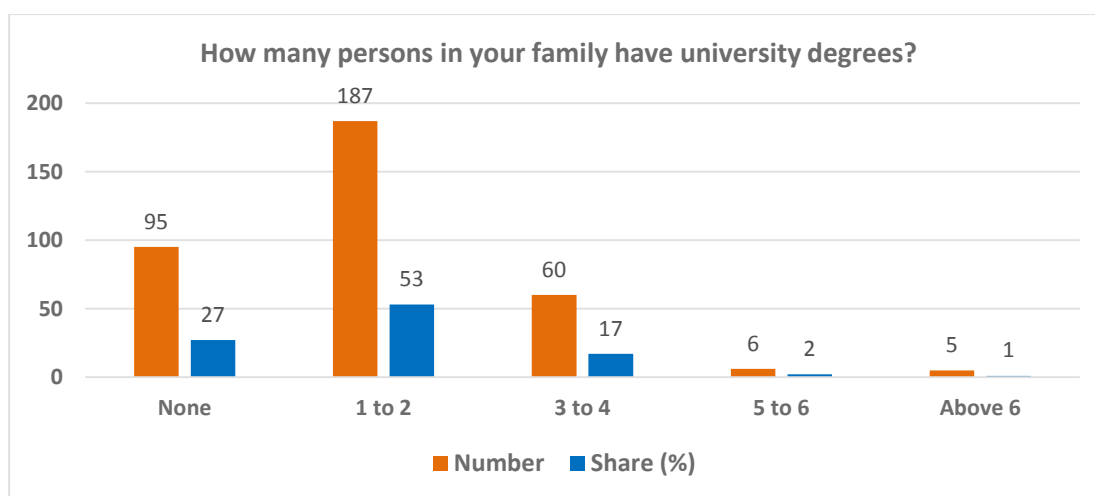


Figure 5.12 The status of holding university degree by family members in QN2

5.1.3.6 Employment

In order to have a better image of employment and unemployment situation in SIOM area, some questions were asked in QN2, the results of which are shown in figure 5.13.

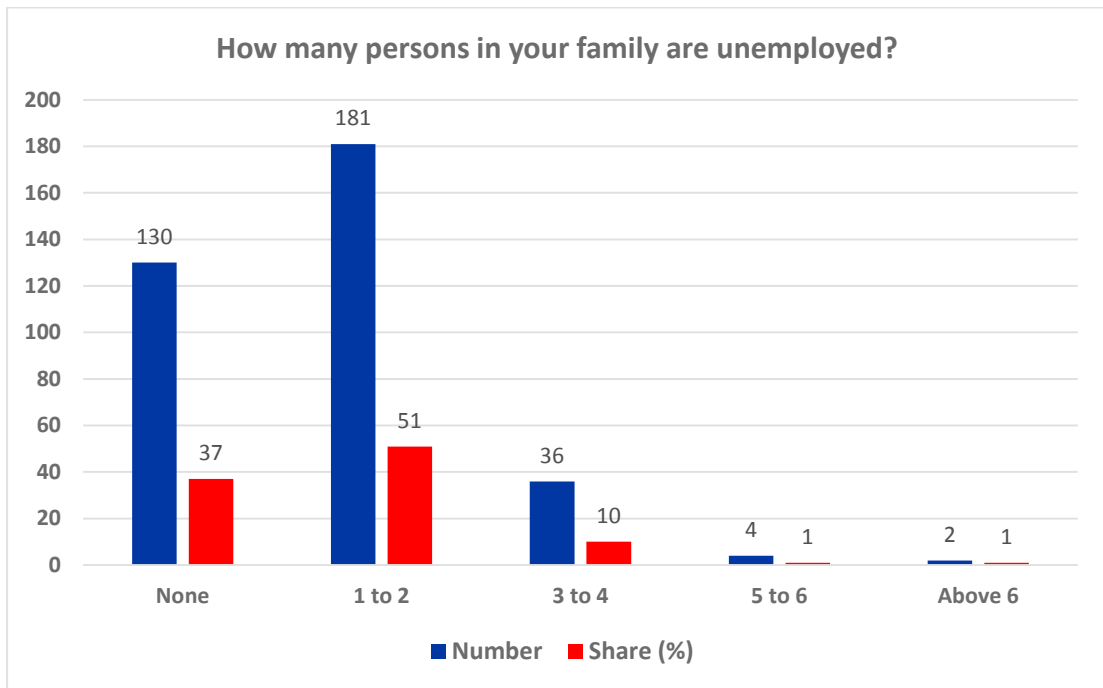


Figure 5.13 Unemployed people in respondents' families in QN2

According to figure 5.13, around 63% of respondents reported that at least one of their family members is unemployed. This can be attributed to this fact that despite of indirect job creation by SIOM projects in the region, people like to be employed directly in SIOM. So, this figure cannot be correct because based on valid data, in Khaf County, the annual unemployment rate was around 7.5% between 1996 and 2001, but because of new job opportunities related to SIOM the rate decreased to 3.5% until 2009. According to the studies, the mining activities had considerable positive effect on job creation⁴⁷⁴.

Meanwhile, of the 222 people who reported at least one of their family members is unemployed, 157 people reported that they have at least one child younger than 7 years⁴⁷⁵. This indicates that although the employment rate in the region is acceptable currently, job creation for the young people (especially in downstream industries and dependent services) will be a necessity.

⁴⁷⁴ A. Tavakoliroodi (2012), *Security, political and economic effects of mining activities in SIOM*, Published by Taybad Azad University, p. 183 (Persian)

⁴⁷⁵ It can be inferred that young mothers are not willing to be employed in official positions and prefer to stay at home and raise their children.

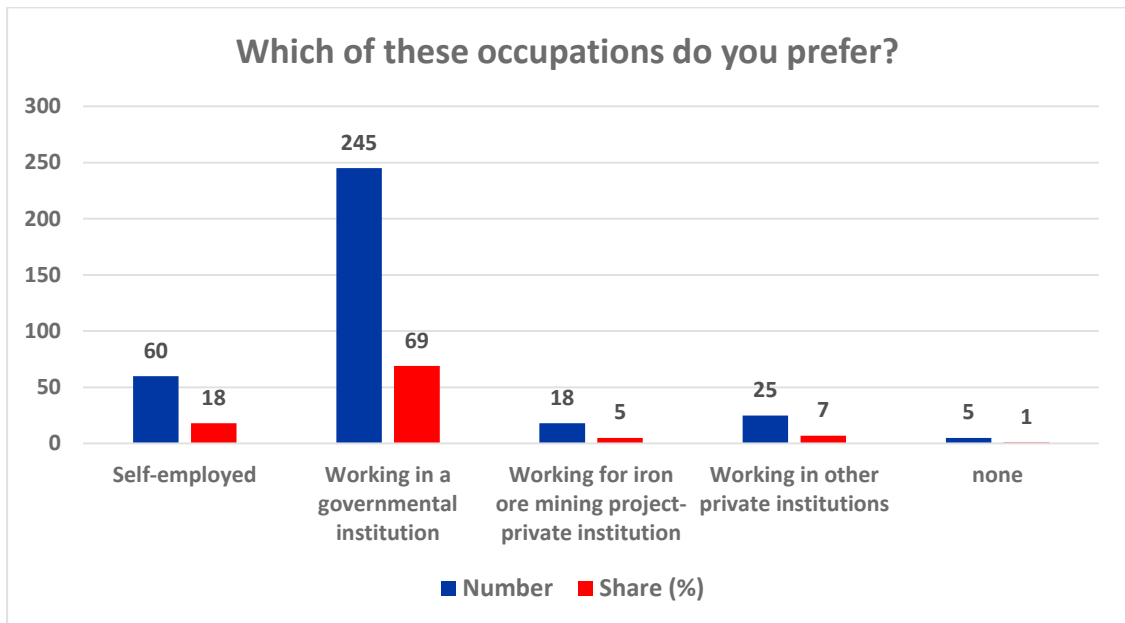


Figure 5.14 Occupation preferences in QN2 respondents

Figure 5.14 shows that most of the respondents (69%) prefer to be employed in governmental companies. It is clearly related to job security and regular salary payment in such institutions.

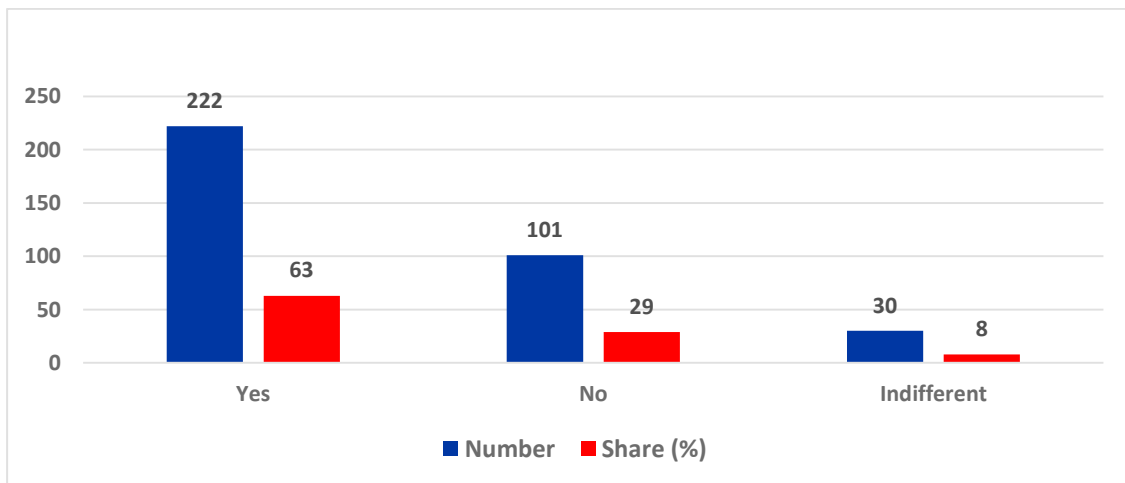


Figure 5.15 Interests in employment in private companies under SIOM projects in QN2

Figure 5.15 illustrates that, 63% of respondents are interested to be employed in private companies under SIOM projects which are implemented by private institutions. It indicates after governmental companies, private ones are the second occupation priority for people.

Although 101 of respondents do not have interest in working in SIOM projects, 55 of them believed SIOM projects created more jobs for local people. Figures 5.16 and 5.17 show the status of SIOM projects` job creation for local people and employment opportunities for their children in the future.

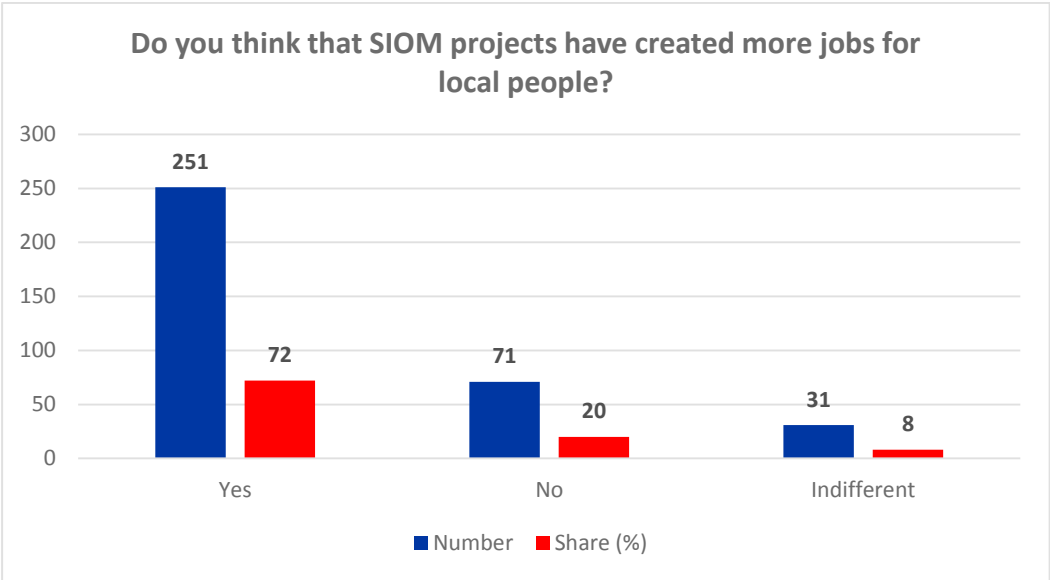


Figure 5.16 Status of SIOM projects job creation in QN2

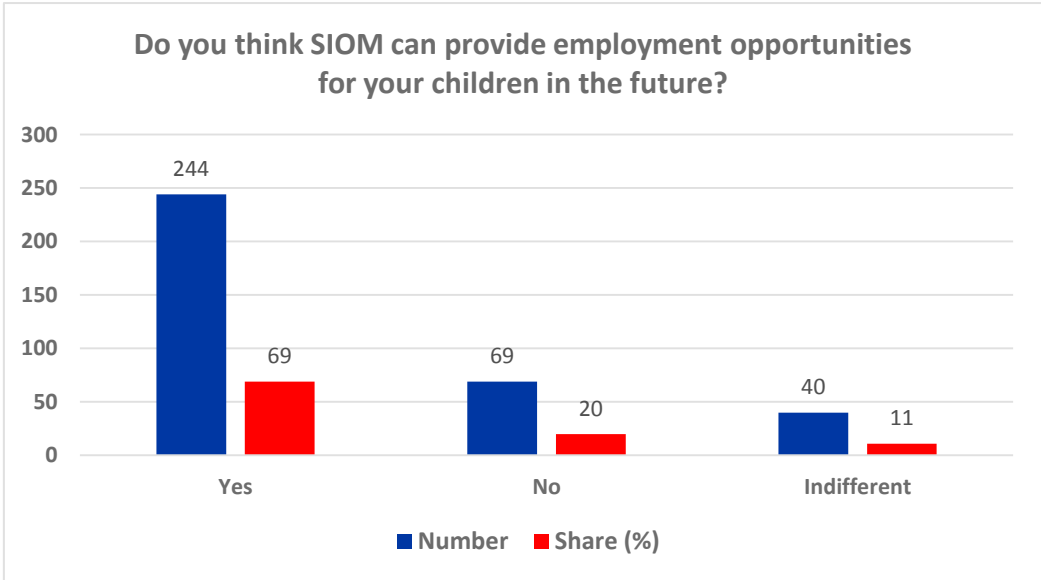


Figure 5.17 Status of future job creation by SIOM in QN2

According to figures 5.16 and 5.17, around 72% of respondents believe that SIOM projects have created more jobs for local people and 69% of them think that SIOM can provide employment opportunities for their children in the future. Almost

majority of respondents, who believe that SIOM have created more jobs for local people, stated that SIOM will offer job opportunities for the next generation.

5.1.3.7 Health

Respondents were asked about their preferences among construction of schools, hospitals and clinics, water treatment facilities, university, parks and sports complexes. In response, construction of more hospitals and clinics was the first preference and next priority was to build park and sports complexes facilities (table 5.8).

Kind of general health/welfare/educational projects	Share	Rank
Water treatment facilities	13%	4
More hospitals and clinics	43%	1
Park and sports complexes	18%	2
University	10%	5
More schools	16%	3

Table 5.8 Priority of the projects according to respondents in QN2

As can be seen in figure 5.18, about 84% of respondents are not satisfied with the number of hospitals in their city and they have to go to other cities for the treatment of some diseases. It is in direction to the obtained results of table 5.8 above, too.

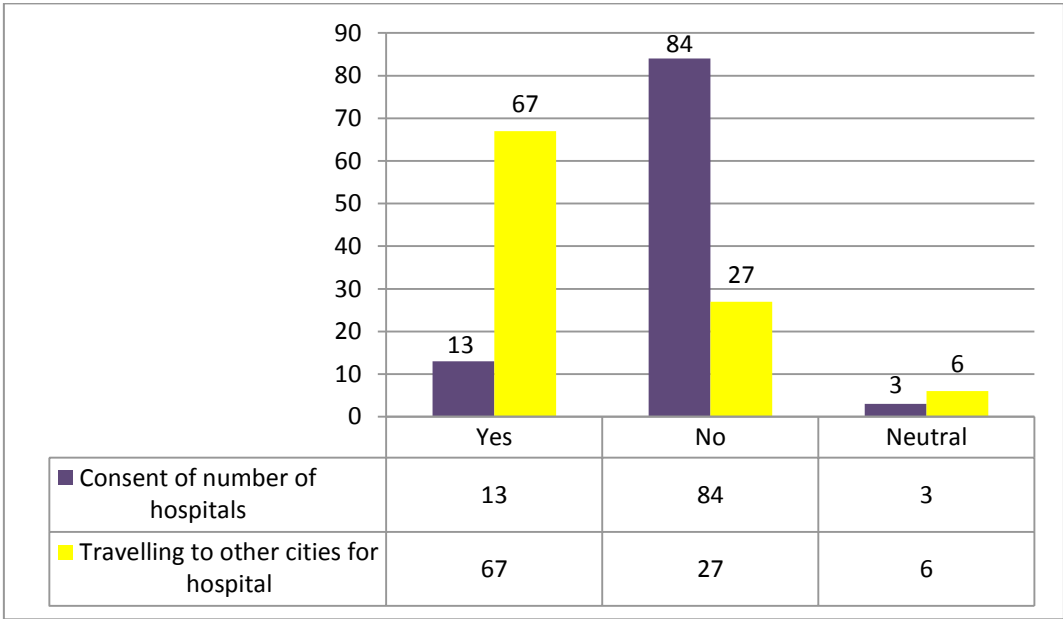


Figure 5.18 Satisfaction of respondents from number of hospitals in QN2

The preferences of the people are directly related to their needs and depend on the local situation and other social responsibilities activities in the communities⁴⁷⁶. Locals expect from SIOM to construct a hospital or health center which should be in accordance with formulated development strategies in the province. However, as a consequence of these interviews, construction of a new medical and health care center in Sangan in cooperation with SIOC, main contractors and Mashhad Medical Sciences University is negotiable.

5.1.3.8 Transportation

Figure 5.19 shows that the majority of respondents use private cars to commute; buses are the second choice. The first priority for needed transportation vehicles by local people is bus. However, 51% of them believe that the train as a suburban vehicle should be developed and 26% of people believe that the aerial transportation should be improved.

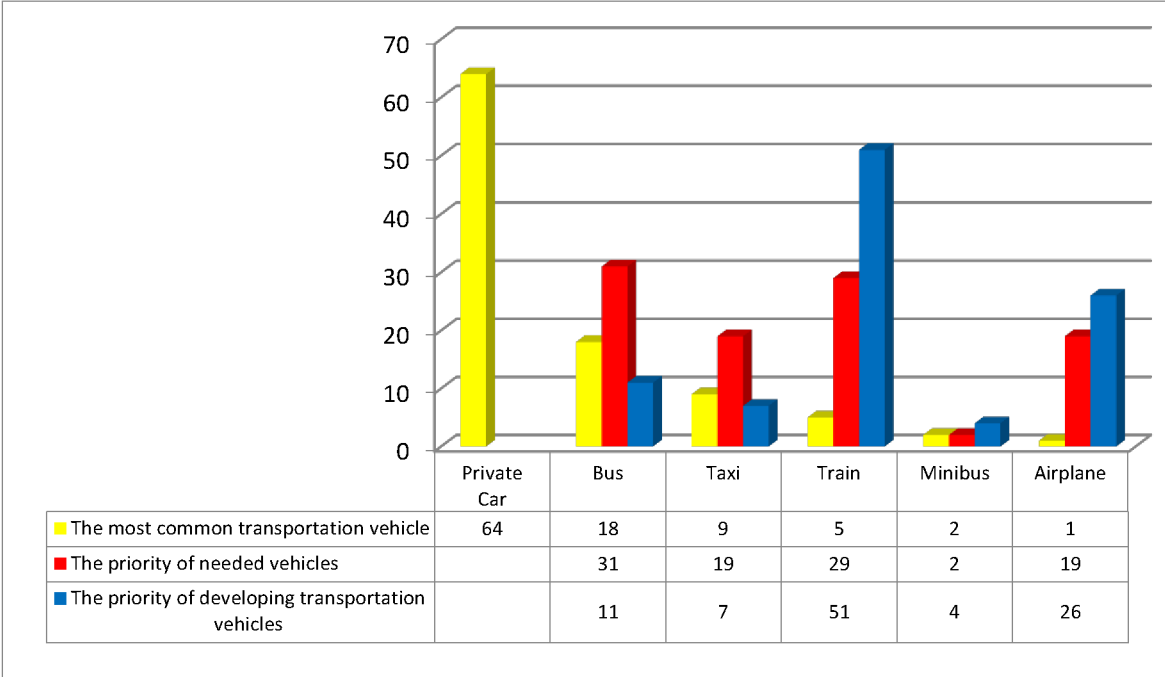


Figure 5.19 Analysis of need to transportation vehicles in QN2

5.1.3.9 Air pollution

Almost 28% of respondents believe that there has been problem with the air quality (pollution, smog, etc.) before SIOM projects and 81% of them believe SIOM projects

⁴⁷⁶ J. Kretschmann and R. Amiri (2013), *Social responsible mining in east Iran: The Sangan Iron Ore Mines*, 23rd World Mining Congress, Montreal, Canada, Canadian Institute of Mining (CIM)

have worsen the air quality and the air became more polluted after the mining projects` inauguration. The questions` results can be seen in table 5.9.

Question \ Answer	Has there been any problem with the air quality before SIOM projects?	Do you think that SIOM projects have worsen the air quality?
Yes	28%	81%
No	64%	13%
Indifferent	8%	6%

Table 5.9 Relationship between air pollution and mining projects in QN2

5.1.3.10 Water and soil conditions

In the same way, the respondents believe that SIOM projects have affected the local underground water level and soil conditions in the region. This is noticeable in table 5.10.

Question \ Answer	Do you think that SIOM projects has effected on the local underground water level?	Do you think that SIOM projects have an effect on local soil condition?
Yes	83%	76%
No	9%	14%
Indifferent	8%	10%

Table 5.10 Respondents opinions regarding SIOM projects effects on underground water level and soil condition in QN2

According to the results, 83% of respondents believed in adverse effect of SIOM projects on local underground water level, while 9% didn't think so and 8% were indifferent. Concerning soil quality, the figures were 76%, 14% and 10% respectively.

5.1.3.11 Social security

About 56% of respondents believe that social security has increased after SIOM projects implementation but 44% believe that social security has not increased since the beginning of SIOM projects. By considering the fact that the area is very close to the Afghanistan border, it is a good achievement which can be mostly attributed to establishment of mining companies. By development of industry in the region, more jobs were created, infrastructures improved, security and safety increased, and the general status of welfare reinforces.

5.1.3.12 SIOM projects acceptance

Although in some cases such as contamination of the environment, SIOM projects have the negative aspects, from the perspective of people in the region, according to the respondents; SIOM projects have a positive impact on the image of the region in general. About 80% of people believe that the SIOM projects should have high priority in government development programs. The questions results are reported in the following table (5.11).

Question \ Answer	Do you think that SIOM has a positive effect on the image of the region?	Do you think that SIOM projects should have high priority in the government development plan?
Yes	74%	80%
No	17%	11%
Indifferent	9%	9%

Table 5.11 SIOM projects acceptance by local people in QN2

5.1.4 Comparison and analysis of questionnaires No. 1 and No. 2

Questionnaires number 1 and 2 were prepared and analyzed to get a better insight of local stakeholder's perception from mineral activities of SIOM in the region and the acceptance of the whole by them. The content of the questionnaires was designed according to the temporal conditions so they are different in some points.

According to the results, around 51% of the respondents to QN1 believed that SIMP activities have not been directly useful for them, while about 23% of them confirmed a positive impact. As the project on that time was at early stages, the useful impacts were still not tangible for the majority of the local people. But with the development of SIMP people's minds changed. 74% of respondents to QN2 stated that SIOM activities had positive impact on the region, while 17% were against and 9% has neutral opinion. In both studies, residents agreed to develop the mining projects in the region (66% in QN1 and 81% in QN2) which shows their positive attitude to SIOM.

Approximately 67% of the respondents to QN1 were aware of the construction of a new technical school and a high school for girls in Sangan by SIMP and IEIOC. In QN2, the feedback was that 58% of respondents believed the educational progress in the region was due to the presence of SIOM and the high schools built in accordance with CSR of the enterprise.

In QN1, respondents were asked to express their tendency to work for governmental organizations (including mining and SIOM). 65.5% were in favor of governmental positions while 13% and 20% were for private companies and free jobs respectively. In QN2, there is the same tendency but with changing percentages: 69% for governmental positions, 7% for private and 17% for free jobs. It indicates governmental institutions (including SIOM projects) are the first choice of residents to engage in. The majority of the residents (75% in QN1 and 71% in QN2) believe SIOM projects have had a positive effect on job creation for the locals.

In both questionnaires, locals were asked about preference for future activities of the SIOM. Constructing a health care complex (hospital) in both of them has the highest rate (39% in QN1 and 43% in QN2). Construction of education centers was the second priority in both surveys (30% in QN1 and 25% in QN2). The third priority was parks and sports clubs with the percentage of 18 in both surveys. These rates show that in spite of considerable progress during the years, main needs of the residents are not still satisfied and SIOM decision makers need to consider these issues with higher priority to develop the region.

In QN1, the residents were asked about unfavorable ecological impacts of the SIOM projects on the region in which dust creation with 49% had the highest rate. They were asked again in QN2 and 81% believed air pollution has accelerated after establishment of mining projects. 64% stated the city was not polluted before these projects. It can be concluded SIOM and other mining companies that are in the region need to develop strategies, set goals, and implement suitable measures to avoid environmental damages and risks in the region.

5.2 Selecting sustainable development indicators for SIOM

As explained in the second part of chapter two “Sustainable Development Indicators”, the high complexity of sustainable development processes makes its realization and quantification a difficult task. Chapter 40 of the Agenda 21 calls on countries and the international community to develop indicators of sustainable development. Such indicators should increase the focus on sustainable development and assist decision-makers to adopt sound sustainable development policies. This part reviews the applicable indicators to assess the realization of sustainable development

in SIOM according to international guidelines and selecting the most relevant ones using multi- criteria decision making process.

5.2.1 Sustainable development indicators of SIOM

To select the most appropriate indicators for the development of SIOM, sustainable development indicators were chosen from core set of CSD indicators⁴⁷⁷ on a basis of a two stage process. Firstly, the indicators are selected by the criteria long term measurability and relevance for the most important stakeholders of the mining project. Secondly, the evaluation is based on a Fuzzy Delphi Method (FDM) (appendix 4) using questionnaires that are distributed among representatives of the different stakeholder groups.

So while selecting the indicators, those have been chosen that meet the criteria availability, authenticity, possibility of quantification, application in the study area, possibility of detecting a long term trend and citation in relevant scientific literature. Indicators that cannot be measured in the long term to evaluate SIOM due to a poor availability of data in the region had to be eliminated⁴⁷⁸.

For step 2, a questionnaire (appendix 5) was prepared in which all selected indicators were listed in three pillars depending if they describe economic, social or environmental aspects (Tables 5.12 to 5.14). There are various multi- hierarchy decision making methods to rate indicators and prioritize them according to importance. Here FDM was the applied method. The questionnaire was distributed among 20 experts from different stakeholder groups. Most of them are external stakeholders. Each participant was asked to rate the importance of every indicator within the spectrum of “very low” to “very high”. The stakeholders include governmental authorities in Sangan, mining managers and engineers, professors in Khorasan-e-Razavi Province, religious leaders in the Sangan region and members of local communities. The following indicators have been selected in step 1.

⁴⁷⁷ United Nations’ Department of Economic and social Affairs (DESA), *Indicators of Sustainable Development: Guidelines and Methodologies*, Published by UN, New York, third edition, October 2007, ISBN 978-92-1-104577-2

⁴⁷⁸ J. Kretschmann and R. Amiri (2015), *How to select the most appropriate indicators for sustainable mining- a case study of Sangan iron Ore Mines (SIOM) in Iran*, Proceedings of Sustainable Development in Minerals Industry Conference (SDIMI), 12-15 July, Vancouver, Canada

Indicator	Importance				
	Very Low	Low	Moderate	High	Very High
Length of Roads					
Length of Railway					
Increase in family's income					
Farmers' income					
Employment- population ratio					
Share of women in wage direct employment in the mining sector					
Ratio of annual Electricity consumption in mining sector to total energy consumption in Khaf County					

Table 5.12 List of economic indicators in the FDM questionnaire

Indicator	Importance				
	Very Low	Low	Moderate	High	Very High
Access to primary sanitary facilities					
Access to potable water					
Access to electricity and other energy sources					
Under-five mortality rate					
Nutrition status of residents					
Immunization against infectious childhood diseases					
Net enrolment rate in primary education					
Women net enrolment rate in high school					
Adult illiteracy rate					
Population growth rate					
Emigration rate					
Dependency rate					
Telephone and internet users					
Number of drug users					
Life expectancy					

Table 5.13 List of social indicators in the FDM questionnaire

Indicator	Importance				
	Very Low	Low	Moderate	High	Very High
Water quality					
Average depth of aquifers					
Water consumption in Sangan mining complex					
Wastewater production					
Air quality					
Solid waste production					
Ratio of sanitary disposed solid waste to total solid waste produced					
Protected areas					
Endangered species					
Area of land assigned to mining activities					

Table 5.14 List of environmental indicators in the FDM questionnaire

There are different scales to rate preferences such as 1-5 (Likert scale), 1-7 etc. In this study judgments were ranked on a 1-9 scale. This scale is more common in Fuzzy Delphi studies and also recommended by Saaty (2003)⁴⁷⁹ for multi-criteria decision making analyses. The importance degree of the criteria is represented by:

- (1): very low
- (3): low
- (5): moderate
- (7): high
- (9): very high.

5.2.2 Selection of indicators using Fuzzy Delphi Method

The traditional Delphi Method has been widely used to obtain expert opinions through survey. Questions come from related scientific literature and those recommended by experts. The Delphi approach has three characteristics: (a) anonymous responses, (b) interaction and controlled feedback, (c) a statistical group response⁴⁸⁰. The questionnaire procedure requires asking the opinion of experts on

⁴⁷⁹ T. L. Saaty (2003), *Decision-making with the AHP: Why is the principle eigenvector necessary*, European Journal of Operational Research, 145(1)/2003, p. 85-91

⁴⁸⁰ Y.L. Hsu, C.H. Lee, V.B. Kreng, (2010), *the application of fuzzy Delphi method and fuzzy AHP in lubricant regenerative technology selection*, Expert Systems with Applications, 37: 419- 425

multiple occasions, which results in certain methodological difficulties, such as: (1) failure to take fuzziness into account leading to misinterpretation of the opinions; (2) systematic suppression of variables, i.e. sometimes the factors that are selected by at least 50% of the experts are retained; (3) process losses in coordination and communication; (4) repeatedly surveying the experts is more costly and time-consuming. Furthermore, there is a noteworthy problem to solve the fuzziness (expected ambiguity) of common understanding of expert opinions⁴⁸¹.

To overcome these difficulties, it is proposed to apply the FDM to group decisions. This method is an analytical method founded upon the Delphi Method and the Fuzzy Theory. It is based on a similarity function to assess the level of agreement between experts. But, the FDM assures no misinterpretation of expert opinions since it considers the fuzziness that every survey process has to deal with. Thus, more objective evaluation factors can be determined through statistical analysis since the efficiency and quality of questionnaires are enhanced. Some of the more representative strengths of the FDM are:

- Time saving,
- Fewer surveys,
- Increased recovery rate and
- Guarantee of completeness and consistency of the group opinion⁴⁸².

The FDM steps are⁴⁸³:

A. Collecting opinions of the decision group: find the evaluation score of each alternate indicator's significance given by each expert by using linguistic variables in questionnaires (Linguistic variables are statements, based on opinions or preferences of experts, which can be used as recommendations when solving a problem; e.g. not important to very important).

⁴⁸¹ B. Glumac, Q. Han, J. Smeets, and W. Schaefer (2011), *Brownfield redevelopment features: applying fuzzy Delphi*, Journal of European Real Estate Research, 4/2011, p.145- 159

⁴⁸² A. P. Sanchez-Lezama, J. C. Arroyo and C. A. Hernandez (2014), *Applying the fuzzy Delphi method for determining socio-ecological factors that influence adherence to mammography screening in rural areas of Mexico*, Methodological Issues, 30(2)/2014, p. 245-528

⁴⁸³ Y.L. Hsu, C.H. Lee, V.B. Kreng, (2010), *the application of fuzzy Delphi method and fuzzy AHP in lubricant regenerative technology selection*, Expert Systems with Applications, 37: 419- 425

B. Setting up triangular fuzzy numbers: among the various shapes of fuzzy number triangular fuzzy number (TFN) is the most popular one. It is a fuzzy number represented with three points as follows: $A = (a_1, a_2, a_3)$: calculate the evaluation value of the triangular fuzzy number of each alternate indicator given by experts, find out the significance triangular fuzzy number of the alternate indicator. Importance of parameter i over parameter j according to the k^{th} specialist:

$$\begin{aligned}
 a_{ij} &= (\alpha_{ij}, \delta_{ij}, \gamma_{ij}) \\
 \alpha_{ij} &= \min(\beta_{ijk}) \quad k=1,2,\dots,n \\
 \delta_{ij} &= \left(\prod_{k=1}^n \beta_{ijk} \right)^{1/n} \\
 \gamma_{ij} &= \max(\beta_{ijk}), \quad k=1,\dots,n
 \end{aligned} \tag{1}$$

Where α_{ij}, γ_{ij} are the lowest and the highest importance value given by the stakeholders (experts) respectively, and δ_{ij} is the arithmetic mean of their opinions, it is obvious that the fuzzy components are defined: $\alpha_{ij} \leq \delta_{ij} \leq \gamma_{ij}$.

The values of these components vary in $\{1/9, 9\}$. In this stage, the fuzzy pair-wise comparison matrix of different parameters is:

$$\tilde{A} = [\tilde{a}_{ij}]$$

Where:

$$\tilde{a}_{ij} \times \tilde{a}_{ji} \approx 1 \quad \forall i, j = 1, 2, \dots, n$$

or as follows:

$$\tilde{A} = \begin{bmatrix}
 (1,1,1) & (\alpha_{12}, \delta_{12}, \gamma_{12}) & (\alpha_{13}, \delta_{13}, \gamma_{13}) \\
 (1/\gamma_{12}, 1/\delta_{12}, 1/\alpha_{12}) & (1,1,1) & (\alpha_{23}, \delta_{23}, \gamma_{23}) \\
 (1/\gamma_{13}, 1/\delta_{13}, 1/\alpha_{13}) & (1/\gamma_{23}, 1/\delta_{23}, 1/\alpha_{23}) & (1,1,1)
 \end{bmatrix}$$

The relative weight of the parameters is

$$\tilde{Z}_i = [\tilde{a}_{ij} \otimes \dots \otimes \tilde{a}_{in}]^{1/n} \tag{2}$$

$$\tilde{W}_i = \tilde{Z}_i \otimes (\tilde{Z}_{i \oplus \dots \oplus n})^{-1} \quad (3)$$

Where $\tilde{a}_1 \otimes \tilde{a}_2 = (a_1 \times a_2, \delta_1 \times \delta_2, \gamma_1 \times \gamma_2)$ and \tilde{W}_i is a linear vector showing the fuzzy weight of i^{th} parameter. In order to change the fuzzy parameters into non-fuzzy parameters, the mean of fuzzy parameters is computed and the weight of parameters is stated by a definite figure.

$$W_i = \left(\prod_{j=1}^3 w_{ij} \right)^{1/3} \quad (4)$$

Figure 5.20 summarizes the process of selecting relevant sustainable development indicators in SIOM.

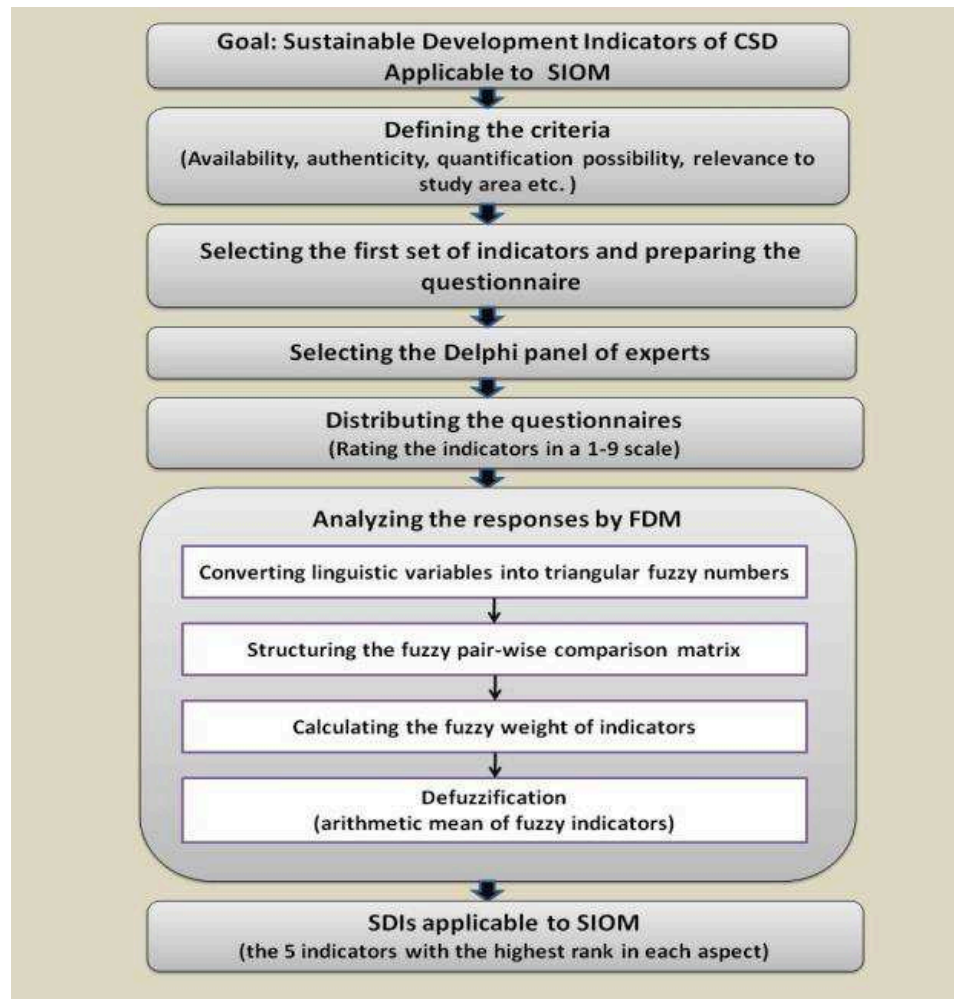


Figure 5.20 Selection processes of SDIs applicable to SIOM

5.2.3 Results

Applying the FDM to questionnaires and analyzing them according to the process (appendix 6), results of step 2 can be tabulated as follows. Tables 5.15, 5.16 and 5.17 present the rankings of social, economic and environmental indicators respectively to choose the most important SD indicators to evaluate SIOM.

Pillar	Indicators	Rank
Social	Life expectancy	1
	Net enrolment rate in primary education	2
	Nutrition status of residents	3
	Access to primary sanitary facilities	4
	Access to electricity and other energy sources	5
	Telephone and internet users	6
	Population growth rate	7
	Number of drug users	8
	Women net enrolment rate in high school	9
	Access to potable water	10
	Dependency rate	11
	Immunization against infectious childhood diseases	12
	Adult illiteracy rate	13
	Under-five mortality rate	14
	Emigration rate	15

Table 5.15 Ranking of social indicators according to FD weights

Pillar	Indicators	Rank
Economic	Length of railway	1
	Ratio of annual electricity consumption in mining sector to total energy consumption in Khaf County	2
	Increase in family's income (per capita)	3
	Length of roads	4
	Employment- population ratio	5
	Farmers' income	6
	Share of women in wage direct employment in the mining sector	7

Table 5.16 Ranking of economic indicators according to FD weights

Pillar	Indicators	Rank
Environmental	Water consumption in Sangan mining complex	1
	Area of land assigned to mining activities	2
	Ratio of sanitary disposed solid waste to total solid waste produced	3
	Solid waste production	4
	Wastewater production	5
	Average depth of aquifers	6
	Endangered species	7
	Air quality	8
	Protected areas	9
	Water Quality	10

Table 5.17 Ranking of environmental indicators according to FD weights

According to the ranking in the table 5.15-5.17, five indicators in each pillar and totally fifteen indicators with the highest priority according to stakeholder's judgments have been selected as the most appropriate ones to evaluate the sustainable development SIOM. These are the indicators that are measurable and widely accepted as the most important ones. In the social pillar of SD, they include: life expectancy, net enrolment in primary educations, nutrition status of residents, access to primary sanitary facilities and access to electricity and other energy resources. The most important indicators in economic pillar in a descending order are: length of railway, ratio of annual electricity consumption in the mining sector to total energy consumption in Khaf County, increase in family's income (per capita), length of roads and employment- population ratio. The indicators with highest priority in environmental pillar are water consumption in Sangan Mining Complex, area of land assigned to mining activities, ratio of sanitary disposed solid waste to total solid waste produced, solid waste production and wastewater production respectively.

5.3 Calculation of selected SD indicators for SIOM

In this part of research, the selected indicators have been calculated based on available and reliable data which have been gathered from the local sources. In the following, there will be a very short introduction, calculation method in research, related data, comparison graphs and results and interpretation for each indicator in three different social, economic and environmental pillars, as far as possible.

5.3.1 Social indicators

5.3.1.1 Life expectancy

- Introduction: Life expectancy provides a summary of overall health conditions for populations, which are in turn an integral part of development. This indicator captures both fatal and non-fatal health outcomes and provides a more complete picture of the impact of morbidity and mortality on populations⁴⁸⁴.
- Calculation method: Life expectancy is calculated as the number of years a person is expected to survive based on the statistical average. Gathering the required data to calculate this indicator for Khaf County was not easy to measure by the author. That's why the analysis was referred to conducted studies and trustable statistics according to which following sections are written.
- Data and graphs: In 2006, life expectancy at birth was 72.57 in Khaf County and 72 in Khorasan-e-Razavi Province⁴⁸⁵. Nationally, this indicator was 71.1 for men and 73.1 for women⁴⁸⁶. According to the national population and housing census in 2011, this indicator was measured 71.6 in the Khorasan-e-Razavi Province while it was 72.4 in the whole country. Considering the genders, life expectancy at birth in Khorasan-e-Razavi Province was 70.2 for men and 73 for women, whilst in the whole country; it was 71.5 and 74 respectively. To be more precise, this indicator was nationally 72.8 in urban

⁴⁸⁴ United Nations (2007), *Indicators of Sustainable Development: Guidelines and Methodologies*, The Department of Economic and social Affairs (DESA), Third edition, New York

⁴⁸⁵ H. Shayan (2006), *An analysis on mortality in Khorasan-e-Razavi Province*, Publications of Human Science Faculty, University of Mashhad, Iran (Persian)

⁴⁸⁶ Statistical center of Iran (2006), *Atlas of Selected Results of the 2006 National Population and Housing Census*, (Persian)

Access at: http://www.amar.org.ir/Portals/0/Files/abstract/1390/sarshomari90_nahaii.pdf

areas and 71.8 in rural areas. In Khorasan-e-Razavi Province, it has been 72.1 and 70.7 respectively in urban and rural areas⁴⁸⁷.

- Results and interpretation

According to the data and statistics, the overall life expectancy has improved in the country for both men and women. Considering Khorasan-e-Razavi Province, this indicator has been lower than the national average in 2011. This can be attributed to weaknesses in economic and social structure including living infrastructures and health opportunities. Considering the results of questionnaire number 2 (Table 5.8), local stakeholders stated that constructing more hospital and more health centers have the highest priority in the region, which confirms the validity of FDM in selecting appropriate indicators for SIOM. Undoubtedly, such drawbacks affect the indicator unfavorably. It is expected that improving the living conditions in Khaf County along with mining activities development lead to better condition which in the long run may help to achieve higher life expectancy among residents especially if health needs were realized.

5.3.1.2 Net enrolment rate in primary education

- Introduction: The indicator shows the proportion of children of primary school age who are enrolled in primary school. Net enrolment refers only to children of official primary school age, and excludes children of other age groups enrolled in primary school age as well as children of primary school age enrolled in other levels of education. Universal primary education is an important goal of the international sustainable development agenda⁴⁸⁸.
- Calculation method: Dividing the number of enrolled children in primary schools to total number of children at the primary school-age in Khaf County.
- Data and graphs: Table 5.18 and figures 5.21 and 5.22 present the data, calculations and the output graphs. In the table 5.18 ratio is illustrated the number of enrolled children in primary schools to total number of children at the primary school-age in Khaf County.

⁴⁸⁷ Statistical center of Iran (2011), *Atlas of Selected Results of the 2006 National Population and Housing Census*, published by statistical center of Iran, September 2014, ISBN: 978-964-365-936-3 (Persian), Access at: http://www.amar.org.ir/Portals/1/Iran/Atlas_Census_2011.pdf

⁴⁸⁸ United Nations (2007), *Indicators of Sustainable Development: Guidelines and Methodologies*, The Department of Economic and social Affairs (DESA), Third edition, New York

Year	1996-1997	2006-2007	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Number of enrolled children in primary schools ⁴⁸⁹	12200	12470	11900	14500	15000	16000	16600
Total number of children at the primary school-age ⁴⁹⁰ in Khaf County ⁴⁹¹	18296	16029	15156	15522	15839	16288	16810
Ratio (%)	66.7	77.8	78.5	93.4	94.7	98.2	98.8

Table 5.18 Data and ratio related to net enrolment rate in primary education indicator in Khaf County

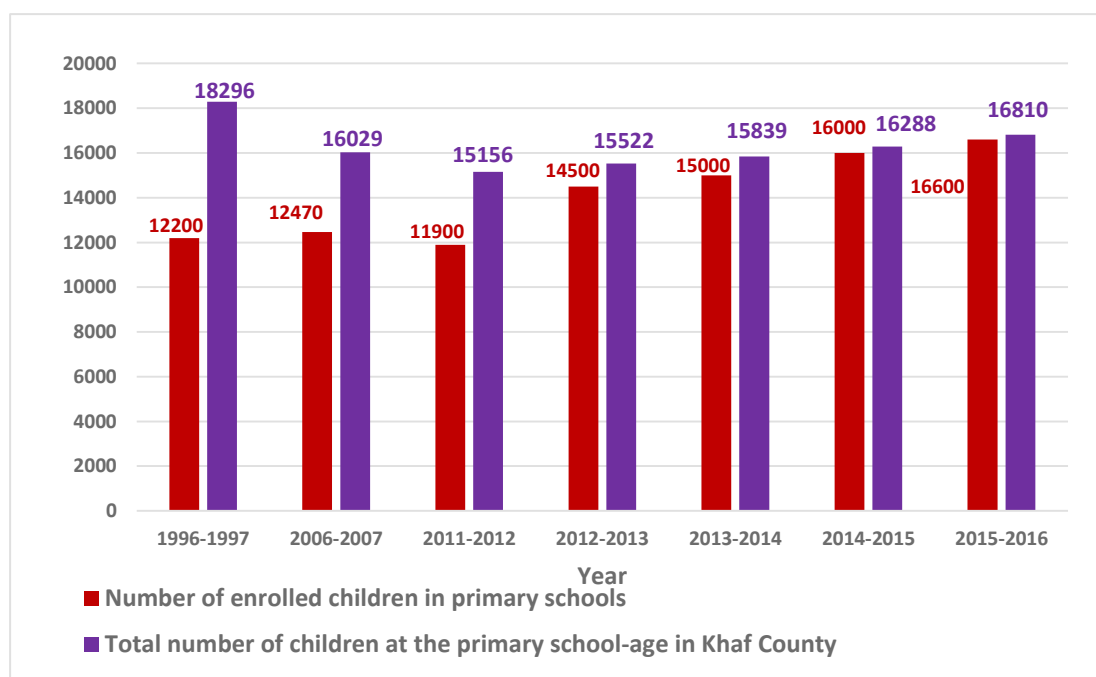


Figure 37.21 Comparison of children enrolled in primary schools and total number of children in school-age

⁴⁸⁹ Education and training office of Khaf County (2015), *Internal report* (Persian)

⁴⁹⁰ According to the regulations in Iran, children at ages 6-11 are considered as those in primary school age.

⁴⁹¹ Statistical Center of Iran, 2015 (<http://amar.org.ir>)

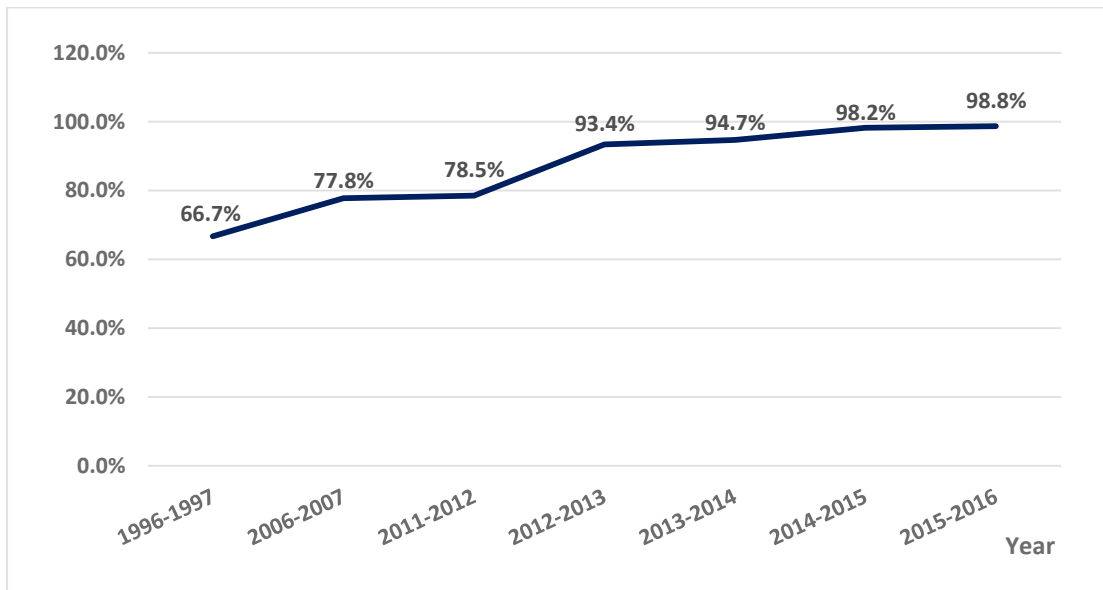


Figure 5.22 Ratio of enrolled children in primary schools to total number of children at the primary school-age in Khaf County during 1996-2016

- Results and interpretation
 - Ratio of enrolled children in primary schools to total number of children at the primary school-age in Khaf County has had an increasing trend during the study period. Considering the future population (Table 5.2), more schools and universities are needed in the regions which is in accordance with the results of questionnaire number 2 (Table 5.8) where the third and fifth priorities were constructing more schools and universities respectively.
 - Net enrollment in primary schools of Khaf County during 1996-2015 proves a 32.1% growth. Construction of high school for girls and technical school for boys by IEIOC and SIMP under the framework of CSR activities has had a substantial role in this growth. Knowing that there is an opportunity for both girls and boys to pursue their higher education in the region, parents were more hopeful to let their children start primary education and proceed with learning.

5.3.1.3 Nutrition status of residents

- Introduction: The purpose of this indicator is to measure long term nutritional imbalance and malnutrition resulting in under nutrition (assessed by underweight and stunting) and overweight. Anthropometric measurements to assess growth and development are the most widely used indicators of nutritional status in a community⁴⁹².
- Calculation method: Dividing the number of children under 5 years old with underweight to the total number of children at the same age range⁴⁹³.
- Data and graphs: Table 5.19 and figures 5.23 and 5.24 present the data and related graphs to this indicator.

Year	1996-1997	2001-2002	2006-2007	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Number of children under 5 with underweight ⁴⁹⁴	14	16	22	18	36	14	23	21
Total number of children under 5 in Khaf County ⁴⁹⁵	1365	2235	2751	2926	3465	3625	4230	4330
Ratio (%)	1.03	0.72	0.80	0.62	1.04	0.39	0.54	0.48

Table 5.19 Data and ratio related to nutrition status indicator in Khaf County

⁴⁹² United Nations (2007), *Indicators of Sustainable Development: Guidelines and Methodologies*, The Department of Economic and social Affairs (DESA), Third edition, New York

⁴⁹³ The United Nation`s first Millennium Development Goal aims at eradicating extreme poverty and hunger. Target 1.C was to halve the proportion of people who suffer from hunger between 1990 and 2015. Globally, about 795 million people are estimated to be undernourished, more than 90 million of which are undernourished and underweight children under age five (<http://www.un.org/millenniumgoals/poverty.shtml>). Considering the significance of children`s health, this group was examined in this research.

⁴⁹⁴ Health and treatment center of Khaf County (2015), Internal report (Persian)

⁴⁹⁵ Statistical Center of Iran, 2015(<http://amar.org.ir>)

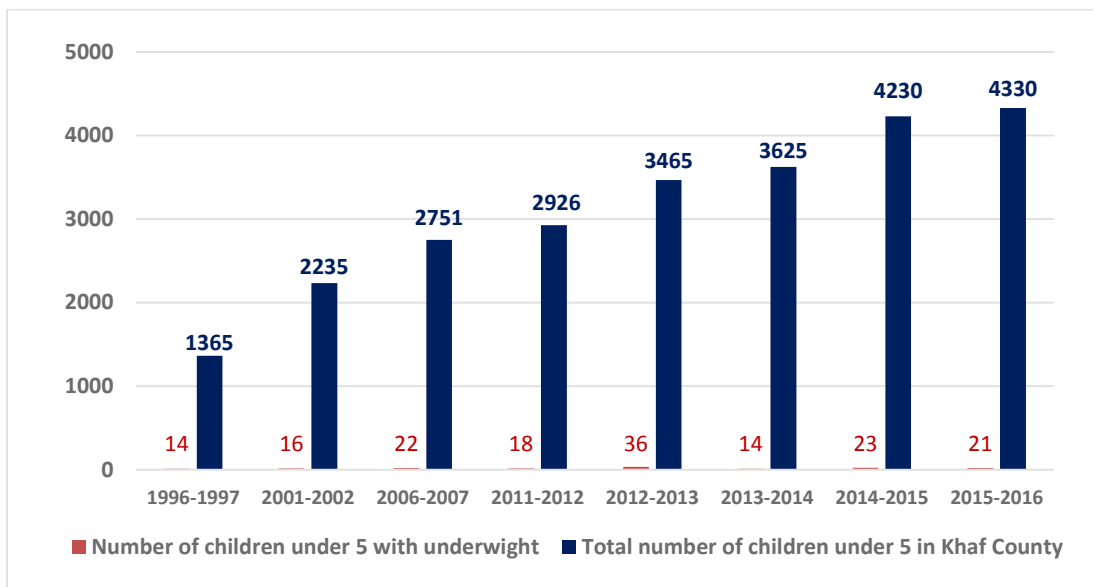


Figure 5.23 Graph related to nutrition status of residents in Khaf County

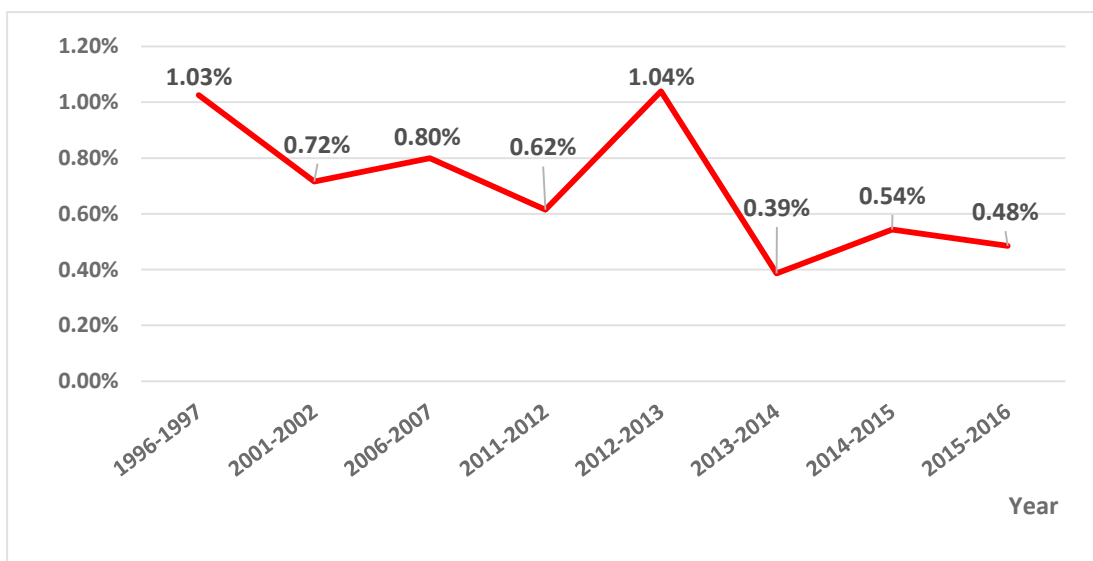


Figure 5.24 Ratio of number of children under 5 with underweight to total number of children under 5 in Khaf County

- Results and interpretation
 - The ratio of children under 5 with underweight to the total number of children under 5 in Khaf County has a fluctuating trend, but it is overall decreasing, because the nutrition status of families has improved.
 - The highest and the lowest percentages are 1.04 and 0.39 respectively with 0.65% difference, which is relatively low.

- The low rate of this indicator can be attributed to lack of comprehensive studies about children`s health statues which should be conducted by health and treatment center of the Khaf County.
- It is estimated that after operation of SIOM development projects, the nutrition status of people improves from 2018. This can be due to more job creation, better economic status, more purchasing power and consequently consuming more nutritious foods.

5.3.1.4 Access to primary sanitary facilities

- Introduction: The indicator monitors progress in the access of the population to primary sanitary facilities. Accessibility of sanitary services, going beyond just physical access, and including economic, social and cultural accessibility and acceptability, is of fundamental significance to reflect on health system progress, equity and sustainable development⁴⁹⁶.
- Calculation method: Dividing the number of households with access to sanitary waste disposal to the total number of all households. Households with stool tank or connected to the wastewater collection grid are counted as ones with sanitary wastewater disposal facilities⁴⁹⁷.
- Data and graphs: Table 5.20 and figures 5.25 and 5.26 present the required data for calculating this indicator and output graphs.

Year	2010-2011	2012-2013	2013-2014	2014-2015
Number of households with sanitary wastewater disposal ⁴⁹⁸	20717	24799	26524	29079
Total households ⁴⁹⁹	28761	31169	32373	33578
Ratio (%)	72	80	82	87

Table 5.20 Data and ratio related to access to primary sanitary facilities indicator in Khaf County

⁴⁹⁶ United Nations (2007), *Indicators of Sustainable Development: Guidelines and Methodologies*, The Department of Economic and social Affairs (DESA), Third edition, New York

⁴⁹⁷ Ministry of Health and Medical Education of Iran (2012), *Set of forms, guidelines and methodologies for gathering the data of measuring the justice in health sector*, ISBN: 978-600-6937-13-7, p. 103 (Persian)

⁴⁹⁸ Health and treatment center of Khaf County (2015), Internal report (Persian)

⁴⁹⁹ Statistical Center of Iran, 2015 (<http://amar.org.ir>)

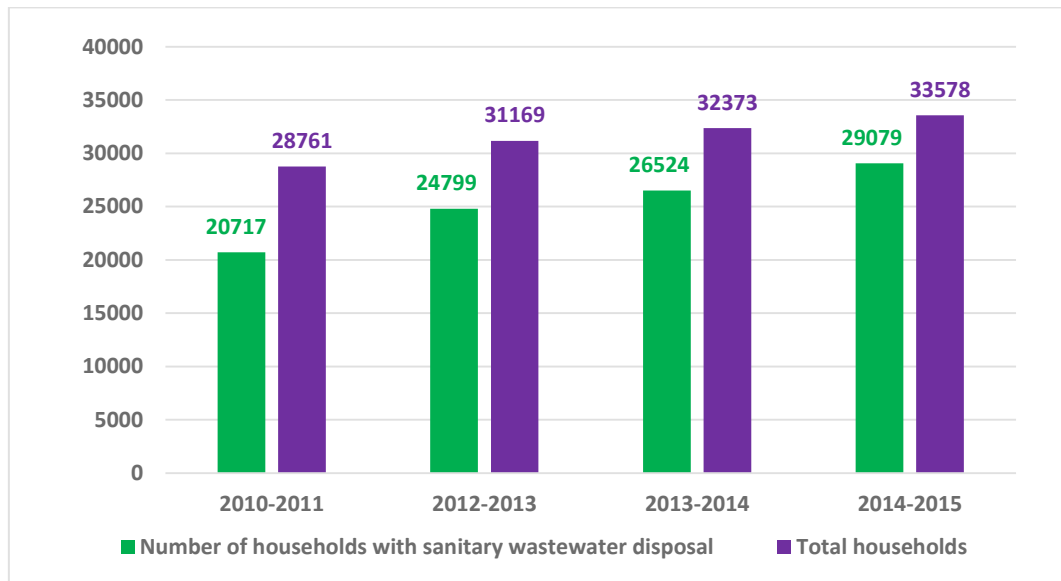


Figure 5.25 Graph related to access to primary sanitary facilities indicator in Khaf County

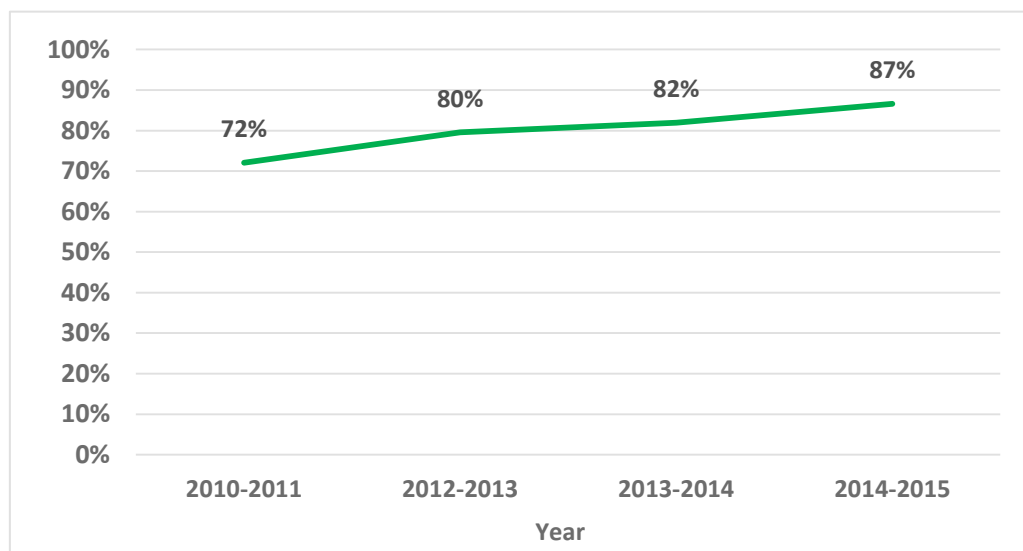


Figure 5.26 Ratio of number of households with sanitary wastewater disposal to total households

- Results and interpretation
 - The ratio of number of households with sanitary wastewater disposal facilities to total households in Khaf County has had an increasing trend in study period which proves the improvements in accessibility of primary sanitary facilities. It should be noted that mining companies (in general any industry in the region) pay value added tax

(VAT) to Iranian National Tax Administration⁵⁰⁰ where shares part of the income with municipalities for civil development. With escalating income of mining companies, more shares belong to municipalities and consequently there are more funds to construct facilities for citizens.

- Installation and renovation of sanitary disposal facilities along with the relevant trainings are necessary for residents in remote areas and villages in Khaf County.
- Due to increasing amount of VAT in the region, after operation of SIOM development projects and improvement in economic status of the residents in Khaf County, this ratio improves from 2018 and people will have better access to primary sanitary infrastructures. However, it is recommended that companies consider establishing sanitary wastewater disposal facilities under the framework of CSR.

5.3.1.5 Access to electricity and other energy sources

- Introduction: The indicator monitors progress in accessibility and affordability of modern energy services including electricity. Electricity and other modern energy services are an essential component of providing basic social services. Lack of access to modern energy services contributes to poverty and deprivation and limits economic development. Furthermore, adequate, affordable and reliable energy services are necessary to guarantee sustainable economic and human development⁵⁰¹.
- Calculation method: Dividing the number of households with access to electricity to the total number of households.
- Data and graphs: Table 5.21 and figures 5.26 and 5.27 present the required data for calculating this indicator and output graphs.

⁵⁰⁰ Access at: <http://en.intamedia.ir/>

⁵⁰¹ United Nations (2007), *Indicators of Sustainable Development: Guidelines and Methodologies*, The Department of Economic and social Affairs (DESA), Third edition, New York

Year	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013
Number of households with access to electricity network ⁵⁰²	21659	22354	24297	25799	28519	29363
Total households in Khaf County ⁵⁰³	23944	25148	27557	28761	29965	31169
Ratio (%)	90	89	88	90	95	94

Table 5.21 Data and ratio related to access to electricity indicator in Khaf County

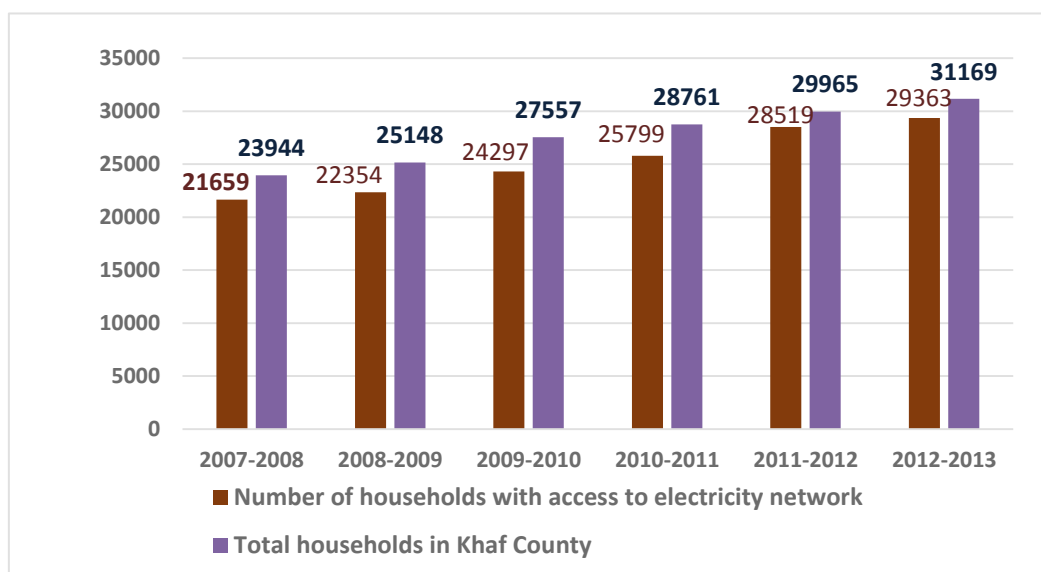


Figure 5.26 Graph related to access to electricity indicator in Khaf County

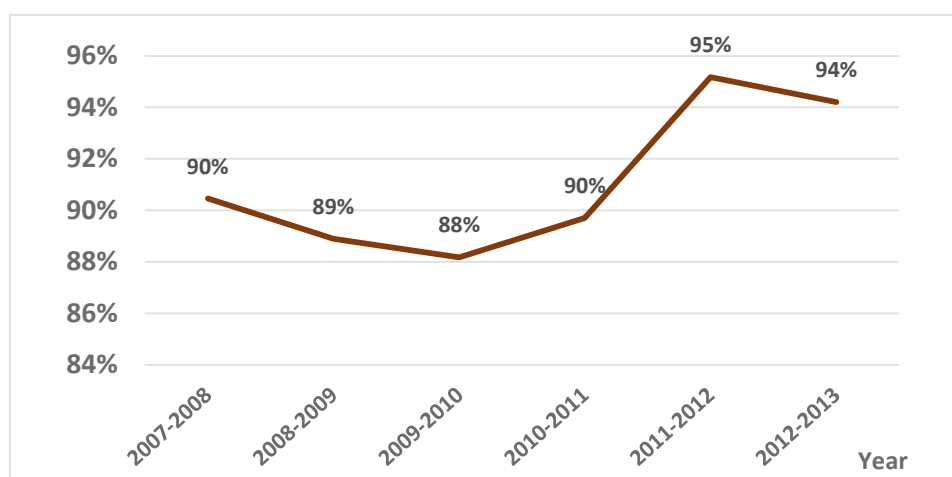


Figure 5.27 Ratio of number of households with access to electricity network to total households in Khaf County

⁵⁰² Statistical center of Iran (2013), *Statistical yearbook of Khorasan-e-Razavi Province*

⁵⁰³ Statistical Center of Iran, 2015 (<http://amar.org.ir>)

- Results and interpretation
 - The ratio of families with access to electricity to the total number of households has an increasing trend during the study period.
 - The lowest rate with 88% has been during 2009-2010 which is attributed to disconnection of some remote villages of Khaf County from the grid and also presence of temporary settlers (those who are in commute between the region and other places) the region. It should be noted that future need of electricity in SIOM will not affect adversely the access to electricity for residents in the region. SIOM development projects have their own specific electricity substation. Besides, residents have the priority in case of emergencies.

5.3.2 Economic indicators

5.3.2.1 Length of railway⁵⁰⁴

- Introduction: Transport is an important tool to help meet overall sustainability objectives. Attributes of sustainable transport follow from the expanded definition of sustainable development: sustainable transport is safe, high-quality, and accessible to all; economically viable; and a positive contributor to local, national and international development⁵⁰⁵. Railways are crucial factors in the economic development selection process. Surveys, trends and anecdotal evidence lend support to this assertion. In an isolated region, railways as “development corridors” have a significant role in improving the overall situation of a region. The reason is that, social, economic and cultural potentials can penetrate into these regions easier, which might accelerate the trend of growth⁵⁰⁶. It is noteworthy that Khaf (Iran) - Herat (Afghanistan) Railway is under construction and will undoubtedly help social and cultural development in both regions.
- Calculation method: Dividing the length of railway in Khaf County to the total length of railways in Khorasan-e-Razavi Province.

⁵⁰⁴ Length of railway means the length of rail roads that are currently under operation.

⁵⁰⁵ United Nations Economic Commission for Europe (2011), *Transportation for Sustainable Development in the ECE Region*, p. 6, Access at: https://www.unece.org/fileadmin/DAM/trans/publications/Transport_for_sustainable_development_in_the_ECE_region.pdf

⁵⁰⁶ A. Tavakoliroodi (2012), *Security, political and economic effects of mining activities in SIOM*, Taybad Azad University (Persian)

- Data and graphs: Table 5.22 and figures 5.28 and 5.29 present the required data for measuring this indicator and output graphs.

Year	2001-2002 ⁵⁰⁷	2006-2007	2011-2012	2013-2014
length of railway in Khaf County ⁵⁰⁸ (Km)	0	0	84	111.6
length of railway in Khorasan-e-Razavi Province ⁵⁰⁹ (Km) ⁵¹⁰	728	730	815	935
Ratio (%)	0	0	10.31	11.94

Table 5.22 Data and ratio related to length of railway in Khaf County and Khorasan-e-Razavi Province

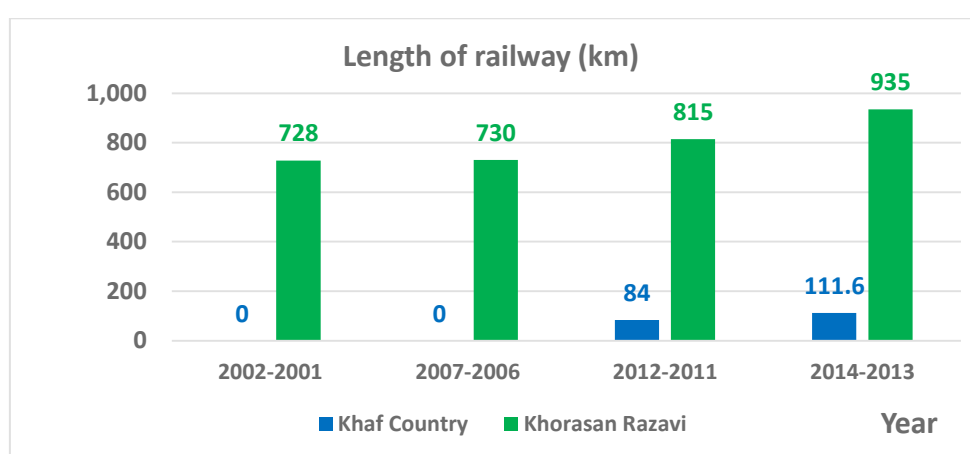


Figure 5.28 Length of railway in Khaf County and Khorasan-e-Razavi Province

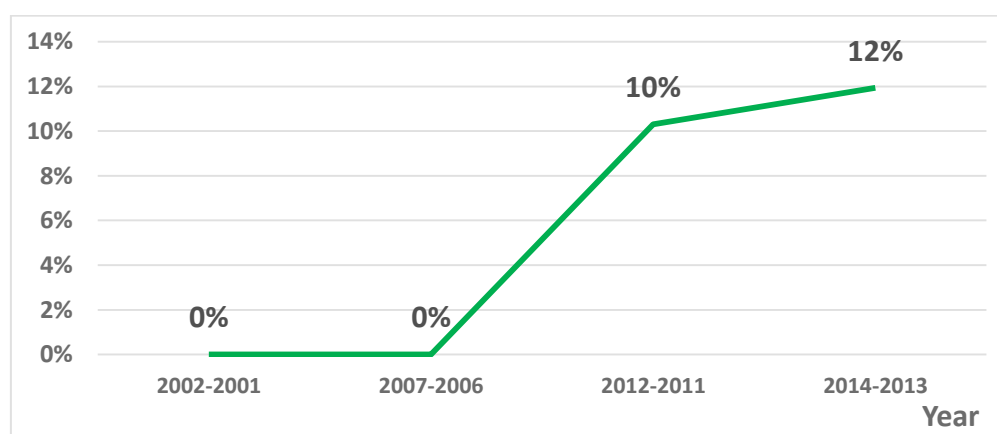


Figure 5.29 Ratio of length of railway in Khaf County to Khorasan-e-Razavi Province

⁵⁰⁷ This data goes back to the time that Khorasan-e-Razavi Province was not divided to three provinces.

⁵⁰⁸ Metra consulting engineering company, engineering department of SIMP and Khaf County road and urban development office (2014), *Internal report* (Persian)

⁵⁰⁹ Statistical center of Iran, *Statistical yearbook of Khorasan-e-Razavi Province*, 2014

⁵¹⁰ This includes length of railway in Khaf County.

- Results and interpretation:
 - The main reason of expanding the national railway to Khaf County was the presence of SIOM in this region.
 - Between 2011 and 2014, increase in railway length under operation in Khaf County was around 27.6 Km which equals 24.7%, while this quantity in the whole Khorasan-e-Razavi Province was 8 Km or 1%⁵¹¹.
 - Since the first iron ore concentration plant was inaugurated in 2012, construction and operation of railways were started and developed from 2011 to transport the products. Construction of Khaf- Herat railway – named restoration of Silk road – facilitates not only the transportation of mineral products, but also easier travelling for people which in the long run provides social, cultural and economic opportunities.

5.3.2.2 *Ratio of annual electricity consumption in mining sector to total energy consumption in Khaf County*

- Introduction: The promotion of energy and in particular of electricity is a high priority of sustainable development. The indicator monitors progress in accessibility and affordability of electricity. Lack of access to electricity limits economic development. Furthermore, adequate, affordable and reliable energy services including electricity are necessary to guarantee sustainable economic and human development⁵¹².
- Calculation method: Dividing the amount of electricity consumption in SIOC to the total electricity consumption in Khaf County.
- Data and graphs: Table 5.23 and figures 5.30 and 5.31 present the required data for measuring this indicator and output graphs.

⁵¹¹ Khaf-Harat Railway project was not incorporated in these calculations for it is under construction.

⁵¹² United Nations (2007), *Indicators of Sustainable Development: Guidelines and Methodologies*, The Department of Economic and social Affairs (DESA), Third edition, New York

Year	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015 ⁵¹³
Annual electricity consumption in SIOC ⁵¹⁴ (1000Kwh)	544	556	870	8,768 ⁵¹⁵	8,817	12,299
Total annual energy consumption in Khaf County ^{516 517} (1000Kwh)	170,109	167,210	204,197	196,962	213,217	220,962
Ratio of annual electricity consumption in SIOC to total annual energy consumption in Khaf County (%)	0.32	0.33	0.43	4.45	4.14	5.57

Table 5.23 Data and ratio related to electricity consumption in SIOC and Khaf County

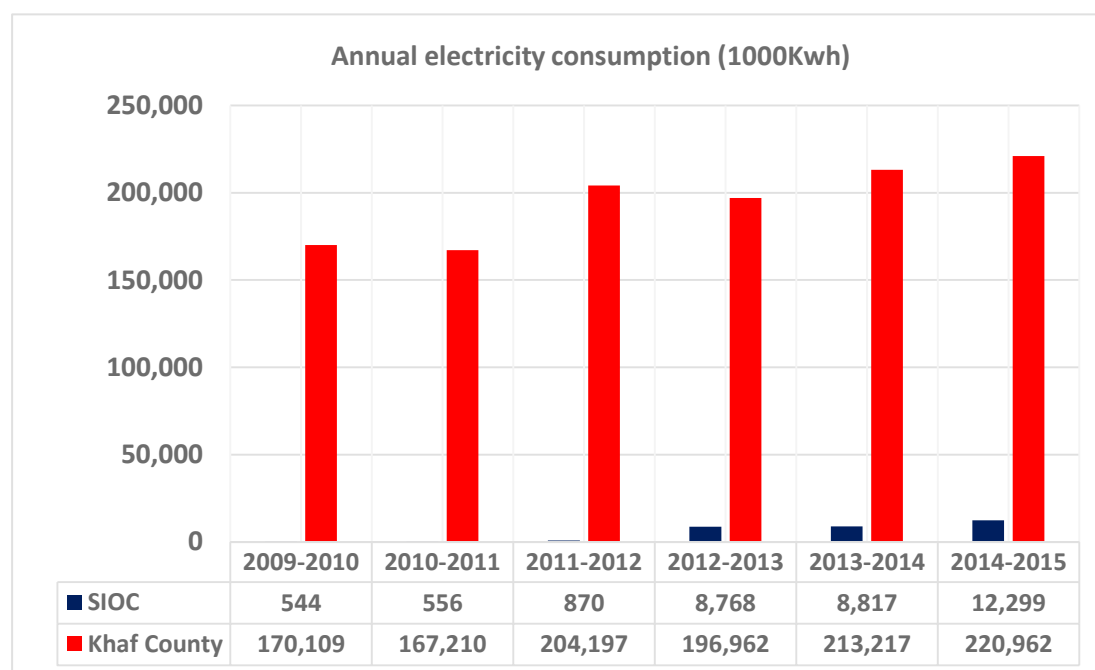


Figure 5.30 Graph related to annual electricity consumption indicator

⁵¹³ In comparison to previous years, electricity consumption increased up to 28% in 2014 and 2015. Although no other plant was inaugurated at this time span, electricity consumption in other construction sites – either governmental or private – led to this increase.

⁵¹⁴ SIOC Technical and Operational Deputy (2015), *Internal report* (Persian)

⁵¹⁵ Electricity consumption in Sangan Complex during this time span has multiplied by ten. The main reason is inauguration of the first Sangan iron ore concentrate plant.

⁵¹⁶ Electricity consumption in Khaf County excludes the consumption in Sangan Iron Ore Complex.

⁵¹⁷ Khaf Electrical Distribution Company (2015), *Internal report* (Persian)

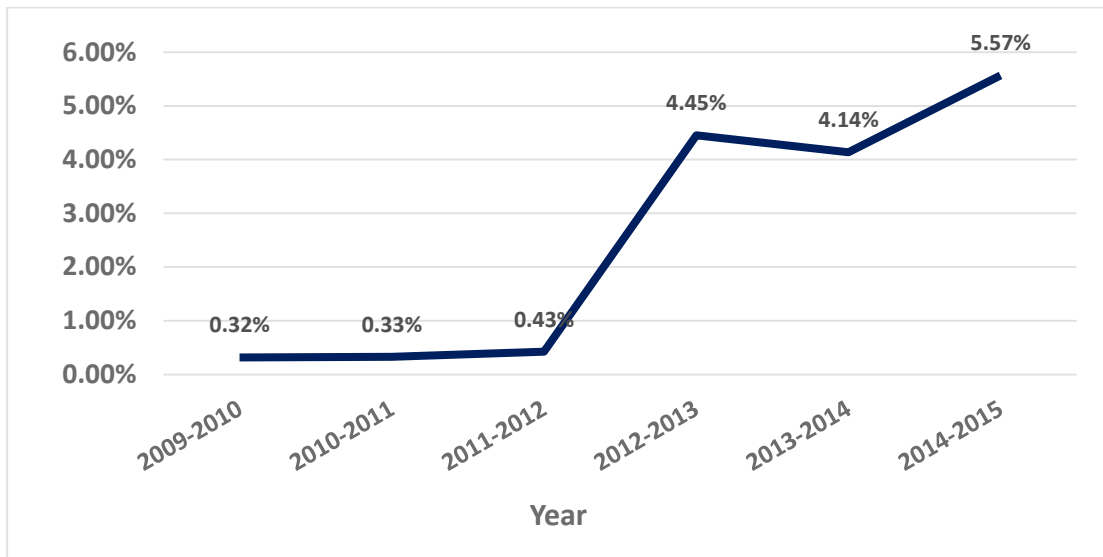


Figure 5.31 Ratio of annual electricity consumption in SIOC to total annual energy consumption in Khaf County

- Results and Interpretation
 - The rate of electricity consumption has increasing trend in the complex and has escalated during the study period⁵¹⁸.
 - The ratio of consumption decreased from 4.45 to 4.14 during 2013-2014 which can be attributed to higher electricity consumption in Khaf County in comparison to the SIOC.
 - According to the estimates, the ratio of electricity consumption in SIOC to Khaf County will be augmented by 40-50 % or 8 times higher than the current rate. This amount will be provided by the specific SIOM electricity substation which is connected to the regional grid.

5.3.2.3 Increase in family's income (per capita)

- Introduction: The indicator is a standard measure of poverty, especially income poverty. It provides information on progress towards poverty alleviation, a central objective and requirement of sustainable development. Progress against poverty is now a widely accepted yardstick for assessing the overall performance of developing economies⁵¹⁹.

⁵¹⁸ Unexpectedly, electricity consumption in Khaf County has decreased during 2012-2013 which can be attributed to Iranian subsidy reform plan.

⁵¹⁹ United Nations (2007), *Indicators of Sustainable Development: Guidelines and Methodologies*, The Department of Economic and social Affairs (DESA), Third edition, New York

- Calculation method: Dividing the average annual income in rural and urban areas⁵²⁰ in Khorasan-e-Razavi Province to Iran.
- Data and graphs (rural): Table 5.24 and figures 5.32 and 5.33 present the data for calculating the rural families' income indicator and output graphs.

Year	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014
Rural families' average annual income in Khorasan-e-Razavi Province ⁵²¹ (MIRR ⁵²²)	34.0	36.9	41.0	51.2	69.3	88.5	105.6
Rural families' average annual income in Iran ⁵²³ (MIRR)	47.1	48.4	52.4	59.3	79.7	101.3	121.1
Ratio of rural family's average annual income in Khorasan-e-Razavi Province to Iran (%)	72.2	76.3	78.3	86.3	86.9	87.4	87.2

Table 5.24 Data and ratio related to rural families' income indicator in Khorasan-e-Razavi Province and Iran

⁵²⁰ According to Iranian Ministry of Interior, rural areas are defined as settlements where at least 100 persons (20 families) live and their main occupations are agriculture, fishing, animal farming and similar activities. Urban areas have at least 10000 settlers and people have different occupations such economic, social, political activities.

Access at: <http://www.moi.ir/portal/File/ShowFile.aspx?ID=3b0b4f78-eb6f-4e67-9875-004ca155fab> (Persian)

⁵²¹ Statistical center of Iran, *Statistical yearbooks of Khorasan-e-Razavi Province*, 2014. Inflation rate is not included.

⁵²² Million Rials

⁵²³ Statistical Center of Iran, 2014 (<http://amar.org.ir>), Inflation rate is not included.

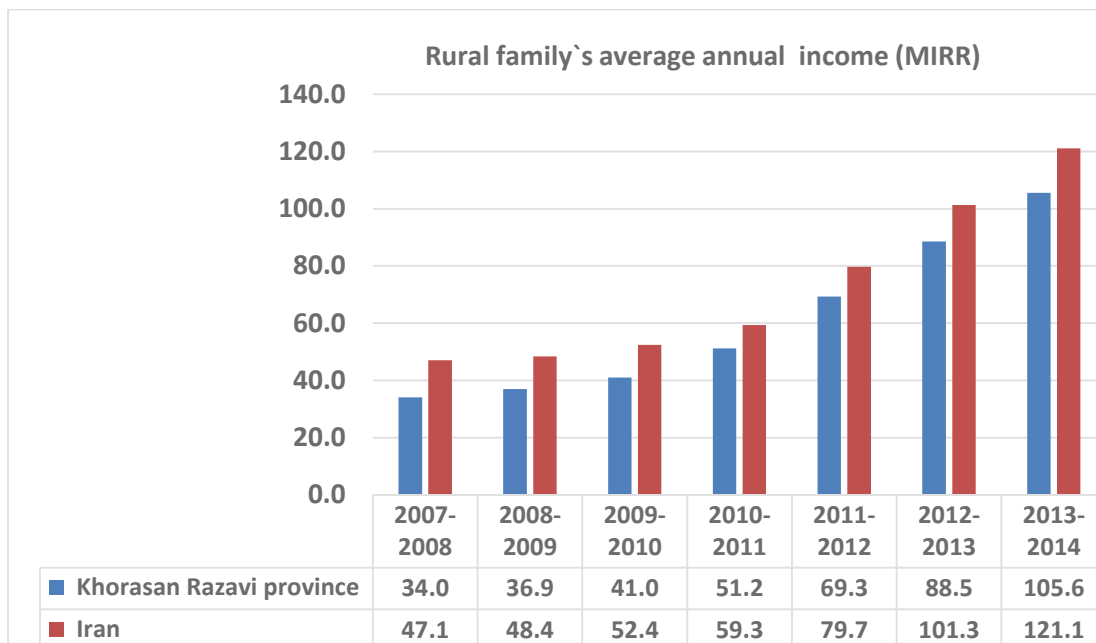


Figure 5.32 Graph related to rural family's average annual income indicator

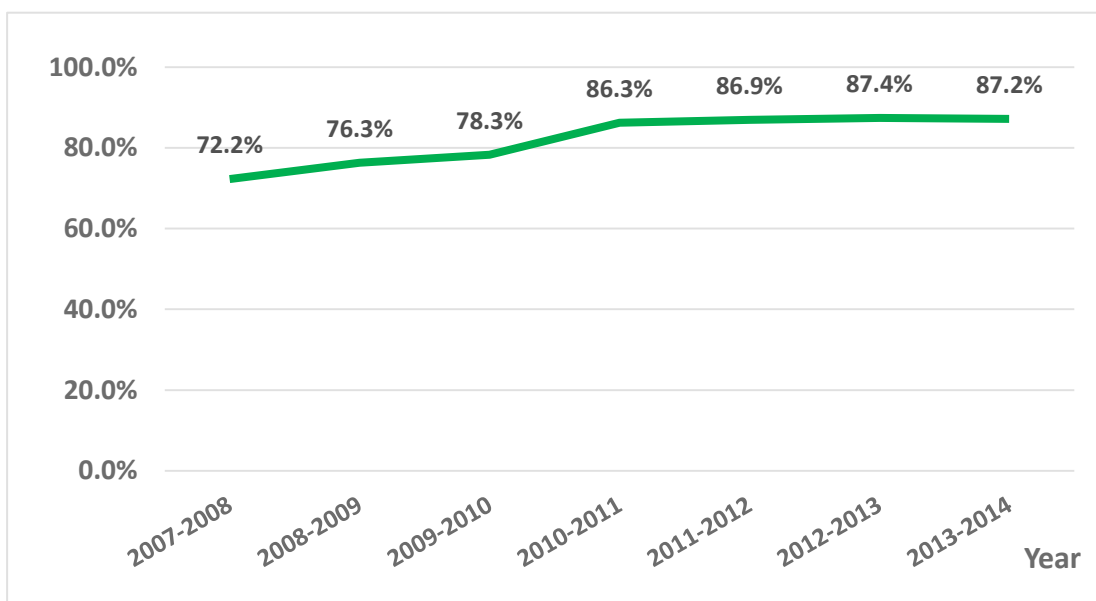


Figure 5.33 Ratio of rural family's average annual income in Khorasan-e-Razavi Province to Iran

- Results and interpretation (rural):
 - The trend of average annual income in rural families has been increasing in Iran and Khorasan-e-Razavi Province.
 - In comparison to the whole country, the average annual income has always been lower in Khorasan-e-Razavi Province. This can be

attributed to low amount of well paid jobs because of poor investment in the region and lack of appropriate infrastructure⁵²⁴.

- The trend of ratio of rural family's average annual income has increased from 2007 till 2012 but has remained stable since then.
 - It is expected that after construction of infrastructures and operation of SIOM development projects, considerable economic effects will occur in the region. Consequently, this trend increases and the status of rural families' income will excel from 2018⁵²⁵. Besides, local rural families have the priority to be employed in the complex; hence their income will have a considerable increase in comparison to agriculture.
- Data and graphs (urban): Table 5.25 and figures 5.34 and 5.35 present the required data for calculating the urban families' income indicator and output graphs.

Year	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014
Urban families' average annual income in Khorasan-e-Razavi Province ⁵²⁶ (MIRR)	63.0	83.0	87.6	97.4	120.9	152.7	182.2
Urban families' average annual income in Iran ⁵²⁷ (MIRR)	78.0	88.2	93.6	106.2	130.3	167.2	204.5
Ratio of urban family's average annual income in Khorasan-e-Razavi Province to Iran (%)	80.7	94.1	93.6	91.8	92.8	91.3	89.1

Table 5.25 Data and ratio related to urban families' income indicator in Khorasan-e-Razavi Province and Iran

⁵²⁴ <http://www.farsnews.com/newstext.php?nn=13940504000497> (access at July 2015)

⁵²⁵ From 2018, most SIOM development projects will be inaugurated.

⁵²⁶ Statistical center of Iran (2014), *Statistical yearbooks of Khorasan-e-Razavi Province*, Inflation rate is not included.

⁵²⁷ Statistical Center of Iran, 2014 (<http://amar.org.ir>), Inflation rate is not included.

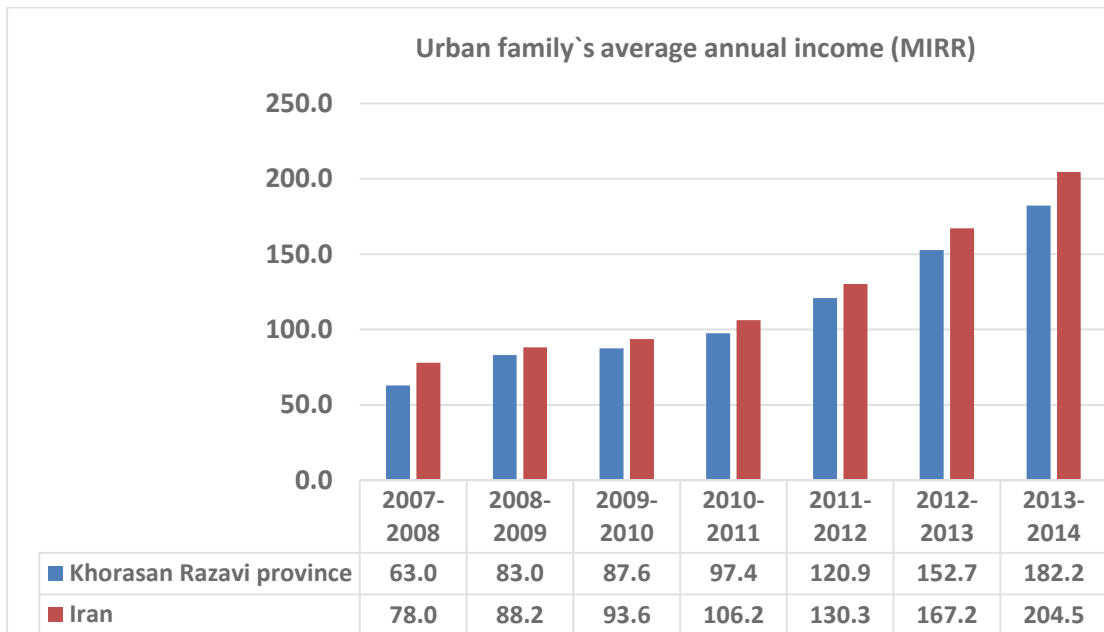


Figure 5.34 Graph related to urban family`s average annual income indicator

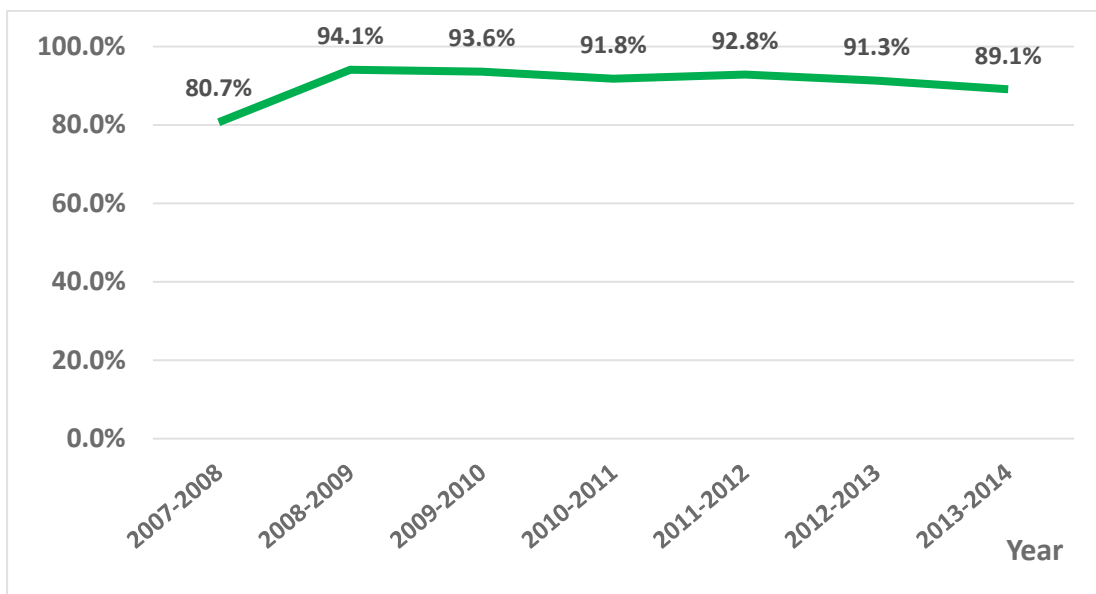


Figure 5.35 Ratio of urban family`s average annual income in Khorasan-e-Razavi Province to Iran

- Results and interpretation (urban):
 - The trend of average annual income in urban families has been increasing in Iran and Khorasan-e-Razavi Province.
 - In comparison to the whole country, the average annual income in urban families has always been lower in Khorasan-e-Razavi Province.

This can be attributed to low amount of well paid jobs because of poor investment in the region and lack of appropriate infrastructure⁵²⁸.

- The trend of ratio of urban family's average annual income has increased by 13% from 2007 till 2009 but has remained almost stable since then.
- It is expected that after construction of infrastructures and operation of SIOM development projects by 2018, considerable economic effects will occur in the region. Both rural and urban families will benefit from this improvement and have the chance to be employed in complex; however, considerable change will be noticed in local rural families' welfare.

5.3.2.4 Length of roads⁵²⁹

- Introduction: Transport is an important tool to help meet overall sustainability objectives. Attributes of sustainable transport follow from the expanded definition of sustainable development: sustainable transport is safe, high-quality, and accessible to all; economically viable; and a positive contributor to local, national and international development⁵³⁰. Nearly every type of business operation relies to some degree upon transportation opportunities afforded by roads. In an isolated region roads as “development corridors”, have a significant impact in improving the overall situation of a region, because new political, social, economic and cultural potentials can penetrate into these regions easier, that might accelerate the trend of growth⁵³¹.
- Calculation method: Dividing the length of roads in Khaf County to the total length of roads in Khorasan-e-Razavi Province.
- Data and graphs: Table 5.26 and figures 5.36 and 5.37 present the required data for calculating the length of roads indicator and output graphs.

⁵²⁸ <http://www.farsnews.com/newstext.php?nn=13940504000497> (access at July 2015)

⁵²⁹ Includes roads that are under operation.

⁵³⁰ United Nations Economic Commission for Europe (2011), *Transportation for Sustainable Development in the ECE Region*, p. 6, Access at: https://www.unece.org/fileadmin/DAM/trans/publications/Transport_for_sustainable_development_in_the_ECE_region.pdf

⁵³¹ A. Tavakoliroodi, (2012), *Security, political and economic effects of mining activities in SIOM*, Taybad Azad University (Persian)

Year	2001-2002 ⁵³²	2006-2007	2011-2012	2013-2014
Length of roads in Khaf County ⁵³³ (Km)	122	172	279	283
Length of roads in Khorasan-e-Razavi Province ⁵³⁴ (Km) ⁵³⁵	8,204 ⁵³⁶	6,273	6,850	6,847
Ratio of length of road in Khaf County to Khorasan-e-Razavi Province (%)	1.5	2.7	4.1	4.1

Table 5.26 Data and ratio related to length of roads indicator in Khaf County and Khorasan-e-Razavi Province

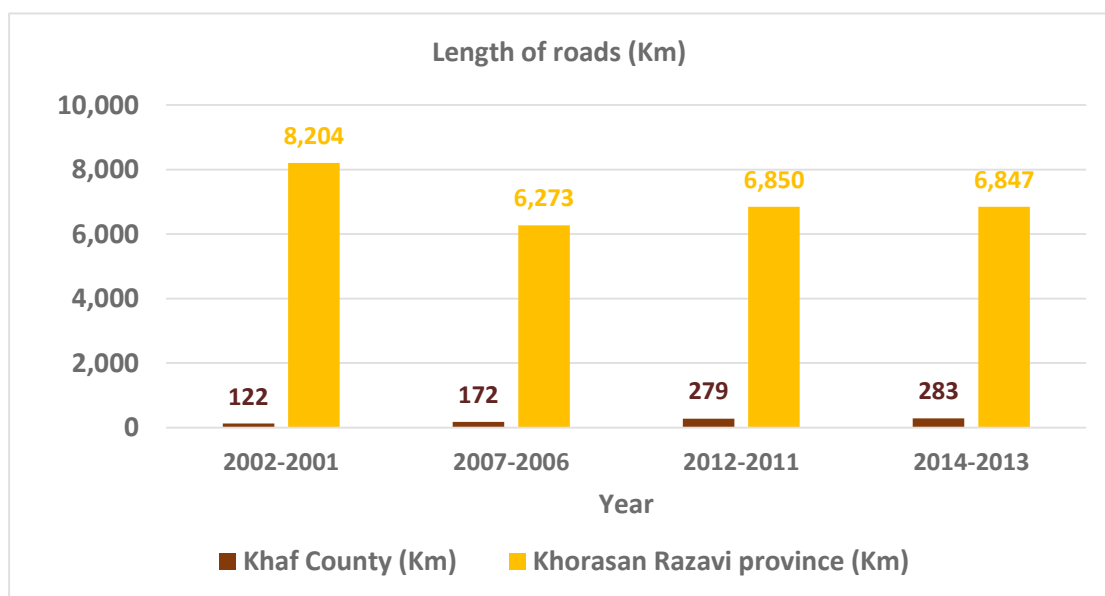


Figure 5.36 Graph related to length of roads indicator

⁵³² This data goes back to the time that Khorasan-e-Razavi Province was not divided to three provinces.

⁵³³ Metra consulting engineering company, engineering department of SIMP and Khaf County road and urban development office (2014), *Internal report* (Persian)

⁵³⁴ Statistical center of Iran, *Statistical yearbooks of Khorasan-e-Razavi Province*, 2014

⁵³⁵ Includes Khaf County and also all kinds of road such as highway, roadway, asphalt, etc.

⁵³⁶ The decrease in length in next years is due to variations in urban boundaries; i.e. some roads used to be known as suburban but after city expansion, they were known as urban roads.

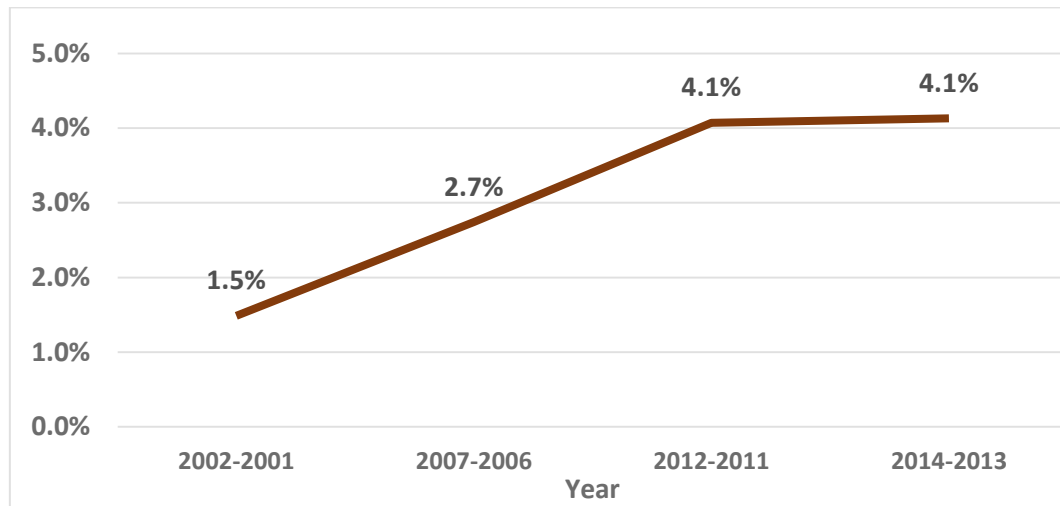


Figure 5.37 Ratio of length of road in Khaf County to Khorasan-e-Razavi Province

- Results and interpretation
 - During 2006-2012, length of roads in Khaf County increased up to 107 Km (38%), while this number for Khorasan-e-Razavi Province during the same time span was 577 Km (8% including Khaf County).
 - During the main part of study period (2006-2014), length of roads in Khaf County made up 19.35% of the total increase in length of operational roads in Khorasan-e-Razavi Province. Considering the area of Khaf County in comparison to the area of whole Province (Khaf County covers 6.77% of the Province), this number is considerable which can undoubtedly be attributed to SIOM and its development plans.
 - No considerable expansion was conducted in roads of Khaf County during 2012-2014. Since new mining projects are under construction by private companies and also due to increase in production capacity in SIOM in next 4 years, road transportation along with rail transportation will definitely be needed more to facilitate transfer of products to factories. Hence, improvement, development and expansion of existing roads in Khaf, Torbat-e-Jam and Ghaen Counties are of immense importance⁵³⁷. It should be mentioned that

⁵³⁷ It should be noted that approximately half part of Khaf County to Torbat-e-Heydarieh road is under construction by cooperation of IMIDRO and Road and Urban Development Office in Khorasan-e-Razavi Province.

according to the results of questionnaire number 2 (Figure 5.19), local stakeholders prefer development of aerial transportation in the region after train. However, since the required infrastructures to improve road and railways already exist, it is cost-efficient to improve other means of transportation. Although it is suggested to set long-term strategies for aerial transportation development⁵³⁸.

- As shown in figure 5.37, the ratio of roads in Khaf County to total length of roads in Khorasan-e-Razavi Province has increased by 2.65% from 2001 till 2014, which needs more improvement due to the need for transportation of employees, residents, facilities, raw materials and SIOM products.

5.3.2.5 *Employment-population ratio*

- Introduction: The employment-to-population ratio provides information on the ability of an economy to create employment. Employment, as opposed to unemployment, is viewed as the desired portion of the economically active population (labor force). Employment-to-population ratios are of particular interest as they can provide information on labor market activity in a given country. For policy purposes, employment-to-population ratios of youth and old are particularly relevant⁵³⁹.
- Calculation method: Dividing the number of employed people to the total number of people at working age.
- Data and graphs: Table 5.27 and figures 5.38 and 5.39 present the required data for calculating this indicator and output graphs.

⁵³⁸ This point is in accordance with the results of SWOT analysis in chapter 4 (table 4.17) where improving the aerial transport was determined as the second priority.

⁵³⁹ United Nations (2007), “*Indicators of Sustainable Development: Guidelines and Methodologies*”, The Department of Economic and social Affairs (DESA), Third edition, New York

Year		1976-1977	1986-1987	1996-1997	2006-2007	2011-2012
Labor force in Khaf County ⁵⁴⁰	Employed	12,695	16,980	20,251	28,967	31,176
	Unemployed	4,350	1,955	1,456	2,876	2,626
Population of working age ⁵⁴¹ in Khaf County ⁵⁴²		22,105	55,819	61,740	84,824	93,783
Employment- population ratio (%)		57.4	30.4	32.8	34.1	33.2 ⁵⁴³

Table 5.27 Data and ratio related to employment-population ratio indicator in Khaf County⁵⁴⁴

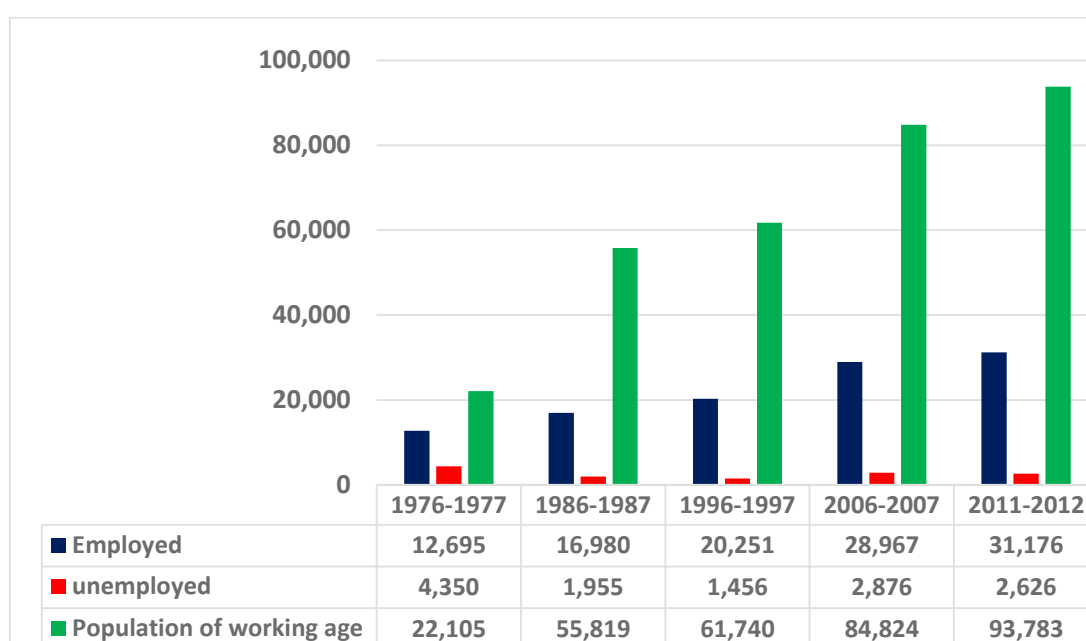


Figure 5.38 Employment and population statistics in Khaf County

⁵⁴⁰ Statistical Center of Iran, 2012 (<http://amar.org.ir>)

⁵⁴¹ Working age in Iran is currently between 15 till 64 but it used be above 10 years old by 1977 which is the reason that the ratio is so high in this period.

⁵⁴² Statistical center of Iran, 2012 (<http://amar.org.ir>)

⁵⁴³ Due to termination of construction phase, almost 200 employees lost their job on that time. Considering the fact that each direct job is followed by 4 indirect jobs, it can be inferred that 800 direct jobs were lost in this period. In total, 1000 jobs were lost which affect the whole employment-population ration in the county (See: figures 3.4 and 3.22 in chapter 3).

⁵⁴⁴ The difference between the number of population in working age and the number of employed and unemployed population is that there are a number of groups such as students and house wives which are neither employed nor unemployed.

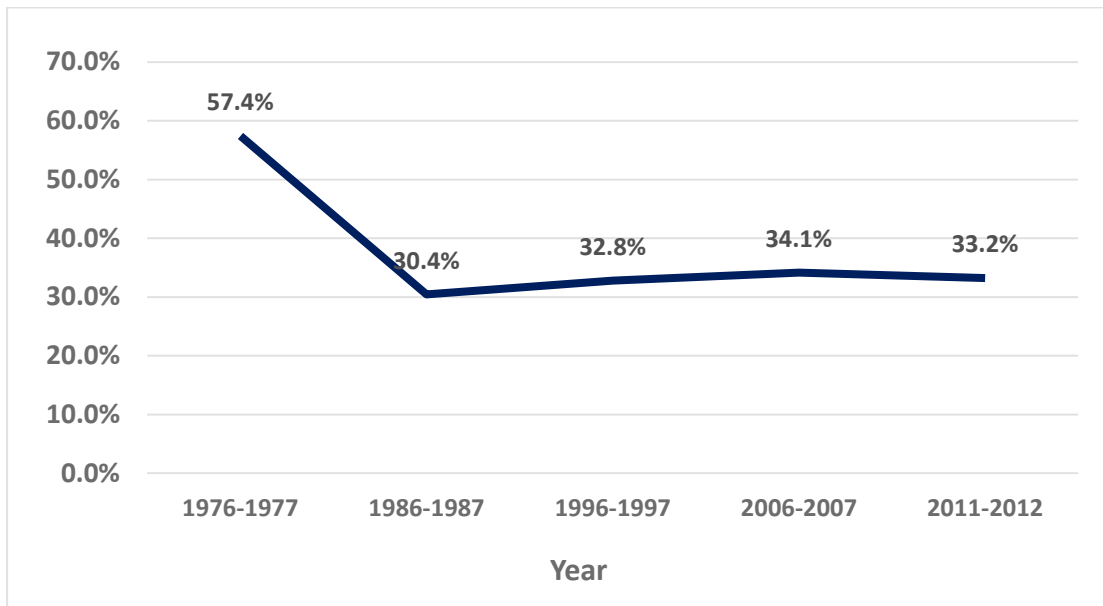


Figure 5.39 Ratio of employed population to population of working age in Khaf County

- Results and interpretation
 - Since 1987, the ratio has had an increasing trend except in 2011-2012. Decrease in employment-population ratio in 2012 can be attributed to termination of constructing the concentrate production plant. Usually, there are non-native workers in construction phase who leave the project after a while and the operation phase runs with less staff. At that time, 199 employees lost their job⁵⁴⁵.
 - It is expected that from 2018, the employment-population ratio excels in Khaf County and neighbor regions (Taybad, Ghaen, Roshtkhar, Torbat-e-Heydarie and Torbat-e-Jam) due to the inauguration of SIOM development projects and ongoing direct and indirect engagement in the project. It has been widely accepted that in mining section, usually 4 times the direct jobs, indirect jobs are created⁵⁴⁶.

⁵⁴⁵ SIMP, IEIOC and SIOC's Human Resources Management Departments (2013), *Internal report* (Persian)

⁵⁴⁶ Tadbir Gostar-e-Asia, Project Control and Planning Consultant of Sangan Iron Ore Mine Project, yearly management reports, 2007 to 2014, p.8 (Persian), According to this report, 2500 direct jobs and 10000 indirect jobs were created during the operational phase of SIMP.

5.3.3 Environmental indicators

5.3.3.1 Water consumption in Sangan Mining Complex

- Introduction: The indicator shows the degree to which total renewable water resources are being exploited to meet the water demands and is thus a measure of water scarcity. Scarce water could have negative effects on sustainability constraining economic and regional development, and leading to loss of biodiversity. It is an important measure of vulnerability to water shortages⁵⁴⁷.
- Calculation method: Dividing the annual water consumption in SIOC to the annual water consumption in Khaf County. Due to lack of access to valid and trustable data, the water consumption in Khaf County was calculated by multiplication of its population and average per capita consumption in Iran (200 liter per day⁵⁴⁸ or 73 cubic meters in year).
- Data and graphs: Table 5.28 and figures 5.40 and 5.41 present the required data for calculating this indicator and output graphs.

Year	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015
Annual water consumption in SIOC ⁵⁴⁹ (1000M ³)	10	32	30	42	50	238	650	1731
Annual water consumption in Khaf County (1000M ³)	8219	8383	8550	8721	8896	9074	9255	9440
Ratio of annual water consumption in SIOC to Khaf County (%)	0.12	0.38	0.35	0.48	0.56	2.62	7.02	18.33

Table 5.28 Data and ratio related to water consumption indicator in SIOC and Khaf County

⁵⁴⁷ United Nations (2007), *Indicators of Sustainable Development: Guidelines and Methodologies*, The Department of Economic and social Affairs (DESA), Third edition, New York

⁵⁴⁸ Resources: <http://www.tasnimnews.com/Home/Single/595667> (January 2015) and http://abfar-kh.ir/portal/index.php?option=com_content&view=article&id=1582:---9-----94421&catid=40:news&Itemid=0 (July 2015)

⁵⁴⁹ SIOC Technical and Operational Deputy (2015), *Internal report* (Persian)

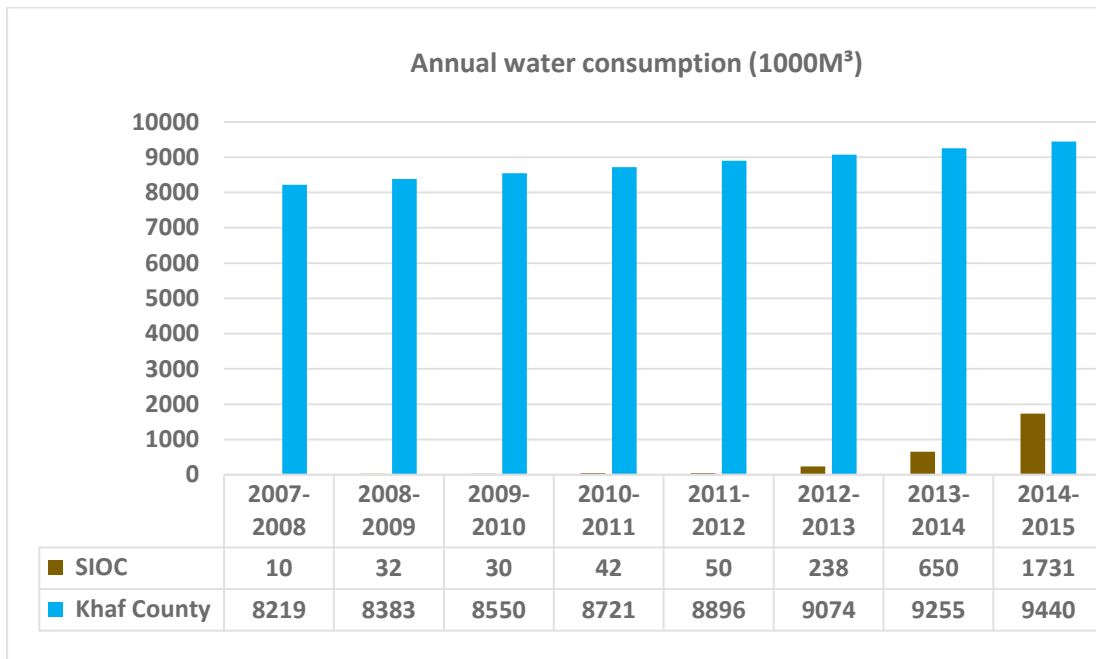


Figure 5.40 Graph related to annual water consumption indicator

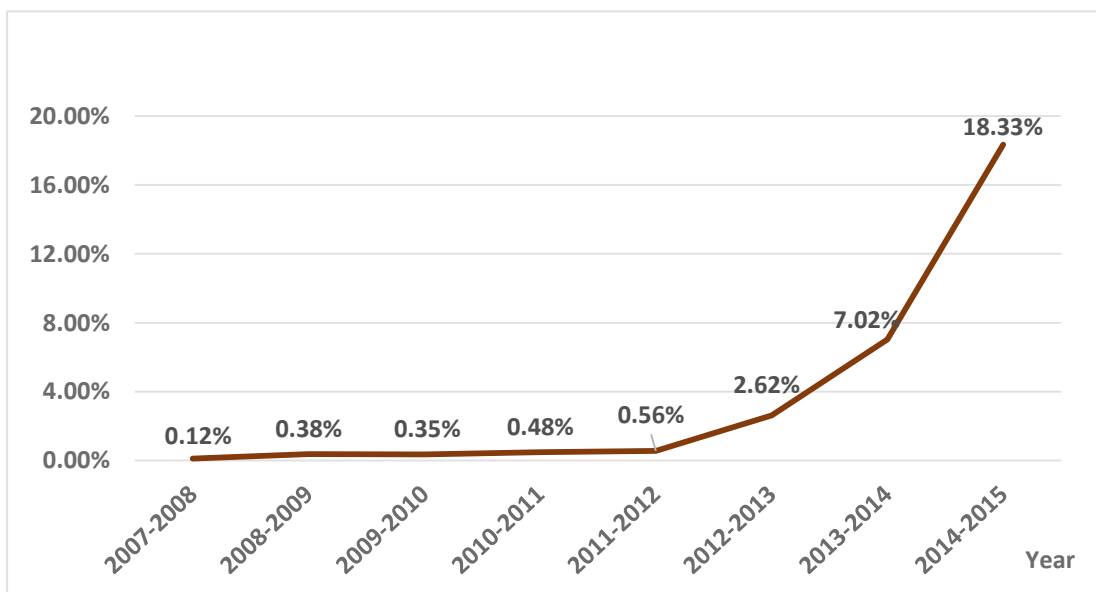


Figure 5.41 Ratio of annual water consumption in SIOC to annual water consumption in Khaf County

- Results and interpretation
 - Water consumption has had an increasing trend in both SIOC and Khaf County.
 - After inauguration of the Sangam first iron ore concentrate plant in 2012, water consumption ratio had boosted from 0.56% to 2.62%.

- The steep slope of increase in water consumption after 2012 depicts the higher demand of industrial water consumption. It is estimated that due to operation of new plants in future, this amount raises.
- Since other new plants will be constructed in the region, it is anticipated that by 2018, the water consumption in SIOC (including private companies` plants) will be higher than the total water consumption in Khaf County. To secure the safe access to water for local residents, investing companies guarantee to utilize measures to provide their required water through recycling. Meanwhile, other options such as inter-basin water transfer are under study.

5.3.3.2 Area of land assigned to mining activities

- Introduction: The indicator provides information on changes in the productive or protective uses of the land resource to facilitate sustainable land use planning and policy development. Such information is useful in identifying opportunities to protect land uses or promote future allocation aimed at providing the greatest sustainable benefits for people. Economically, changes in land use will, for example, result in changes in possible agricultural production and influence employment opportunities. From an environmental point of view, unsustainable land use is an important factor in land degradation may pose a threat to ecosystems, and lead to natural habitat loss and landscape changes⁵⁵⁰.
- Calculation method: Dividing area of lands assigned to mining activities to total area of Khaf County.
- Data and graphs: Table 5.29 and figures 5.42 and 5.43 present the required data for calculating this indicator and output graphs.

⁵⁵⁰ United Nations (2007), *Indicators of Sustainable Development: Guidelines and Methodologies*, The Department of Economic and social Affairs (DESA), Third edition, New York

Year	2000-2001	2005-2006	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014
Area of land assigned to mining activities ⁵⁵¹ (KM ²)	29.8	59.8	166.7	213.1	268.1	346.5	375.1	486.4	490.8
Khaf County area (KM ²)	9797	9797	9797	9797	9797	9797	9797	9797	9797
Ratio of area of land assigned to mining activities to Khaf County area (%)	0.30	0.61	1.70	2.17	2.74	3.54	3.83	4.96	5.01

Table 5.29 Data and ratio related to area of land assigned to mining activities indicator in Khaf County

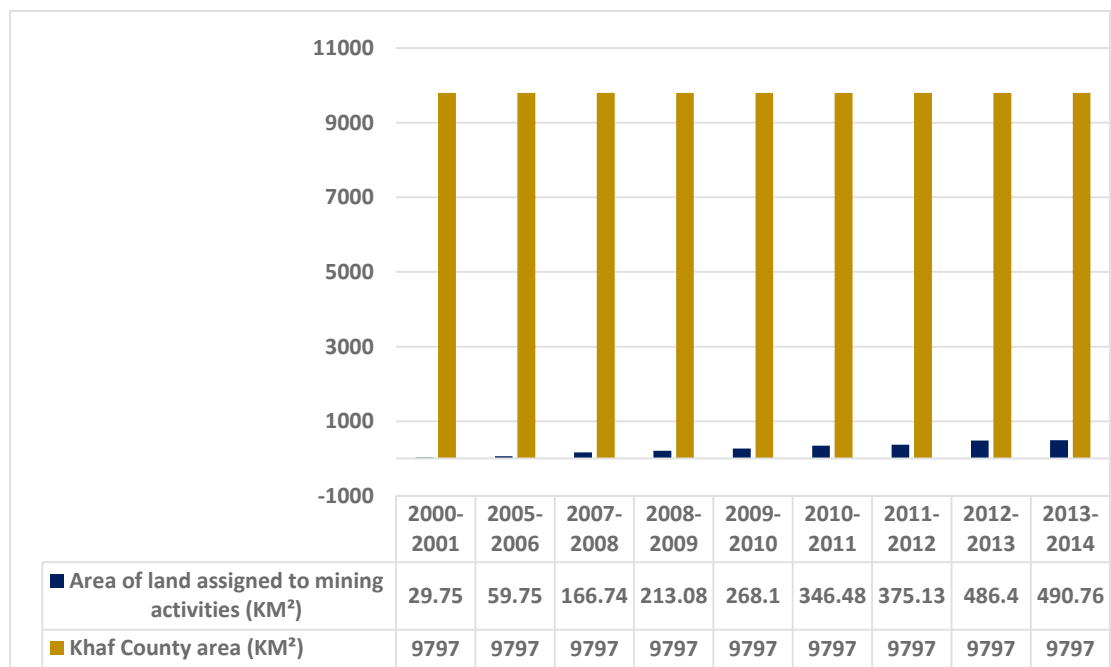


Figure 5.42 Graph related to area of land assigned to mining activities indicator in Khaf County

⁵⁵¹ Iranian Mining Engineering Organization (2015), Access at: <http://www.ime.org.ir/>

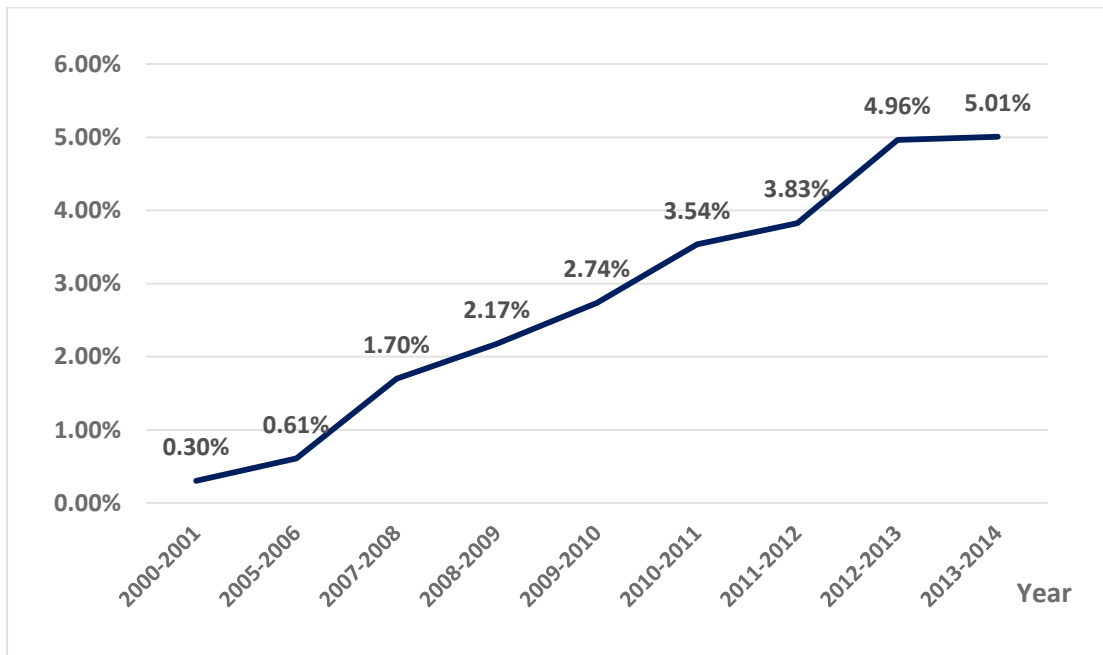


Figure 5.43 Ratio of area of land assigned to mining activities to Khaf County area

- Results and interpretation
 - Area of lands assigned to mining activities has increased gradually from 2001. This can be attributed to various issues including: establishment of IMIDRO in 2001, assigning a specific budget to the exploration and exploitation of Sangam Iron Ore Mines and also a higher demand for iron ore in the world and consequently the higher price of this mineral till 2014⁵⁵².
 - During 2013-2014, the ratio of land in Khaf County assigned to mining activities reached 5% which is a considerable amount. However, since this region lacks rich vegetation cover and also due to high water shortage which makes agriculture an infeasible land use, this ratio can be justified in Khaf County region if the mining companies do something as compensation and provide recreational areas regarding to the results of QN2 (Table 5.8).
 - The ratio of main Sangam Iron Ore Mines area (29.75 Km²) to the total area of other lands assigned to mining activities in Khaf County

⁵⁵² The highest share of area assigned to mining activities in Khaf County belongs to placer mining (461 Km²) while these share for Sangam massive iron ore is only 29.75 Km².

(461 Km²) was around 6.45% in 2013-2014 while this ratio was only 0.3% in comparison to the whole Khaf County area.

- Considering the global decreasing trend of iron ore price and high sensitivity of Iranian Department of Environment to placer mining activities, it is expected that this ratio will not exceed more than 5% during coming years.

5.3.3.3 Ratio of sanitary disposed solid waste to total solid waste produced

- Introduction: The provision of adequate sanitation is necessary for poverty alleviation and to protect human health and the environment. The indicator monitors progress in the accessibility of the population to sanitation facilities, a basic and essential social service⁵⁵³.
- Calculation method: Dividing the number of household with sanitary waste disposal system to the number of all households.
- Data and graphs: Table 5.30 and figures 5.44 and 5.45 present the required data for calculating this indicator and output graphs.

⁵⁵³ United Nations (2007), *Indicators of Sustainable Development: Guidelines and Methodologies*, The Department of Economic and social Affairs (DESA), Third edition, New York

Year	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015
Number of households with sanitary waste disposal ⁵⁵⁴	22,377	21,305	25,706	23,648	31,753
Total households in Khaf County ⁵⁵⁵	28,761	29,965	31,169	32,373	33,578
Ratio of number of households with sanitary waste disposal to total households in Khaf County (%)	78%	71%	82%	73%	95%

Table 5.30 Data and ratio related to sanitary disposed solid waste to total solid waste produced indicator in Khaf County

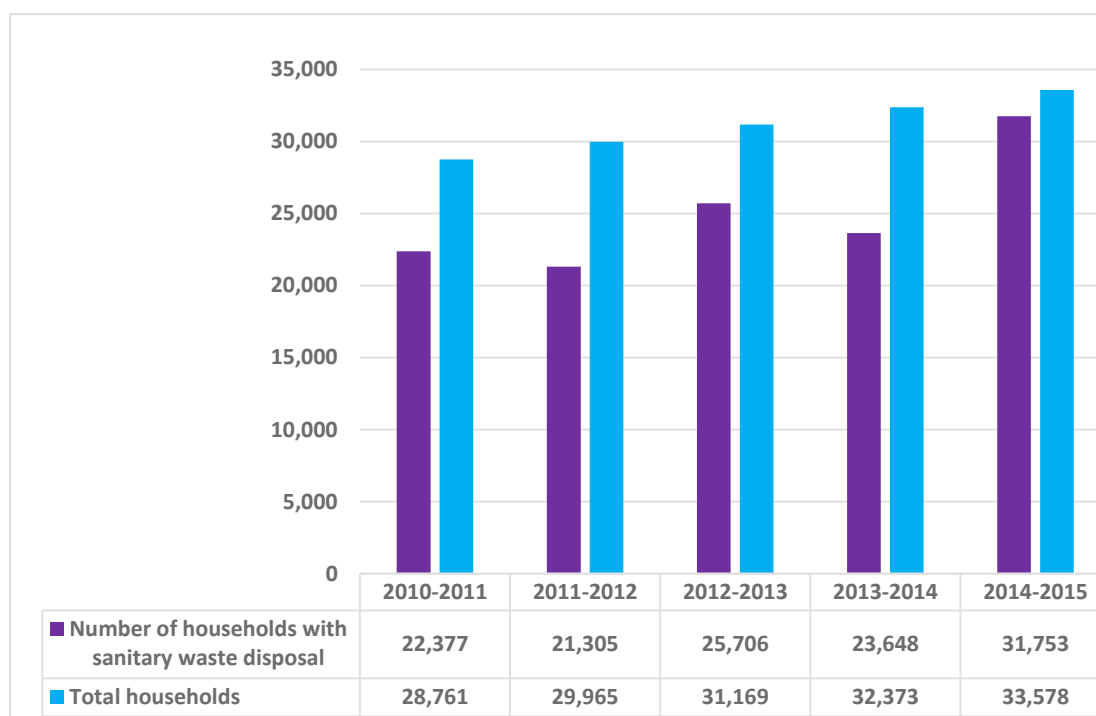


Figure 5.44 Graph related to households with sanitary waste disposal system

⁵⁵⁴ The Health and Treatment Network of Khaf County (2015), *Internal report* (Persian)

⁵⁵⁵ Statistical center of Iran, 2015 (<http://amar.org.ir>)

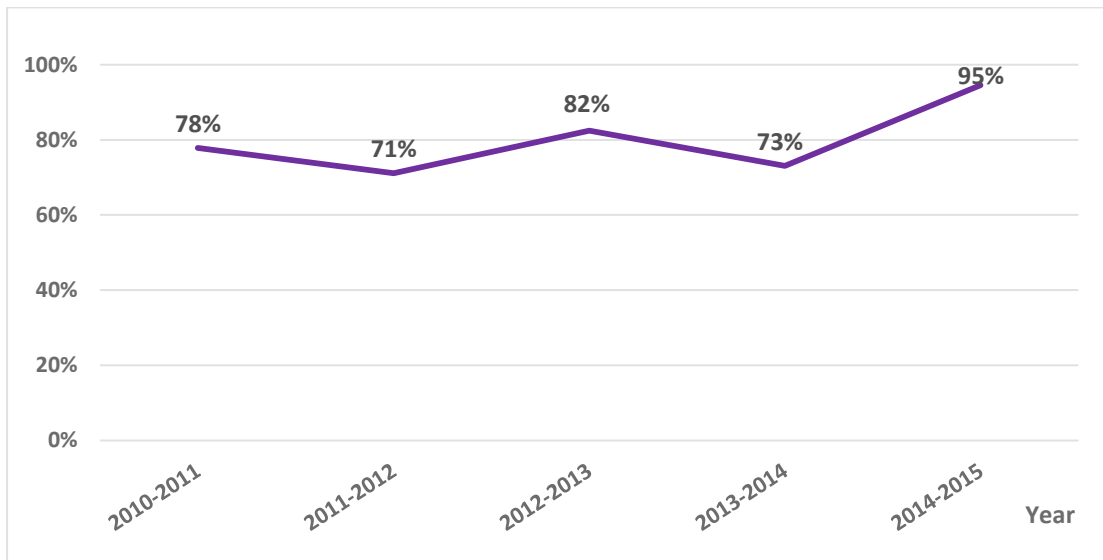


Figure 5.45 Ratio of number of households with sanitary waste disposal to total households in Khaf County

- Results and interpretation
 - During the study period, due to municipality`s development plans, the ratio of households number with sanitary waste disposal to the total households in Khaf County has increased from 78% to 95%. Due to increasing amounts of VAT in the region, after operation of SIOM development projects and improvement in economic status of the residents in Khaf County, this ratio improves from 2018 and people will have better access to sanitary waste disposal.
 - The decrease in ratio in 2012 and 2014 can be attributed to cessation of waste collection systems in some villages⁵⁵⁶.

5.3.3.4 Solid waste production

- Introduction: The main purpose is to show the trend in the generation of waste produced by human activities. Waste represents a considerable loss of resources both in the form of materials and energy. The treatment and disposal of the generated waste may cause environmental pollution and expose humans to harmful substances and bacteria, and therefore impact on

⁵⁵⁶ According to Dr. A. Tavakoliroodi who was the Meyer of Khaf city from 2013 till 2015.

human health. Generated waste shows if there is decoupling of waste generation from economic growth⁵⁵⁷.

- Calculation method: Dividing the amount of solid waste produced in SIOC to the amount of solid waste produced in Khaf County. Due to lack of access to valid and trustable data, the solid waste production in SIOC and Khaf County were calculated by multiplication of SIOC personnel number and Khaf County population and average of solid waste generation in Khaf County (824 gr. daily⁵⁵⁸ or 0.3 ton annually) per capita⁵⁵⁹.
- Data and graphs: Table 5.31 and figures 5.46 and 5.47 present the required data for calculating this indicator and output graphs.

Year	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015
SIOC personnel	548	632	1235	1459	1580	1610	1411	1664	1958
Solid waste production in SIOC (ton)	164	190	371	438	474	483	423	499	587
Khaf County population	110378	112584	114835	117130	119471	121859	124295	126779	129313
Solid waste production in Khaf County ⁵⁶⁰ (ton)	32,949	33,586	34,080	34,701	35,367	36,075	36,865	37,535	38,207
Ratio (%)	0.50	0.56	1.09	1.26	1.34	1.34	1.15	1.33	1.54

Table 5.31 Data and ratio related to solid waste production indicator

⁵⁵⁷ United Nations (2007), *Indicators of Sustainable Development: Guidelines and Methodologies*, The Department of Economic and social Affairs (DESA), Third edition, New York

⁵⁵⁸ H. Alidadi, A. Naghizadeh and A. Dadpour (2007), *Quantity and Quality of Solid Waste Production in Khaf city in 2006*, Tenth National Symposium on Environment Health, Hamadan, Iran (Persian)

⁵⁵⁹ It should be clarified that waste in this indicators means the unwanted materials produced by personnel and households not the waste of mineral processing. Besides, personnel produce less waste than the households but the average amount was considered while calculating this indicator.

⁵⁶⁰ In calculation of solid waste production in Khaf County, number of employees in SIOM is not included.

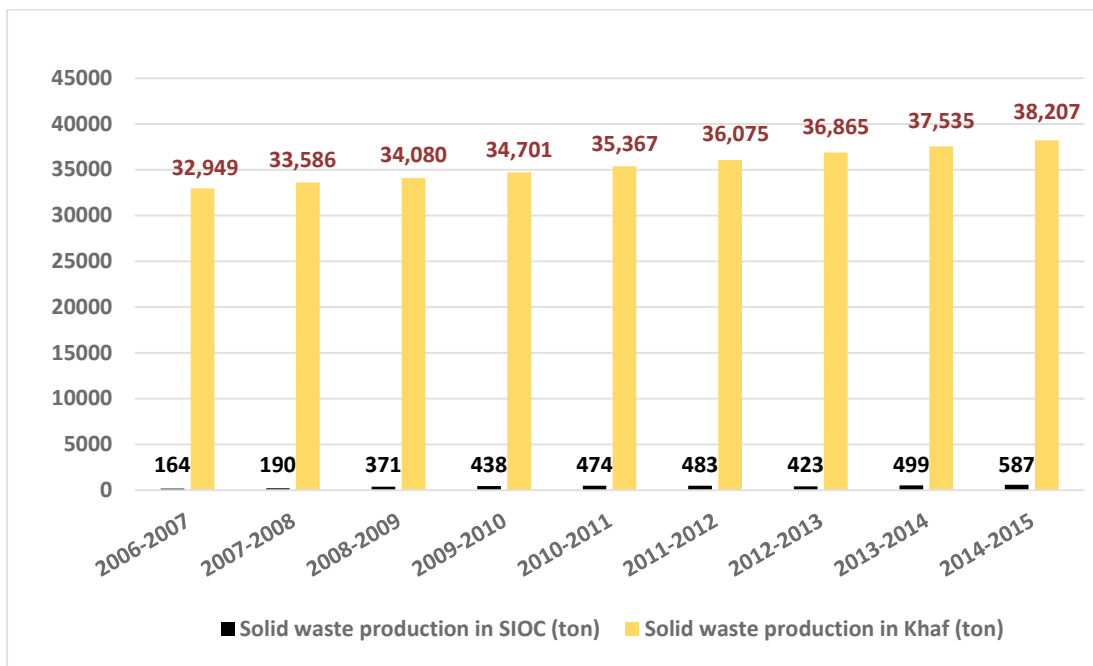


Figure 5.46 Graph related to solid waste production in SIOC and Khaf County

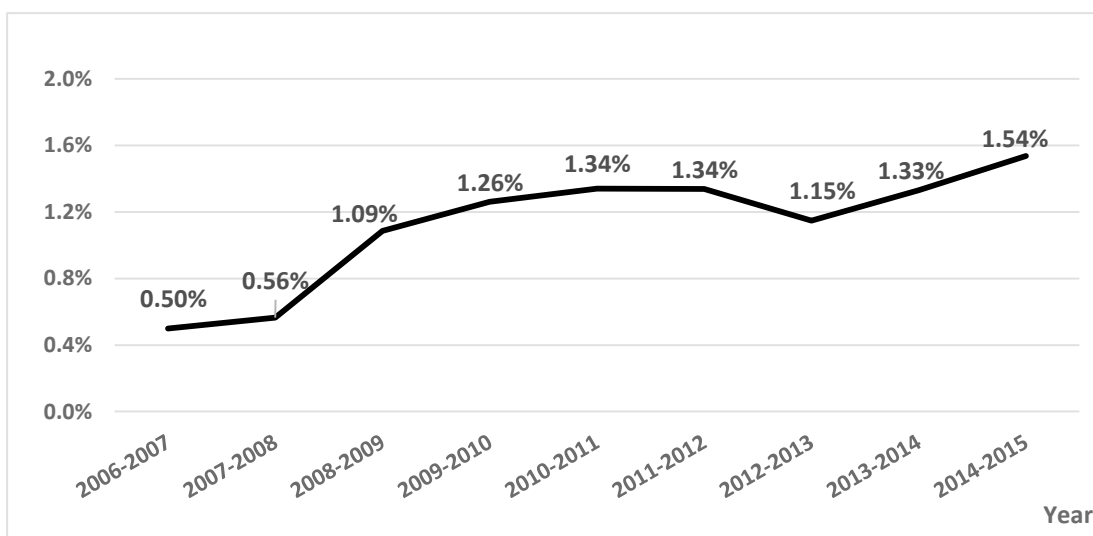


Figure 5.47 Ratio of solid waste production in SIOC to Khaf County

- Results and interpretation
 - The ratio of waste production in SIOC to Khaf County is calculated 1.5% in 2014-2015 which is not a considerable amount. However, it is anticipated that from 2018, this amount reaches 5% due to operation of other phases. This issue should be considered by the municipality of Sangan city and be executed in future plans. Following points are

recommended to include in future development plans: training residents and personnel to produce less waste, improve reuse, establishing recycling plants, using incinerator for special kinds of the waste and running compost farms for wet waste.

5.3.3.5 Wastewater production

- Introduction: This indicator assesses the amount of wastewater⁵⁶¹ from domestic and industrial/commercial point sources and monitors progress towards sanitary wastewater treatment within the framework of integrated water resources management. It helps to identify communities where wastewater treatment action is required to protect the ecosystem. Untreated or insufficiently treated wastewater can result in increased nutrient levels, high levels of organic matter and hazardous substances, posing threats to aquatic ecosystems and human health⁵⁶².
- Calculation method: Dividing wastewater production in SIOC to wastewater production in Khaf County. According to scientific references, generated wastewater in Iranian rural communities is 60 to 70% of water consumption⁵⁶³. Based on the standard pattern of water consumption in Iran, wastewater production share is calculated 76.5%⁵⁶⁴. Hence, per capita wastewater generation in Khaf County is considered as 70% of water consumption which make 51.1 M³ in year. So, the wastewater production in SIOC and Khaf County were calculated by multiplication of SIOC personnel number and Khaf County population and average of wastewater production (51.1 M³ in year) per capita.
- Data and graphs: Table 5.32 and figures 5.48 and 5.49 present the required data for calculating this indicator and output graphs.

⁵⁶¹ Not including industrial wastewater and disposal.

⁵⁶² United Nations (2007), *Indicators of Sustainable Development: Guidelines and Methodologies*, The Department of Economic and Social Affairs (DESA), Third edition, New York

⁵⁶³ B. A. Ghochani, H. Meisami, R. Rahmani, A. Eskandari and S. Saidi (2008), *Introduction of New Wastewater Gathering and Separation Systems*, Iranian National Enforcement Center Publications, Mashhad, Iran, ISBN: 978-964-04-2956-3, p. 20 (Persian)

⁵⁶⁴ Iranian Environmental Health Website, 2015 (Access at: <http://www.environmentalhealth.ir>)

Year	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015
SIOC personal	548	632	1235	1459	1580	1610	1411	1664	1958
Wastewater production in SIOC (1000 M ³)	28	32	63	75	81	82	72	85	100
Khaf County population	110378	112584	114835	117130	119471	121859	124295	126779	129313
Wastewater production in Khaf County ⁵⁶⁵ (1000 M ³)	5612	5721	5805	5911	6024	6145	6279	6393	6508
Ratio (%)	0.50	0.56	1.09	1.26	1.34	1.34	1.15	1.33	1.54

Table 5.32 Data and ratio related to wastewater production indicator

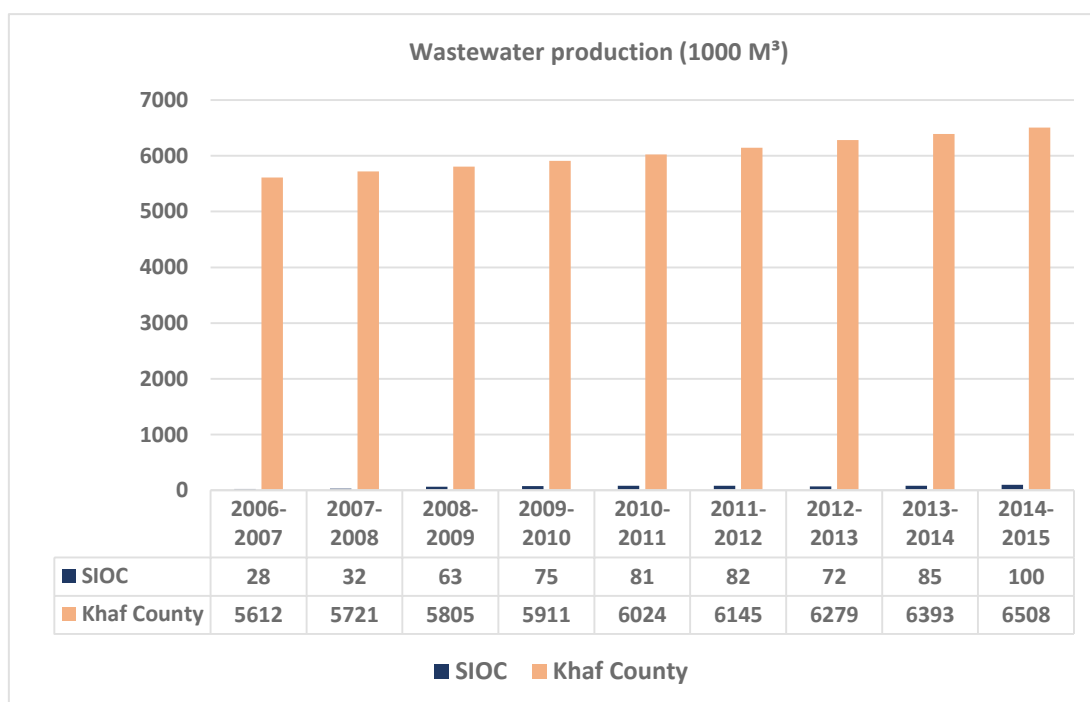


Figure 5.48 Graph related to wastewater production in SIOC and Khaf County

⁵⁶⁵ Number of personnel in SIOC is not included.

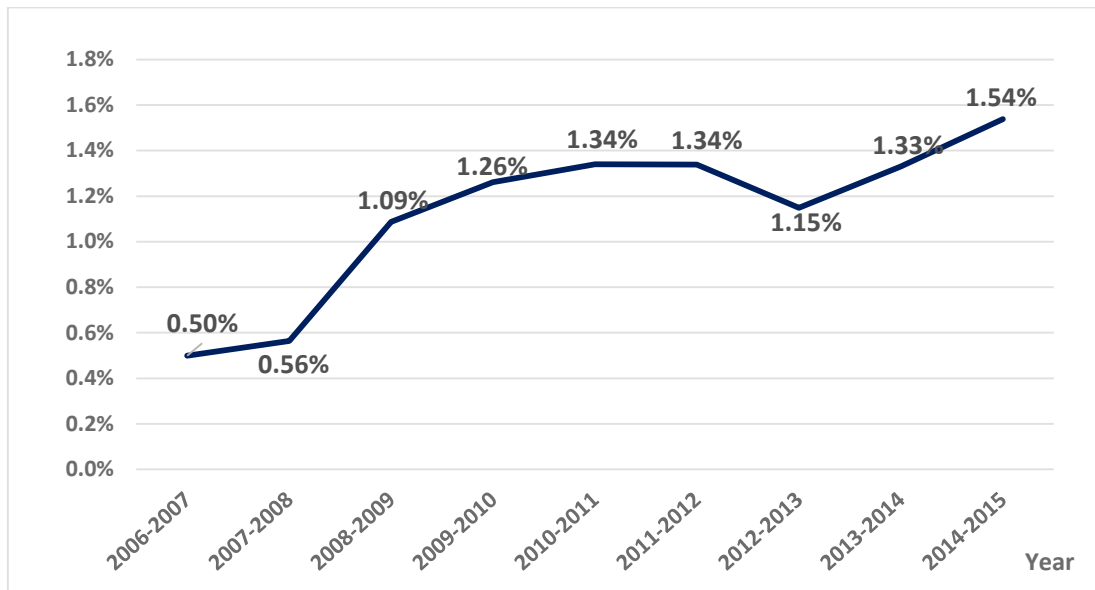


Figure 5.49 Ratio of wastewater production in SIOC to Khaf County

The first concentrator plant of Sangam will produce 2.23 MTPY of tailings (dry basis) which will be sent to a TSF⁵⁶⁶ as slurry. The original TSF has a negative water balance in which no water is recovered to the process. The thickened tailings (generally referred to as "paste") method presents a new paradigm in tailings disposal. The most important advantage of this method is higher water recovery. It is estimated that when a paste of 75 percent solids produced, approximately 0.87 Mm³ of water can be recovered from the tailings system and reuse in the process. More water can be reclaimed from the decants of the TSF, but it needs more studies⁵⁶⁷. As the SIOM area is faced with water shortage, recycling the water from tailings, deployment of applicable technologies for a sustainable water consumption reduction and apply different solutions for water recovery are inevitable. Therefore, a paste thickening system and high compression thickener with filtration for any new plant in this mining area is necessary to implement⁵⁶⁸.

⁵⁶⁶ Tailings Storage Facility

⁵⁶⁷ F. Rashidinejad and S. Naraghi (2011), *Tailings Disposal Options Study for Sangam Iron Ore Project, Iran*. Proceedings Tailings and Mine Waste, November 6-9, Vancouver, Canada

⁵⁶⁸ J. Kretschmann and R. Amiri (2014), *Solutions for a Sustainable Water Consumption Reduction in Sangam Iron Ore Mines in Iran*, in Proceedings of Sixth Aachen International Mining Symposia (AIMS), The Sixth International Symposium on Mineral Resources and Mine Development, Aachen, Germany, ISBN: 978-3-941277-20-5, p. 445-456

- Results and interpretation
 - Since wastewater generation has positive correlation with (employee) population and water consumption, due to the increasing number of employees in SIOM, wastewater generation had an increasing trend during the study period and it is expected that this trend continues in the future.
 - The ratio of wastewater generation in SIOC to Khaf County is calculated 1.54% by 2014-2015 which is not a considerable amount. It is estimated that from 2018 due to operation of other phases, this amount soars to 5%.
 - Considering the severe water shortage in the region, it is highly recommended to establish and operate water recycling facilities in the complex.

5.4 Strategic measures according to the SDIs' calculation

Furthermore to the strategies determined according to SWOT analysis and based on calculation of selected SD indicators, following strategic measures are suggested to facilitate achieving sustainable goals in SIOM and the whole region generally.

Pillar	Indicator	Strategic measures
Social	Net enrolment rate in primary education	In 2015, the net enrolment in primary schools was 98.8% which implies that still 1.2% of children in Khaf County are deprived of learning opportunity. This has to be recognized by Education and Training Office of Khaf County in remote villages and other investors (especially private one in SIOM) to provide facilities and equip the education centers as new CSR activities in the area.
	Access to primary sanitary facilities	Considering the severe water shortage in the region, collecting the rural and urban wastewater and leading them into water treatment plants for recycling has a high priority which should be implemented by IMIDRO and other private companies which are engaged in SIOM development projects with co-operation of Khorasan-e-Razavi Province Water and Wastewater Company. The recycled water can be used for future use of some plants.
Economic	Length of railway	Due to implementation of new projects in Sangam by private section, construction of new loading station(s) seems inevitable which needs to be planned and implemented as soon as possible by private investors in SIOM. On the other hand, a connecting corridor among Sangam Iron Ore Mines and consuming plants and ports should be considered to facilitate transportation for future production capacity of SIOM (20.5 MTY).
	Ratio of annual electricity consumption in SIOC to total annual energy consumption in Khaf County	Currently, the SIOC has access to 50 MW of electricity. Considering the production of 3 MTPY Iron ore fine and lump, 17.5 MTPY iron ore concentrate and 15 MTPY iron ore pellet, almost extra 220 MW of electricity is required. Since a 400MW station is under construction in 10 Km of SIOC, it is suggested to connect the under construction plants to that station.
	Length of roads	Considering the necessity of development of roads leading to SIOM (Khaf-Taybad, Khaf-Ghaen, and Khaf-Torbat-e-Heydariyeh) due to their capacities and increasing the safety level, the widening, sanitation and renovation of them should be planned and implemented as soon as possible by IMIDRO and Khorasan-e-Razavi Province Road and Urban Development Organization.
Environmental	Water Consumption in Sangam Mining Complex	Since Khaf county is located in an arid area and there is no possibility of exploiting underground water resources, water supply will be the main and the most critical challenge of SIOM development which needs accurate planning and comprehensive strategies and measures by IMIDRO and other private investors.
	Ratio of sanitary disposed solid waste to total solid waste produced	During operation phase of SIOM development projects, number of households and amount of produced waste will increase due to immigration of expert forces. Hence, the municipalities in the Khaf County need to plan for sanitary waste disposal and equip the system with appropriate technology. For instance, they can use the revenue form VAT for this purpose.
	Solid waste production	Average of solid waste generation in Iran's big cities is as follows: Tehran, 900 gr; Tabriz, 800 gr; Isfahan, 600 gr; and Zanjan, 350 gr ⁵⁶⁹ . Average of this amount in Khaf County is 824 gr Which is higher than all these cities except Tehran. This necessitates having a comprehensive waste management plan to decrease the production and its implementation by municipalities and related officials in the region. Again, they can use the revenue form VAT for this purpose, too.
	Wastewater production	Considering the critical water shortage in the region and high demand of water from 2018, it is crucial to implement wastewater treatment projects and execute water recycle plans by IMIDRO and Khorasan-e-Razavi Province Water and Wastewater Company.

Table 5.33 Strategic measures for SIOM based on calculation of SD indicators

⁵⁶⁹ H. Alidadi, A. Naghizadeh and A. Dadpour (2007), *Quantity and Quality of Solid Waste Production in Khaf city in 2006*, Tenth National Symposium on Environment Health, Hamadan, Iran (Persian)

Chapter 6

Conclusion, Outlook and Suggestions

6 Conclusion, outlook and suggestions

6.1 Conclusion: strategic challenges and solutions

According to the obtained results from the whole research, the main challenges for SIOM sustainable development and their proposed solutions are as follows and summarized in table 6.1:

6.1.1 Water shortage

Historically, Khaf County is known for arid and dry weather in summer and low temperate in winters. Due to high distance from the sea and low precipitation, there is generally no specific Permanent River in the area, just temporary ones in winter after rainfall. Besides, there are 120 windy days during the year, called “Sistan 120 Days Wind” which boosts the rate of evaporation. The area is faced with low precipitation and high evaporation causing water shortage in the region. The situation is worsened by the fact that the industries need more water as they develop the operations⁵⁷⁰. Water shortage is the most important challenge against the development of the mining and minerals industries in the study area⁵⁷¹. The only available source for raw water supply is a nearby aquifer that is insufficient in the long run.

Solutions: Deployment of new technologies and methods for sustainable water consumption reduction (i.e. using recent technological advances in the field of water management such as handling, reducing water consumption and wastewater recovery in SIOM by IMIDRO and all other private investors)⁵⁷²

6.1.2 Lack of transportation capacity

In order to carry the products, both systems of road and railway are used. Considering the production of 3 MTPY Iron ore fine and lump, 17.5 MTPY iron ore

⁵⁷⁰ J. Kretschmann and R. Amiri (2014), *Solutions for a Sustainable Water Consumption Reduction in Sangam Iron Ore Mines in Iran*, in Proceedings of Sixth Aachen International Mining Symposia (AIMS), The Sixth International Symposium on Mineral Resources and Mine Development, Aachen, Germany, ISBN: 978-3-941277-20-5, p. 445-456

⁵⁷¹ J. Kretschmann, R. Amiri and F. Rashidnejad (2013), *Sustainable mining approach to Sangam iron ore mines project*, Proceedings of 6th international conference on sustainable development in the minerals industry, 30 June- 3 July, Milos Island, Greece, p. 678-682

⁵⁷² This is the main solution; however a set of probable and applicable strategies that ameliorate the water crisis management in SIOM are mentioned in sub-chapter 3.1.2 Environmental Aspects.

concentrate and 15 MTPY iron ore pellet from SIOM which 20.5 MTPY of them should be transferred from the area in the near future (Table 1.6), the capacity of the network of roads and train loading stations leading to site is not sufficient. Meanwhile, two sustainable development indicators from economic pillar i.e. length of railway and length of roads which have been selected by applying FDM (Table 5.16) shows the importance of this challenge in the region. Moreover, according to the second survey (Figure 5.19), development of the aerial transportation is the second priority in the region. Due to all the above mentioned subjects and importance of transportation in realization of sustainable development in the area, following solutions have been suggested for this main challenge.

Solutions:

- Construction of an airport in Khaf County by cooperation of governmental and private institutions' investors
- Widening, sanitation and renovation of the road network leading to SIOM (Khaf-Taybad, Khaf-Ghaen, and Khaf-Torbat-e-Heydarieh) by IMIDRO and Khorasan-e-Razavi Province Road and Urban Development Organization
- Construction of new train loading station/s by private investors in SIOM
- Investigating of the connecting railway corridors from SIOM to target plants and sea ports in terms of capacity for secure transportation of future production

6.1.3 Waste and tailings

One of the major challenges in current and future open-pit mining is tailings' disposal. Tailings and mine wastes have the potential to leave environmental, social and economic legacies for thousands of years⁵⁷³.

The first phase of SIOM (SIMP) consists of a mine development in two orebodies (B & CN), a primary crusher, crushed ore handling, stacking and a 2.6 MTPY concentrator plant with an overall impoundment facility capable of storing all the tailings produced during the process operations. Mine waste dumps are created around the periphery of each pit by end-dumping from haul trucks. A total of 193 Mt

⁵⁷³ D. Van Zyl (2009), *Life Cycle Assessment and Tailings Management Trade-Off Studies, An Approach to Implementation*, Proceedings of the Sustainable Development Indicators in the Mineral Industry (SDIMI), Gold Coast, Australia, p. 251-255

of waste rock will be generated during the 34 years mine life-cycle of anomalies B and CN. It is anticipated that approximately 75 million tons (roughly 45 million cubic meters) of tailings will be generated at the same time⁵⁷⁴.

These amounts are related to the first Sangan iron ore concentrator plant and its mines development which are under operation now. Considering the capacity of other projects by IMIDRO and private companies, the generation of mine waste and tailings will be increased by 7 to 8 times. This huge amount of waste faces the decision makers of SIOM with a challenge.

Solutions: Performing integrated waste dump and tailing management under IMIDRO's supervision, emphasizing on reducing waste production, improving reuse and recycling

6.1.4 Religious conflicts

In Khaf Town which is the preliminary inseparable area near SIOM, there are two main different Islamic branches, namely Shia and Sunni which have a lot of commons and basic roots. However, there are a few differences that sometimes cause minor problems in the region. Obviously, this important subject should be considered to put some special management view on it. According to the latest report, two third (2/3) of residents in Khaf County are Sunni⁵⁷⁵. However, in the whole country, 89% of Iranians are Shia and only 9% are Sunni. In spite of many common beliefs among followers of these two branches, there are minor hidden contradictions and conflicts between them, especially among uneducated ones. Since the overall development of the region requires cooperation and unity of all people, this challenge should be considered by the religious leaders, governmental authorities in County and also managers who are involved in SIOM companies and projects to facilitate teamwork and collaboration.

Solutions:

- Having regular meetings with leaders of both Islamic branches in the region to facilitate trust building

⁵⁷⁴ AMEC Americas Ltd. (2007), *Tailings Dam Design Report*, Report No. DP01R3-AB01-C0000-AS107, SIMP technical archive, Sangan, Iran

⁵⁷⁵ A. Tavakoliroodi (2012), *Security, political and economic effects of mining activities in SIOM*, Taybad Azad University, p. 183 (Persian)

- Performing cultural training programs against religious conflict in the region
- Highlighting the common religious aspects of both branches and enforcing religious decrees for integration
- Holding ceremonies and gatherings with the presence of Shia and Sunni clergies and followers in common events, especially during Islamic Unity Week (Haft-e-Vahdat), initiated by the founder of the Islamic Revolution of Iran, Imam Khomeini in November 1981⁵⁷⁶

6.1.5 Resource nationalism

Resource nationalism – even called resource protectionism - is characterized by the tendency of people and governments to assert direct control over natural resources located on their territory⁵⁷⁷. Resource nationalism illuminates one of the most pervasive challenges facing advocates of sustainable development: the messiness of trade-offs between economy, environment and social concerns; and the difficulty of prioritizing and ordering as between sustainable development at local, regional and national levels⁵⁷⁸. According to a report, Resource nationalism was the biggest risk in 2011 and 2012. Because the mining and minerals sector rebounded quickly from the global financial crisis, it became an early target to help restore treasury conditions. Resource nationalism places a large cost burden on mining and metals companies and can influence the decision of where to invest in a particular country⁵⁷⁹.

I.R. of Iran and SIOM are not excluded from this global pressure which will be reinforced in the course of time due to financial fluctuations and escalating global need to minerals. The local stakeholders in Khaf County sometimes resist against the

⁵⁷⁶ According to Sunni Islamic narrations, the 12th of Rabi al-Awwal is recognized as the birth date of Prophet Muhammad (SAW), while according to Islamic sources relied upon by Shia Muslims the auspicious birthday of the Holy Prophet (SAW) was on 17th of Rabi-al-Awwal (Equivalent to second week of December according to Christian calendar). In order to bridge this difference and use it as an opportunity to unite the ranks of Muslims, the founder of the Islamic Revolution of Iran, Imam Khomeini (SA) designated the period of celebrations from 12th to the 17th of Rabi al-Awwal as the Islamic Unity Week. This dynamic concept aims to bring all Muslim schools of thought on the common platform of Islamic unity. (Source: <http://www.rohama.org/> - Website of Union of Islamic World Students)

⁵⁷⁷ Global Market Internationals (2012), *Mining Market Review*, Willis Publications, Spring 2012, p.53, Access at: <http://www.willis.com/naturalresources/pdf/MiningMarketReview2012.pdf>

⁵⁷⁸ H. Ward (2009), *Resource Nationalism and Sustainable Development*, Working paper of International Institute for Environment and Development (IIED), p. 58, Access at: <http://pubs.iied.org/pdfs/G02507.pdf>

⁵⁷⁹ C. Macdonald (2012), *Social Responsibility in the Mining and Metals Sector in Developing Countries*, Australian Government, ISBN 978-1-921812-72-9, p. 9

entrance of nondomestic workers and exclusive control of firms over mineral resources in the area which in the long run can lead to a challenge between local and nonlocal stakeholders.

Solutions:

- Performing cultural training programs against resource nationalism in the region
- Establishing a public company and allocating some parts of the shares to the local people
- Improving CSR measures to mitigate the risks of resource nationalism by positioning the investors as a provider of benefits within the local community
- Allocating some parts of SIOC shares to personnel in order to increase the productivity

6.1.6 Post mining management

One of the most important strategic aspects of mining and mineral industries is post mining management which must be considered from the perspective of sustainable development and taking into account the interests of future generations.

As mentioned in different parts of this research, there are various constraints in the region where SIOM is located, including: severe shortage of precipitation, desert vegetation cover, poor pasture and forage production, and poor quality of agricultural soil. Hence, development of agriculture and ranching are not recommended for job creation in the region. Since no other considerable industry is established in the region and its neighborhood, the safest option for development is sustainable exploitation of the iron ore resources in the area. Considering the limited period of mining activities in this region, it is necessary to plan the post mining phase right from the early stage of construction and operation.

Solutions: Establishing a fund for mine rehabilitation and the sustainable land development and supporting employment after mines' closure⁵⁸⁰

⁵⁸⁰ As it mentioned before, IMIDRO as the estate owner of SIOM will sell the crude iron ore to the investors' beneficiation plants in their operation period. The first priority strategy for SIOM in this research has been achieved "*Defining a comprehensive crude iron ore pricing method by considering all the effective factors*" (see table 4.17). In this pricing method one of the effective factors can be a specific share for mine rehabilitation and the sustainable land development and supporting

Main Challenges	Solutions	Remarks
Water shortage	Deployment of new technologies and methods for sustainable water consumption reduction	SO1 from SIOC SWOT Matrix (Table 4.15)
Lack of transportation capacity	Construction of an airport in Khaf County by cooperation of governmental and private institutions' investors	ST1 from SIOC SWOT Matrix (Table 4.15)
	Widening, sanitation and renovation of the road network leading to SIOM (Khaf-Taybad, Khaf-Ghaen, and Khaf-Torbat-e-Heydarieh) by IMIDRO and Khorasan-e-Razavi Province Road and Urban Development Organization	Strategy from calculating SD indicators (Table 5.33)
	Construction of new train loading station/s by private investors in SIOM	Strategy from calculating SD indicators (Table 5.33)
	Investigating of the connecting rail way corridors from SIOM to target plants and sea ports in terms of capacity for secure transportation of future production by IMIDRO	
Waste and tailings	Performing integrated waste dump and tailing management under IMIDRO's supervision, emphasizing on reducing waste production, improving reuse and recycling	---
Religious conflict	Having regular meetings with leaders of both Islamic branches in the region to facilitate trust building	---
	Performing cultural training programs against religious conflict in the region	WT3 from SIOC SWOT Matrix (Table 4.15)
	Highlighting the common religious aspects of both branches and enforcing religious decrees for integration	---
	Holding ceremonies and gatherings with the presence of Shia and Sunni clergies and followers in common events	---

employment after mines' closure. The income of proposed fund will be this share and goes to a charity which is under the supervision of a board of trustees. The articles of association and structure of the charity should be approved by IMIDRO. It would be better that the chairman of IMIDRO or his representative will be the chief of the board. The board of trustees should define economical action plans for increasing the value of the deposited money from the early stage of establishing of the fund. Before mine closure, the fund should achieve his goals especially supporting employment after mines' closure. The money can be spent in eco-tourism (with respect to historical attractiveness of Khaf County), establishing the mining training center, nature restoration, investment in civil development, or any other kind of activities due to future technological progress in the direction if improving local society's welfare by fulfilling their needs. The implementation of the above projects will lead to sustainable employment which is very important for post mining life of the region and will prevent immigration of the local people to other places.

Main Challenges	Solutions	Remarks
Resource nationalism	Performing cultural training programs against resource nationalism in the region	WT3 from SIOC SWOT Matrix (Table 4.15)
	Establishing of a public company and allocating some parts of the shares to the local people	SO3 from SIOC SWOT Matrix (Table 4.15)
	Improving CSR measures to mitigate the risks of resource nationalism by positioning the investors as a provider of benefits within the local community	---
	Allocating some parts of SIOC shares to personnel in order to increase the productivity	WT2 from SIOC SWOT Matrix (Table 4.15)
Post mining management	Establishing a fund for mine rehabilitation and sustainable land development and supporting employment after mine closures	WO3 from SIOC SWOT Matrix (Table 4.15)

Table 6.1 Main challenges and suggested solutions in SIOM

6.2 Outlook: SIOM as a role model for sustainable mining in Iran

The Islamic Republic of Iran is ranked among the world's 15 most mineral-rich countries. Hence, sustainable mining management should have priority among the country's managerial strategies⁵⁸¹.

SIOM is an example of a large scale mining which is located in a special geographical and remote area. During the development of the mining complex various social (see 3.2.1), environmental (see 3.2.2), and economic (3.2.3) activities have been conducted in the Sangan area which are briefly listed below. In general, these activities have been contributed positively to the development of the region.

- Social measures include construction of schools for girls and boys, sponsoring local organizations, job creation, decreasing criminal activities especially on the border with Afghanistan, and improving occupational safety and health.

⁵⁸¹ J. Kretschmann and R. Amiri (2015), *Sustainable Mining Management in Iran based on Islam and Iranian Laws and Regulations*, in Proceedings of Fifth Aachen International Mining Symposia (AIMS), Mineral Resources and Mine Development, Aachen, Germany, ISBN: 978-3-941277-22-9, p. 265-278

- Environmental measures include preparation of EIA and EMP report in cooperation with country's high-ranked universities, and regular monitoring programs.
- Economic measures include improving the railway and road infrastructures, and growth in industry.

In the framework of this research, stakeholder analysis was also conducted to consider their expectation. Due to a variety of stakeholders, they were examined in two categories: internal and external. Such an analysis and execution of its outputs increase the acceptance of the project and facilitate its future progress (See 4.5).

Since Iran is an Islamic country and its constitution is in accordance with Islamic ethics, an analysis of the religious fundamentals seemed to be helpful to determine managerial strategies. The Quran was chosen as the main source to find out the position for environment and its exploitation in Islamic ethics (See 4.3.2). Moreover, national rules and regulations were also reviewed in details to ensure the legal support of sustainability (See 4.3.3).

All above-mentioned analysis and their results should pave the way for better and more sustainable management of SIOM. Hence, the SWOT method was applied to examine the strengths, weaknesses, opportunities and threats for SIOC which can be generalized for all private investor institutions in SIOM. Conducting this analysis, a couple of strategic measures were suggested which had the highest ranks among other alternatives (See 4.6: Strategy formulation for SIOM).

Besides, the undertaken measures in Sangam Iron Ore Mines have been examined to assess its influence on sustainable development of the region. To achieve this, 15 indicators have been selected by using Fuzzy Delphi Method. Calculations of these indicators provide the planners and decision makers with tangible output and trends (See 5.3: Calculation of indicators).

Such a research is recommended to all Iranian mining companies and their managerial board. Measures and approaches that distinguish this research and make it a role model of sustainable strategic management are: selecting the sustainable development indicators by Fuzzy Delphi Method, tracking the progress of SD realization quantitatively, identifying main stakeholders and their expectations,

reviewing religious and legal regulations and laws and finally determining the backbones and drawbacks of the system by SWOT analysis.

6.3 Suggestions for similar mining countries

According to the results of the research, following suggestions are presented to other developing mining countries like Iran:

- Strategy formulation by considering sustainable development principals which was used in this research is a successful and an efficient model that facilitates reaching the goals via strategic management benefits (including strategy revision according to the feedbacks).
- Identification and review of key stakeholders and their main expectations before the strategy formulation were constructive and helpful to reach the favorable results and manage the current and future challenges.
- If mines are located in remote and less developed areas, it is highly recommended to consider post mining plans from the early stage of operational phases to secure sustainable developed conditions of living for local people and communities (whose welfare increase with growth of mining and minerals industry).
- Benefiting from national environment protection regulations and applying religious decrees in the mining sector is also suggested to improve the acceptance of projects and companies which lead to creation of win-win situation.
- Projects in the framework of corporate social responsibilities should be implemented in the first phases of conducting mining activities according to the needs of local people and also the budget and the funds.
- Due to the creation of climate change phenomena and stricter environmental regulations, the cost of reducing the environmental impact of mining and mineral industries will increase in the future, and will have a significant impact on economic indexes. Therefore, accurate environmental and feasibility studies or review of previous ones with the aim of optimizing the above mentioned costs is emphasized.
- Selecting the applicable sustainable development indicators by scientific methods (such as the FDM applied in this research), calculating the indicators according to the trustable local and national sources and comparing the results

with other regions, provide the decision-makers with a realistic image of the necessities and priorities to realize most appropriate regional sustainable development. Besides, the formulated strategies will also be more applicable and constructive. Conducting similar method is suggested to other countries with mining projects similar to SIOM.

6.4 Suggestions for mining in Islamic countries

Decision makers in Islamic countries need to understand that the conservation of the natural environment is a religious responsibility required by the Holy Quran. Environmental awareness and the protection of natural resources are an integral part of the Islamic beliefs. The Quran and other Islamic sources, due to their high acceptance among Islamic communities, could be utilized to entangle managers and other stakeholders to implement sustainable development principles, strategies and measures. Based on the results of the research, following recommendations are presented in five sections to be followed by other Islamic decision makers and stakeholders within mining projects⁵⁸².

6.4.1 Islam and the Environment

Islamic jurisprudence contains regulations concerning the conservation and allocation of scarce water resources. It has rules for the conservation of land with special zones of graded use; it has special rules for the establishment of rangelands, wetlands, green belts and also wildlife protection and conservation. Islam describes the environment and teaches that it has been created by Allah and describes in general how humans should use the environment (Figure 6.1). Islamic teachings include the necessity to take proactive care of the environment based on Islamic principles of Environmental Protection⁵⁸³.

⁵⁸² J. Kretschmann and R. Amiri (2015), *Sustainable Mining Management in Iran based on Islam and Iranian Laws and Regulations*, in Proceedings of Fifth Aachen International Mining Symposia (AIMS), Mineral Resources and Mine Development, Aachen, Germany, ISBN: 978-3-941277-22-9, p. 265-278

⁵⁸³ *Islam: solution to climate change/global warming*, Published online in January 2011, Access at: <http://www.slideshare.net/moreonislam/islam-solution-to-climate-change-global-warming>. Last access: 12/2014

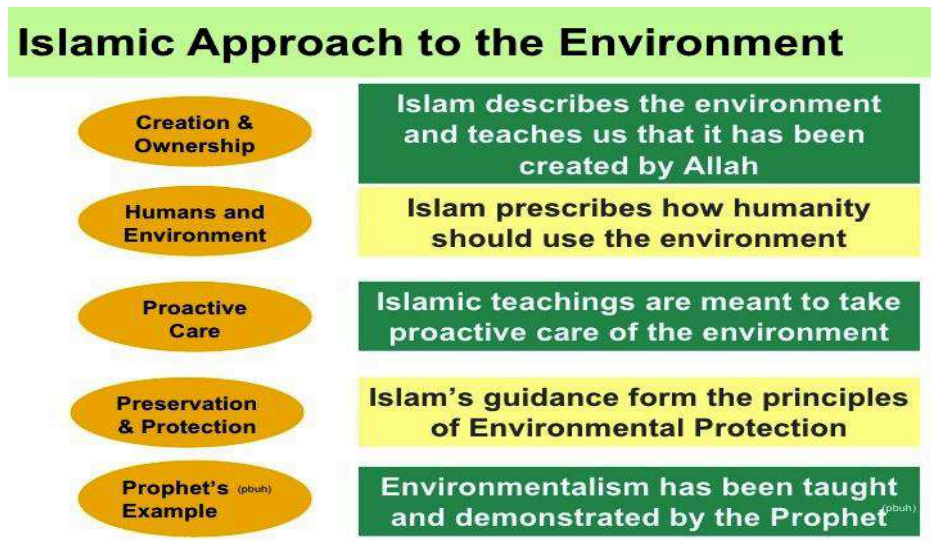


Figure 6.1 Islamic approaches to the environment⁵⁸⁴

6.4.2 A General introduction to Islam's attitude towards the conception of the universe, nature, natural resources and the relation between man and nature

The right to utilize and subjugate natural resources God has endowed upon man, necessarily involves a commitment on man's part to conserve them both quantitatively and qualitatively. It follows that man should not distort the environment because it must remain permanently suitable for human life and settlement. Nor should man use natural resources unsustainably or in such a way as to destroy living resources or spoil habitats and food bases. The attitude of Islam to the environment, the sources of life and the resources of nature is a positive attitude in general as much as it is based on protection and prohibition of abuse and destruction; it is also based on construction and development. This is clear in the idea of revival and restoration or recovery of lands through agriculture, mining, cultivation and construction⁵⁸⁵.

⁵⁸⁴ In the Figure 6.1, Prophet means the Prophet Mohammad (PBUH).

⁵⁸⁵ J. Kretschmann and R. Amiri (2015), *Sustainable Mining Management in Iran based on Islam and Iranian Laws and Regulations*, in Proceedings of Fifth Aachen International Mining Symposia (AIMS), Mineral Resources and Mine Development, Aachen, Germany, ISBN: 978-3-941277-22-9, p. 265-278

6.4.3 Protection and conservation of all basic natural resources⁵⁸⁶

All elements of life are highly emphasized in the Holy Quran to be kept far from harm. Since mining activities affect all these elements, sustainable mining management in Islamic countries (including Iran) needs to take Islamic considerations into account, so that nature conservation can be guaranteed along with national rules and regulations.

- **Water:** Owing to the importance of this vital element as the main source of life, God made its use the privilege of all human beings, without discrimination.
- **Air:** Winds are described as an evidence of God's omnipotence, bounty, provision and perfection.
- **Plants and Animals:** The Quran considers them living communities, exactly like mankind. Hence the necessity of conserving and developing them both for their own sake and for the benefit of mankind is clear.

According to the results of the questionnaire number 2, local stakeholders reckon mining activities affect natural environment and its elements unfavorably. Considering the fact that plants, animals, air, and water are sacred elements, Islamic countries should pay special attention to conserving them.

6.4.4 Islamic principles and institutions governing the protection and conservation of the environment

As the Muslim interaction with the environment evolved, it is manifested into a range of rules and institutions that can be classified into two groups: legislative principles and institutions⁵⁸⁷ (For details see: 4.3.2.5). Both of these principles define the regulations that need to be considered in human-nature relations.

⁵⁸⁶ J. Kretschmann and R. Amiri (2015), *Sustainable Mining Management in Iran based on Islam and Iranian Laws and Regulations*, in Proceedings of Fifth Aachen International Mining Symposia (AIMS), Mineral Resources and Mine Development, Aachen, Germany, ISBN: 978-3-941277-22-9, p. 265-278

⁵⁸⁷ J. Kretschmann and R. Amiri (2015), *Sustainable Mining Management in Iran based on Islam and Iranian Laws and Regulations*, in Proceedings of Fifth Aachen International Mining Symposia (AIMS), Mineral Resources and Mine Development, Aachen, Germany, ISBN: 978-3-941277-22-9, p. 265-278

Besides, Islamic jurisprudence includes many rules that serve as the foundation of many regulations and laws concerning sustainable development, including⁵⁸⁸ (For details see: 4.3.2.6):

- Do no harm
- Warding off evil takes precedence over bringing benefits
- Sustaining personal harm to ward off public harm
- Harm shall be removed

Including above mentioned Islamic rules and regulations in decision making should be a necessity for managers in Islamic countries who seek for realizing Islamic sustainable development.

6.4.5 Water as a scarce resource

Muslims believe that water is a gift from God and that it is a proof of God's existence, his greatness and uniqueness. The Holy Quran calls on Muslims to contemplate the rain, the rivers, and the salty and sweet water. They should recognize water as a sign of His Bounty. Water is a highly valued and precious resource and Islamic law goes into detail to ensure its conservation and equitable distribution⁵⁸⁹. Water is one of the three things that every human is entitled to: grass (pasture for cattle), water, and fire. Water should be freely available to everybody⁵⁹⁰. A search conducted by iQuran Pro. Software shows that there are 78 verses in the Holy Quran focusing on water issues. The following ones have particular importance:

- “We made from water every living thing⁵⁹¹”
- “Behold...In the rain which God sends down from the skies and the life which he gives therewith to an earth that is dead⁵⁹²...”
- “Lawful to you is the pursuit of water-game and its use for food - for the benefit of yourselves, and those who travel⁵⁹³”

⁵⁸⁸ J J. Kretschmann and R. Amiri (2015), *Sustainable Mining Management in Iran based on Islam and Iranian Laws and Regulations*, in Proceedings of Fifth Aachen International Mining Symposia (AIMS), Mineral Resources and Mine Development, Aachen, Germany, ISBN: 978-3-941277-22-9, p. 265-278

⁵⁸⁹ A. Stacey (2009), *Water and Sanitation*, Published at Islam Religion.com on 2 March 2009, Access at: <http://www.islamreligion.com/articles/2289/>

⁵⁹⁰ Water in Islam, Access at: <http://english.islammessage.com/ArticleDetails.aspx?articleId=305>

⁵⁹¹ The Holy Quran, Al- Anbya (Sura 21), aya 30

⁵⁹² The Holy Quran, Al- Baqarah (Sura 2), aya 164

⁵⁹³ The Holy Quran, Al- Ma'idah (Sura 5), aya 96

As can be seen, the importance of water and conservation of its resources are highly emphasized in the Holy Quran and Islamic laws and jurisprudence. Since some Islamic nations including Iran have water scarcity, it is recommended to consider Islamic thoughts to define water management strategies for mining activities.

APPENDIXES

APPENDIXES

1. Clear attention of the First to the Fifth Five-Year Plans of Iran to the principles of sustainable development

In the following tables, the explicit rules, regulations and executive bylaws in the First to the Fifth Five-Year Plans of Economic, Social and Cultural Development Plan of the Islamic Republic of Iran have been presented which consider the principles of sustainable development⁵⁹⁴.

First five-year plan (1989 to 1993)	Description	Date of approval
Single Article	Note 13. In order to provide the necessary facilities to prevent and avoid the pollution caused by polluted industries, factories and workshops have a duty on their products with sales of thousands of diagnoses to spend on pollution control and indemnity resulting from pollution and to create green space under the supervision of the Department of Environment. Cost of funds from this source will be calculated as the acceptable cost of the institution.	February, 1, 1990
Executive book of regulations of article 13 of the Law on the First Economic, Social and Cultural Development Plan of the Islamic Republic of Iran	<p>Article 9. The Department of Environment based on local conditions and the establishment of factories and workshops determines how to create a required green space and environment beautification program and declare it to factories and workshops. Factories and workshops are required to act based on plans and guidelines set by the deadlines specified when creating green space and environment beautification program.</p> <p>Note 2. The required green space of factories and workshops that have more than one hectare of land can be up to 25% of total area of those factories and workshops.</p>	September, 10, 1990

⁵⁹⁴ H. Tabibi Tavakoli (2011), *The complete Set of rules and regulations in First till Fifth Five- year Development Plans*, Ferdowsi Publications, ISBN: 974-964-8347-45-6 (Persian)

Second five-year plan (1995 to 1999)	Description	Date of approval
Single Article	<p>Note 19. Government is obliged to apply the conservation and rational energy consumption and environmental protection in order to carry out the following actions:</p> <p>4. Set the seasonal work program in factories and industries by the relevant ministries so that the power consumption and energy reduced in the months of peak consumption</p> <p>5. Developing and implementing the necessary criteria for the granting of loans with preferential rates to industries and institutions for the implementation of the energy consumption reform</p> <p>6. Allocate 0.2% of revenues from energy sales during the program to do the necessary research in the field of energy saving and management by the relevant ministries</p> <p>8. Allocate a portion of the contents of textbooks for schools and universities to the importance and necessity of managing the consumption of water and different kinds of energy and public education of community through media and press in this field in order to promote a culture of saving and avoiding waste and squander resources</p>	December, 11, 1994
Single Article	<p>Note 82. A. Throughout second program, all social and economic activities must be conducted in compliance with environmental considerations and to do this, the following is required:</p> <p>1. Large manufacturing projects and services must be running before and at the stage of feasibility studies and locating based on patterns adopted by the Supreme Council of environmental protection about the environmental assessment.</p> <p>2. Any industrial and mining activities must be done in the framework of sustainable development objectives with regard to environmental standards.</p> <p>3. The exploitation of natural resources of the country should be based on the environmental potential and tolerable capacity in a way that taking correct advantages of the natural resources, the environmental causes of balance fitness are provided.</p> <p>4. The use of energy in the country has to go through appeals on the consumption pattern and the reduction in fuel pollution.</p>	December, 11, 1994

Second five-year plan (1995 to 1999)	Description	Date of approval
Macro qualitative objectives of basic policies and general policies of the second development plan	<p>First part - Macro qualitative objectives:</p> <ul style="list-style-type: none"> 1. Efforts to achieve social justice 4. Increasing productivity 6. Growth and economic sustainable development with a focus on agriculture 10. Environmental protection and optimal use of country natural resources 14. Systematization and application of research as a means to solve country development problems <p>Second part - Basic policies:</p> <ul style="list-style-type: none"> 1. Working toward social justice through: <ul style="list-style-type: none"> 1.1. Optimal division of resources and public facilities with defining the status quo role of provinces and territories and efforts aimed at bringing the provinces and regions that at the beginning of the program in social and economic affairs compared to the extent of the country medium are less than average 1.2. Development and improve the quality of life of the general conditions include improved distribution of income and wealth and reduce the Gini coefficient 1.4. Prevention of false and illegal income from rates of false and illegal or inappropriate windfall 1.6. Priority attention to disadvantaged areas and rural employment, health, education, and civil production 1.9. Provision of public health and public insurance development 1.12. Consistent decisions for deprivation and remove regional imbalances in land use planning program 1.14. Direction and guidance to the major share of funds to social sectors including culture, public education, healthcare, higher education and research, and physical education 4. Increasing productivity through: <ul style="list-style-type: none"> 4.10. Encourage the community to use more efficient of resources through various training, cultural, and economic centers 4.11. Rely on the efficient use of energy and prevent 	December , 11 , 1994

Second five-year plan (1995 to 1999)	Description	Date of approval
	<p>the waste of it</p> <p>4.12. Creating and strengthening quality control systems</p> <p>4.13. Emphasis on the use of appropriate technology, according to the conditions of employment of labor, capital and raw materials</p> <p>6. The development of sustainable economic growth with a focus on the agricultural sector through:</p> <p>6.4. Trying to plan and create a regional balance according to the relative advantages of each region and the facilitation of the development of the association through the expansion of infrastructure and productive capacity with regard to capabilities and conditions of each area</p> <p>6.7. Optimal utilization of existing capacity in all fields</p> <p>6.9. Emphasis on complete lines and manufacturing, industrial chains</p> <p>6.16. Determining the strategy and priorities for economic and commercial activities in line with the set pattern</p> <p>10. Environmental protection and optimal use of country natural resources through:</p> <p>10.1. Emphasis on the correct preservation, restoration, development and exploitation of natural resources</p> <p>10.2. Development of detailed exploration operations, equip and prepare the required mining industries of the country.</p> <p>10.6. Formulate necessary regulations, standards, criteria and indicators of environmental protection and modification of existing law and legal framework in all fields by taking advantage of the latest scientific findings and consistent with the conditions and possibilities of the country.</p> <p>10.7. Efficient use of energy by changing consumption patterns, increasing efficiency of consumption energy and the use of clean and alternative energy.</p>	

Second five-year plan (1995 to 1999)	Description	Date of approval
Executive regulations of note 82 of the second development plan	<p>Article 2. In order to comply with sustainable development in the areas of industrial and mining waste management - here in after in regulations is called "hazardous wastes" - Department of Environment is required to develop a management strategy of these wastes that include the necessary definitions and criteria as follows:</p> <p>A. Regulations concerned with hazardous waste reduction in manufacturing processes through production policy management and deployment of clean technologies</p> <p>B. Regulations concerned with the safe transport of hazardous waste</p> <p>C. Regulations concerned with making recovery system and final hazardous waste disposal.</p> <p>Article 3. All industrial and mining sectors shall be disposed of hazardous wastes from their activities in a way that the national program guidelines and criteria in article 2 of this regulation will be determined</p> <p>Article 4. Any mining activity and engage in the exploration and exploitation of mines is required to comply with environmental regulations and standards. Department of Environment is required to approve the mentioned environmental regulations and standards regarding to sustainable development goals by the Supreme Council of Environment transparency.</p> <p>Article 9. In order to coordinate the activities of governmental bodies and large industrial plants and manufacturing environmental products to achieve sustainable development goals, the above mentioned plants are required to establish a branch of an environmental office in coordination with state employment office under the direct supervision of the highest official of the state or the managing director of large plants.</p>	October, 14, 1998

Third five-year plan (2000 to 2004)	Description	Date of approval
The overall cultural policies and objectives of the Third Development Plan of the country	<p>6.1. Strengthening and development of public education for conservation and efficiency of national resources to prevent misuse of resources.</p> <p>6.2. Use of cultural resources and capacity in the country for optimal utilization of public resources.</p> <p>6.6. Provide appropriate patterns of use of public resources and national wealth</p>	March, 16, 1999
Third Economic, Social and Cultural Development Plan of the Islamic Republic of Iran	<p>Article 61:</p> <p>B. New profit and non-profit construction projects trade agreements will be permitted only after the following steps:</p> <p>1. Studies on aspects of technical, economic, social and environmental feasibility.</p> <p>Chapter twelve - environmental policy</p> <p>Articles 104. In order to protect environment and sustainable utilization of natural resources, the following is required:</p> <p>A. The exploitation of natural resources should be based on the potential sources.</p> <p>B. To strengthen and support the "non-governmental organizations that support the environment and natural resources", individuals and legal assistance to these organizations can be considered as an acceptable cost.</p> <p>C. To reduce the polluting factors of the environment, particularly in the context of natural resources and water resources, production plants are required to comply with the terms of their technical characteristics to the environment and take action to reduce emissions. Costs in this case can be considered as an acceptable cost for the plants.</p> <p>Fines proportionate to the damage taken from the plants that refused to reduce the polluting factors of the environment and their activities cause pollution and environmental degradation and getting back into the general revenue to be cost as the annual budget bills for environmental projects plans. The regulations of this paragraph containing the amount of fines, how to obtain and how to calculate the cost of crimes</p>	April, 5, 2000

Third five-year plan (2000 to 2004)	Description	Date of approval
	<p>proposed by Department of Environment and will be approved by the Board of Ministers.</p> <p>Article 105. Before running and at the stages of feasibility studies and positioning, all the major manufacturing and service projects should be subject to environmental assessment based on the regulations proposed by Supreme Environmental Protection Council and approved by the Board of Ministers. Compliance assessment of the mentioned projects is required by the project managers. Supervising the implementation of this article is on the PBO.</p> <p>Article 121. To apply the saving, rational energy consumption and environmental protection, the government is obliged to perform the following steps:</p> <p>A. Preparation of standards and technical specifications related to the energy consumption of equipment, processes and systems of energy, in order that all consumers, manufacturers and importers of equipment, systems and processes required complying with the specifications and standards. The criteria can be codified by a committee composed of representatives of the Ministry of Energy, Ministry of Petroleum, Institute of Standards and Industrial Research of Iran, the Department of Environment and the formulation of the relevant ministries.</p>	
<p>Areas of law enforcement strategies of the Third Economic, Social and Cultural Development Plan of the Islamic Republic of Iran</p>	<p>1. The executive strategies of industry and mining sectors:</p> <p>1-20- At the first year of the plan, the Ministry of Industries and Mines is responsible for codifying and announcing the specific rules for exploitation of different mines to reduce wastes. These regulations also include a ban on the use of outdated technologies in certain groups of mining operation (taking into account the considerations and exemptions for small mines).</p> <p>3. Executive strategies for water and agriculture</p> <p>F. Amend the preservation, restoration and exploitation of country natural resources (forests and fields) with the following main points:</p> <ul style="list-style-type: none"> - Modify the terms and conditions of transfer of land to achieve optimal 	<p>January, 22, 2001</p>

Third five-year plan (2000 to 2004)	Description	Date of approval
	<p>utilization of natural resources and to achieve sustainable development goals.</p> <p>6. The energy sector</p> <p>6.23. To raise public awareness, environmental benefits of renewable energy use in textbooks, media and public campaign is explained.</p>	
<p>Implementation strategies for the higher education sector of the Third Economic, Social and Cultural Development Plan of the Islamic Republic of Iran</p>	<p>9. the Ministry of science, research and technology is bound to cooperate with Ministry of health and medical education and the representative of the Supreme Leader in universities until the end of September, 2001 the following actions of the Islamic and cultural affairs to the university:</p> <ul style="list-style-type: none"> - Support collaborative research between universities and seminaries experts in solving issues of the society and with the community in the areas of art, such as the principles of sustainable development, economy, culture, management and so on. 	<p>August, 19, 2001</p>
<p>Executive bylaw of article 61 of the Third Economic, Social and Cultural Development Plan of the Islamic Republic of Iran</p>	<p>Article 2. Swap agreements, a new non-profit and for-profit projects, add new projects to the projects in progress or increase the volume and starting operation of the projects is only possible to the acceptance by the Management and Planning Organization based on the followings:</p> <p>A. The studies are based on technical, economic, social and environmental feasibility.</p>	<p>August, 21, 2000</p>
<p>Executive bylaw of article 70 of the Third Economic, Social and Cultural Development Plan of the Islamic Republic of Iran</p>	<p>Article 19. The duties of water, agriculture and natural resources (soil, agriculture and horticulture, livestock, fisheries and aquaculture) committee is determined as follows:</p> <p>C. Planning and supervising the management, operation and restoration of natural resources</p> <p>E. Check on how to use water and water resources on the basis of capacity planning in order to optimize it for all consumer sectors, including, agriculture, drinking, industry and services.</p> <p>X. Review and planning to increase irrigation efficiency by using modern irrigation systems and reduce water losses in transmission and distribution</p>	<p>February, 14, 2001</p>

Third five-year plan (2000 to 2004)	Description	Date of approval
	<p>networks</p> <p>D. Planning for collection and treatment of waste water through the creation of networks for the supply of agricultural water</p> <p>Y. The necessary coordination in the field of exploitation of the soil and water and the efficient use of prone land and water resources potential of provinces and offer the correct culture system.</p> <p>Article 21. The duties of the mining industry committee is determined as follows:</p> <p>E. Review and necessary coordination for the transfer of polluting industries out of the cities</p> <p>X. Follow environmental issues arising from the development of the mining industry</p> <p>Article 34. The duties of the employment and investment committee is determined as follows:</p> <p>D. The coordination of job creation in both developed and less developed regions of the province</p> <p>Article 36. The duties of the spatial planning, population and environment committee is determined as follows:</p> <p>E- Review and locate major construction projects (beyond province rules) with respect to environmental and land use planning</p>	
<p>Executive bylaw of article 85 of the Third Economic, Social and Cultural Development Plan of the Islamic Republic of Iran</p>	<p>Article 4. Use of foreign finance for government projects within annual budget requires the following steps:</p> <p>D. Presenting the plan to the Economy Council for:</p> <p>4. Verification of observing environmental conditions in the project implementing</p>	<p>October, 16, 2000</p>
<p>Executive bylaw of paragraph A of article 104 of the Third Economic, Social and Cultural</p>	<p>Article 2. In order to implement this paragraph following requirements should be met:</p> <p>B. In exploiting of resources the technical precautions to protect water and soil and to minimize environmental waste is required.</p>	<p>July, 15, 2001</p>

Third five-year plan (2000 to 2004)	Description	Date of approval
Development Plan of the Islamic Republic of Iran	<p>C. In order to maintain forest areas and areas under the protection of the environment, the Ministry of Defense and armed forces logistics, in coordination with the armed forces locate the site of military exercise.</p> <p>D. Any exploitation of fish stocks in seas and inland waters subject to compliance with technical standards in accordance with the relevant sector detection</p> <p>I. Directors of project products and services whose land transfer result to the issuance of the final document shall allocate at least twenty-five per cent of the projected area in the green space plan</p> <p>J. Protection of flora and fauna under threat of the generation extinction is required based on criteria and guidelines approved by the Supreme Council of Environment.</p> <p>L. To maintain environmental sustainability, giving priority to non- chemical projects combat plan particularly biological control combat of pests and plant diseases is emphasized.</p>	
Executive bylaw of paragraph B of article 104 of the Third Economic, Social and Cultural Development Plan of the Islamic Republic of Iran	Article 4. Organizations shall spend incoming help based on educational goals presenting by the Executive Committee in order to help raise awareness and effective participation of the people and culture through educational activities and applied research in the field of environmental protection and natural resources.	January, 24, 2001
Executive bylaw of paragraph C of article 122 of the Third Economic, Social and Cultural Development Plan of the Islamic Republic of Iran	Note 4. For private institutions' power plants that do not use fossil fuels, due to the reduction of fuel consumption and reduce environmental pollution, it is supposed to be paid 74 Rials per kwh of electricity from the funds of energy efficiency.	March, 3, 2001

Fourth five-year plan (2005 to 2009)	Description	Date of approval
Chapter one- preparation for rapid economic growth	<p>Article 30. In order to identity the face of the cities and villages, the strength of the construction, achieve sustainable development and improve the living environment in cities and villages, the government must take the following action in in parts of rural, urban and housing civil:</p> <p>A. The identity of physical appearance and landscape of cities, sustaining and spreading the culture of architecture and urban planning and redevelopment of urban services</p> <p>B. Immunization and retrofitting of buildings and cities to reduce the human and financial losses caused by the disaster</p>	September, 1, 2004
Chapter 4- knowledge-based development	<p>Article 52. In order to guarantee equal access to educational opportunities, especially in the less developed regions, spread the knowledge, skills and enhance the power of human productivity, especially for girls, and the qualitative and quantitative development of the public education, the government is obliged to accomplish the following:</p> <p>Q. Providing appropriate facilities for removing educational deprivation through expansion of boarding schools, central rural and central accommodation, distance education by media and providing students nutrition, health and transportation, other costs related to the creation and expansion of boarding schools, educational places and spaces, making and expanding of educational, training and sports spaces suitable for males and females, preparing and implementing the necessary programs to expand preschool education particularly in bilingual regions.</p>	September, 1, 2004
Chapter 5- Environmental Protection	<p>Article 59. in order to estimate the economic value of natural resources, environmental pollution and the cost of environmental degradation in the process of the development of national accounts and its calculation, the Management and Planning Organization of the country in cooperation with the Department of Environment and other related corporations is bound to calculate, adjust and pass legislation to the relevant authorities the values and the cost of priority items such as: forest, water, soil, energy, biodiversity, and environmental pollution in sensitive parts.</p>	September, 1, 2004

Fourth five-year plan (2005 to 2009)	Description	Date of approval
Chapter 5- Environmental Protection	Article 60. In order to strengthen and empower the relevant structures with the environment and natural resources, the government is obliged to set up and maintain the necessary mechanisms to develop public education and professional environment in all educational centers and higher education institutions, support investment in the environment and natural resources and create suitable structures to strengthen environmental activities in organizations affecting the environment.	September, 1, 2004
Chapter 5- Environmental Protection	Article 61. The government must take action during the Fourth Plan to the following: A. Begin a self-reported plan for monitoring pollution sources. All production, services and fundamental plants should make sample and measure the pollution and its damage based on the guidelines of the Department of Environment and provide the results to this organization. B. In order to avoid the increase of vegetable indiscriminate consumption of pesticides and chemical fertilizers, making the way that leads to greater use of compost and biological should be gradually adopted C. Waste management plan and approach in cooperation with municipalities, counties and rural leaders should be done.	September, 1, 2004
Chapter 5- Environmental Protection	Article 64. Environmental Protection Agency is required: A. To subject the relevant executive regulations proposed by the environmental protection council and approved by the Board of Ministers for raising public awareness and to achieve sustainable development in order to preserve the environment and emphasizing the impact and priority of the groups from the beginning of the fourth program of economic, social and cultural development of the Islamic Republic of Iran All relevant corporations, governmental media and the Islamic Republic of Iran Broadcasting is required to implement the training program without receiving any payment related to this article	September, 1, 2004

Fourth five-year plan (2005 to 2009)	Description	Date of approval
Chapter 5- Environmental Protection	Article 65. The government is required to formulate the principles of ecologically sustainable development, especially in production and consumption patterns and instructions for the relevant corresponding optimization. Related organizations obliged to observe the principles and guidelines set out in their action plans.	September, 1, 2004
Chapter 5- Environmental Protection	Article 66. In order to reduce country funds cost, basic resource consumption and environmental policies for the implementation of green management program including management of energy, water, raw materials, and equipment (including paper), solid waste reduction and recycling (in buildings and vehicles) all executive agencies and non-governmental organizations and public bodies are required to act according to the regulation by the Department of Environment and the State management and planning organization, in cooperation with the relevant corporations staff which will be approved by the Board of Ministers.	September, 1, 2004
Chapter 5- Environmental Protection	Article 68. B. It will be allowed to the government complying with the principles 72 and 85 of the basic law of the Islamic Republic of Iran to establish "the National Environment Fund" depended on the environmental protection agency for the reduction of pollutants into the environment and its destruction. The required capital to do these activities is supported by the non-governmental internal and external sectors.	September, 1, 2004
Chapter 5- Environmental Protection	Article 69. The government is required to set up and implement the protection, restoration, modification, development and utilization of renewable natural resources based on the following priorities: E. The development of green space and making hand-plant forests a minimum of five hundred thousand hectares	September, 1, 2004
Chapter 5- Environmental Protection	Article 89. Based on the service level separation, the Ministry of Health and Medical Education is obliged to design equitable access to public health services and logistic needs in different parts of the country, and provide a minimum standard of health services in the country. In the case of health, safety and environment (HSE) units, regulations will be exclusively concerned.	September, 1, 2004

Fourth five-year plan (2005 to 2009)	Description	Date of approval
Chapter 8- Improving human security and social justice	<p>Article 95. The Government is required to provide and implement the social justice and stability, reduce social and economic inequalities, reduce the amount of income among different groups of the society and distribute of revenues in the country, as well as poverty reduction and the empowerment of the poor, the deprived and the efficient allocation of resources through targeted subsidies and social security payments, and a comprehensive program of combating poverty and creating social justice with the following topics:</p> <p>D. Design special events employment, strengthening social participation, education, job skills and life skills, especially for the lower-income population of three groups in the country</p> <p>E. Promoting participation of non-governmental organizations and charity in combating poverty and identify orphaned children and underlined poverty families in all parts of the country by the regional managers and apply economic, cultural, and social support for people mentioned by them and responsible institutions in the system of social security</p>	September, 1, 2004
Chapter 9- Cultural development	<p>Article 112. In order to strengthen the position of the youth in the community, as the country's human resource capital, and considering the special attention, advancement and growth of the young generation, the government is obliged to prepare and organize youth affairs program under the framework of the Fourth Plan within six months from the adoption of this law containing required executable programs, including the general attitude modification practices and create a positive culture of introspection towards the young, the groundwork for intellectual and academic growth, attendance, participation, empowerment and promoting all-round sustained development process in the country, increase the physical and mental health and well-being and create excitement, motivation and hope for the future among young people and job concerns, marriage, housing and social damage in the context of a high attitude and as a central policy with the maximum available capacity of the system and non-governmental organizations, creating capacity in the country as well as benefiting from the reform of the administrative system, economic structures, social and cultural rights through the exercise of strategic management system.</p>	September, 1, 2004

Fourth five-year plan (2005 to 2009)	Description	Date of approval
Chapter10- National security	<p>Article 119. In order to enhance public safety and social discipline, the government is required to take necessary steps to fulfill the following:</p> <p>A. public education and promoting the rule of law, order, tolerance and healthy environment</p> <p>B. The development of border transportation, and enhance communication and exchange of information with neighboring countries in the region to curb crime, smuggling and drug trafficking, illicit trafficking and abuse in the form of bilateral and multilateral agreements and collective security arrangements</p> <p>G. Combating the occurrence areas of anomie, social conflict, political violence and urban violence</p> <p>I- Provide the necessary mechanisms to promote the public participation, to ensure public order and security</p>	September, 1, 2004
Chapter 12- The modernization of the government and to promote the effectiveness of the government sovereignty	<p>Article 140. In order to develop the private institutions and non-governmental organizations and the participation of cooperatives and other sectors of civil society in the governance of the country and increase the efficiency of public administration, in facing the challenges and take advantage of opportunities and national resources, government can be allowed to do the following:</p> <p>A. Contribute to the creation and development of non-governmental organizations and the law necessary for the development of entrepreneurship, promote a culture of service, administrative transparency and the development of health and environmental protection and enhancement of environmental and health standards of the people, based on the objectives and accountability</p>	September, 1, 2004

Fourth five-year plan (2005 to 2009)	Description	Date of approval
<p>Bylaw paragraph "C" law enforcement of Article 122 of the Third Economic, Social and Cultural Development Plan of the Islamic Republic of Iran, Article 20 of the Fourth Economic, Social and Cultural Development of the Islamic Republic of Iran</p>	<p>Article 4. Note 4. For private institutions power plants that use fossil fuels or gas, due to the reduction of fuel consumption and reduce environmental pollution, 74 Rials per kwh is paid from the energy efficiency in the fuel supply of the funds</p>	<p>July, 30, 2005</p>
<p>Bylaw Article 134 law enforcement of the Third Economic, Social and Cultural Development Plan of Islamic Republic of Iran, Article 20 of the Fourth Economic, Social and Cultural Development plan of the Islamic Republic of Iran</p>	<p>Article 2. Environmental Protection Agency directly or at the request of the Ministry of energy determines the extent of the pollution and declares it to the relevant department and the Department of Energy and determines appropriate deadlines for the control and elimination of pollution. Pollutant unit bound to deposit the related offenses to The treasury up to the time of decontamination.</p> <p>Article 3. If the plant continues to pollution and avoids the fines payment, Ministry of Energy will cut the water use and will suspend the license of water exploitation of that plant.</p> <p>Article 6. Deposit placed to the treasury from the row in which the laws annual budget will be is given to the Environmental Protection Agency to be distributed among the executive trustee of the protection departments, the quality of water resources and wastewater disposal and treatment health tracking by the request of Ministry of Energy and supervising of Environmental Protection Agency as follows:</p> <p>A. Determination, ownership of Privacy and protection of groundwater and surface water resources</p>	<p>July, 30, 2005</p>

Fourth five-year plan (2005 to 2009)	Description	Date of approval
	<p>B. Monitor the quality of groundwater and surface water resources</p> <p>C. The collection, treatment and disposal of urban, rural, industrial areas, towns and garrison sewages.</p> <p>D. Information and educate the public in order to protect the quality of water resources and encourage employee and non-employee in relation to the activities and efforts so as to implement this regulation considering article 41 of national employment law</p> <p>Article 7. To prevent the continuation of the payment of fines and forcing polluters to decontamination, for plants that do not apply to the decontamination, after the deadline, the penalty will be doubled and is calculated as the ratio by a factor of two over the previous year</p> <p>Note: Plants to identify that have done the appropriate action to resolve pollution, subject to ninety percent discount of the fines</p>	
<p>Bylaw Article 32 of the Fourth Economic, Social and Cultural Development Plan of the Islamic Republic of Iran</p>	<p>Article 1.</p> <p>J- the feasibility of the project: Period in which emerging technologies and its relating procedures, evaluation, selection, study and preliminary design consisted of a thorough and careful review, full and clear description of the design from the aspects of technical, economic, social and environmental, and financing is hold in order to make decisions about starting or not starting the project. This period can be divided into an initial feasibility study (preliminary feasibility studies and identification) and final feasibility (basic engineering studies, preliminary design and feasibility study).</p>	<p>July, 27, 2005</p>
<p>Bylaw paragraph "A" of Article 62 of the Fourth Economic, Social and Cultural Development Plan of the Islamic Republic of Iran</p>	<p>Article 1. The Environmental Protection Agency is obliged to provide clean air standards by the end of the fourth economic, social and cultural development plan of the Islamic Republic of Iran, in cooperation with the Ministry of health, treatment and medical education and subject to the approval of the Supreme Council of environment legislation.</p>	<p>April, 13, 2008</p>

Fourth five-year plan (2005 to 2009)	Description	Date of approval
<p>Bylaw Article 63 of the Fourth Economic, Social and Cultural Development Plan of the Islamic Republic of Iran</p>	<p>Article 2. The master plan is a national document of the country's coasts, which aims to prevent the destruction and pollution of beaches, sustainable development of coastal areas, ensuring the public's right to exploit the country's beaches and coast to organize the use of the Caspian Sea Coast include priority setting and policy liberalization, environmental standards and criteria set, sailing, fishing and aquaculture, tourism development and providing review, correction and completion of integrated management and the establishment of rules and regulations on the basis of the measures detailed in this regulation provided by the Ministry of housing and urban development approved within one year and accepted by the working group as the main subject of Article 3 of this regulation.</p> <p>A. The Environmental Protection Agency in cooperation with the Ministry of Transportation and other relevant corporations compliance with laws and regulations, is required to prepare standards and regulations related to the prevention of pollution and the degradation of beaches caused by port, maritime, tourism, construction and operation of the marine structures within six months after the notification of this regulation and determines strategies for its implementation in terms of the types of activities that take place within the coastal areas of the country to be presented to the working group, relevant to Article 3 of this regulation.</p> <p>C. The Ministry of agriculture in cooperation with The Environmental Protection Agency and the Ministry of transportation shall determine the laws and regulations, conditions and standards related to the activities of fishing and aquaculture, fishing pier in the coastal regions and the development of forests and natural resources in the recreation areas with the aim of developing and regenerated natural resources within six months to be presented to the working group, relevant to Article 3 of this regulation.</p>	<p>May, 13, 2007</p>
<p>Bylaw paragraph "A" of Article 64 of the Fourth Economic,</p>	<p>Article 3. The Supreme Council of Education is responsible for:</p> <p>A. Promoting the review of the various sections in the school textbooks, quantity and quality of the environment</p>	<p>July, 19, 2006</p>

Fourth five-year plan (2005 to 2009)	Description	Date of approval
Social and Cultural Development Plan of the Islamic Republic of Iran	<p>educational content in coordination with The Environmental Protection Agency according to the time needs.</p> <p>Article 4.</p> <p>The university courses planning council in cooperation with the Department of Environment is responsible for adopting the university courses in all academic disciplines, such as medical group, engineering, art and humanities and science-based agriculture in a way that graduates of the course obtain the necessary and sufficient information related to environment.</p> <p>Article 5. Islamic Republic of Iran Broadcasting (IRIB) is obliged to implement and broadcast environmental educational programs and seminars provided by The Environmental Protection Agency and other organizations especially the Ministry of energy without any payment after the approval of The Environmental Protection Agency within the framework of the general policy of IRIB.</p>	
Bylaw Article 66 of the Fourth Economic, Social and Cultural Development Plan of the Islamic Republic of Iran	<p>Article 1. All executive agencies and non-governmental organizations and public bodies are required to cost credit referred to Paragraph 1 of Article 1 of regulations for implementing green management activities as follows:</p> <p>A. The establishment of the environmental management system involves identifying items that need continuous reform improvement, the formulation and implementation of its remedial program participation, training, personnel involvement, and audit and reporting</p> <p>B. The use of a maximum of fifteen percent (15%) of the credit referred to Paragraph 1 of Article 1 for informing and enlightening the minds of employees</p> <p>C. The optimal consumption of energy through the restoration of buildings and the use of low consumption equipment, new energy, reforming the method of transportation with the aim of reducing fuel consumption and the use of natural gas.</p> <p>D. Optimal consumption of water by the use of appropriate technologies and the need to reform and improve staff awareness</p> <p>E. Paper consumption reduction according to the type of companies and organizations activities (establishment of</p>	June, 24, 2007

Fourth five-year plan (2005 to 2009)	Description	Date of approval
	<p>computer communications system)</p> <p>F. Optimal consumption of raw materials, consumables and equipment</p> <p>G. Reduction of waste through the use of appropriate technologies and increasing productivity</p> <p>H. Improvement and maintenance of equipment rather than replacing</p> <p>I. Waste recycling, water treatment and recycling to create green spaces, etc.</p> <p>J. The use of clean and environmentally friendly technologies to control and optimize the consumption</p> <p>K. Reducing the consumption of sustainable disposable products in environment</p> <p>L. Alternative fuel instead of firewood in rural and tribal areas</p> <p>Article 4.</p> <p>The Environmental Protection Agency is required annually to create a space for exchanging experiences of successful managers of public and private institutions and improve their environmental attitudes to the environment protection and reduce environmental pollution and the implementation of green management activities subject to a row in Article 1 of this regulation and select the green industries and service plants chosen from 1 and 2 attached instructions and encourage and appreciate the constructive competition for the expansion of these plants to provide environmental management system.</p> <p>-----</p> <p>Appendix 1:</p> <p>Article 1 of Appendix 1:</p> <p>Purpose:</p> <ul style="list-style-type: none"> • environmental attitude among industrialists to pay attention to the issue of environmental protection • serious and constructive competition between country industries in applying the principles of protecting the environment during production • creating constructive communication between The Environmental Protection Agency and industry 	

Fourth five-year plan (2005 to 2009)	Description	Date of approval
	<ul style="list-style-type: none"> • creating space for exchanging experiences and achievements of environmental issues among industries plants • encouraging and appreciation of industry leaders in order to reduce and prevent industries environmental damages • promotion and development of environmental culture to environmental technologies and clean production process <p>Article 4 of Appendix 1:</p> <p>Criteria for selection of green industries:</p> <ol style="list-style-type: none"> 1. No placing the name of the plants in the list of The Environmental Protection Agency as pollutants industries 2. Improving filtration systems and emissions control 3. Waste management recycling 4. Clean energy replacement 5. Certificate of environmental management ISO 14000 6. Certification for the establishment of the Health and Safety OHSAS18000 7. Compatibility with clean production process 8. Development of green space 9. Optimal energy consumption and increase efficiency in energy consumption 10. The promotion of environmental science and culture of the managers and staff 11. Reducing the negative effects of industrial waste on the environment <p>-----</p> <p>Appendix 2:</p> <p>Article 1 of Appendix 2:</p> <p>Purpose:</p> <ul style="list-style-type: none"> • creating environmental attitudes among green service units for attention to environmental protection • creating serious and constructive competition between service units in applying the principles of environmental protection during production 	

Fourth five-year plan (2005 to 2009)	Description	Date of approval
	<ul style="list-style-type: none"> • establishing constructive relationship between The Environmental Protection Agency and the service sector • creating space for exchanging experiences and achievements of environmental issues among service units • encouraging and appreciation of service units in order to reduce and prevent environmental damages <p>Article 4 of Appendix 2:</p> <p>Criteria for selection of green services:</p> <ol style="list-style-type: none"> 1. Installation or modification wastewater treatment system 2. Principle disposal and landfill of garbage 3. Waste Management Recycling 4. Creating and development of green spaces 5. Certificate of Environmental Management ISO 14000 6. Optimal energy consumption and increasing efficiency in energy consumption 7. The promotion of environmental science and culture of the managers and staff, creating environmental innovation and comprehensive services 	
<p>Bylaw paragraph "A" of Article 67 of the Fourth Economic, Social and Cultural Development Plan of the Islamic Republic of Iran</p>	<p>Article 1.</p> <p>A. local environmental management is a holistic, guiding and monitoring process that is applied in the framework of the laws and regulations in order to guarantee the sustainability of the local environment and environmental considerations in development projects and the sensitive ecosystem management according to the environment tolerable capacity and participation of all relevant managers.</p> <p>Article 2.</p> <p>Ecosystem management objectives are:</p> <p>A. Vital function of protecting the diversity of ecosystems, including restoration of degraded habitats, prevent and reduce pollution and provide natural water rights for sensitive aquatic ecosystems</p> <p>B. Correct and sustainable exploitation of resources and ecosystem ecological environment based on scientific accurate research</p>	<p>March, 23, 2008</p>

Fourth five-year plan (2005 to 2009)	Description	Date of approval
<p>Bylaw paragraph "C" law enforcement of Article 104 of the Third Economic, Social and Cultural Development Plan of the Islamic Republic of Iran, Article 71 of the Fourth Economic, Social and Cultural Development of the Islamic Republic of Iran</p>	<p>Article 3. All plants that their output pollution is higher than the environmental criteria and standards and plants that their activities also caused the destruction of the environment are obliged to reduce or eliminate pollution and degradation after The Environmental Protection Agency notification and deadline. Expenses for this purpose will be accepted as the tax.</p>	<p>August, 1, 2005</p>
<p>Bylaw paragraph "C" Article 105 of the Third Economic, Social and Cultural Development Plan of the Islamic Republic of Iran, endorsed in Article 71 of the Fourth Economic, Social and Cultural Development Plan of the Islamic Republic of Iran</p>	<p>Article 1: A. Environmental impact assessment is a regular reading process which aims to predict and identify the likely environmental consequences and set a plan or project on the feasibility or location stage during which the options and required sufficient precautions in accordance with the regulations and standards pertaining to remove or reduce the adverse environmental effects are anticipated to be presented and study.</p> <p>Article 3. The Environmental Protection Agency is required in cooperation with relevant executive organizations prepare and publish instructions on how to perform an environmental impact assessment of plans and under evaluation projects by previous arrangement to the Vice President of Strategic Planning and Monitoring. Compliance of the mentioned guidelines by the executor or executors of plans and projects under evaluation is required.</p> <p>Article 8. Of those projects that are likely to cause a combination of environmental hazards and disasters, preparation and delivery of the environmental risk assessment is required to be attached to the evaluation</p>	

Fourth five-year plan (2005 to 2009)	Description	Date of approval
	<p>report.</p> <p>Article 10. The Vice President of Strategic Planning and Monitoring and the supervision of provincial planning and development are required to apply necessary credits for environmental assessment studies related to government projects subject to an environmental impact assessment in the future annual budget that comes to the maximum rate of their annual budget.</p> <p>-----</p> <p>Appendix 1:</p> <p>List of projects subject to environmental impact assessment</p> <p>19. Copper ore mines with minimal extractive capacity of one million tons per year</p> <p>20. Iron ore mines with minimal extractive capacity of 600 thousand tons per year</p> <p>21. Gold ore mines with any capacity</p> <p>22. Lead and zinc mines with minimal extractive capacity of one hundred thousand tons per year</p> <p>23. Other metals mines with minimal extractive capacity of one hundred thousand tons per year</p> <p>24. Coal mines with minimal extractive capacity of 80 thousand tons per year</p> <p>25. Water salt mines with more than four hundred hectare</p> <p>-----</p> <p>Appendix 3:</p> <p>Framework for the assessment of the risk of environmental disaster caused by manufacturing and service plans</p> <p>1. The prediction of likely environmental disaster plans, according to the construction and operation phases</p> <p>2. Review and determine the radius of influence of environmental disasters</p> <p>3. Analyzing and determining the locations and time-critical radius of influence of environmental disasters</p> <p>4. Predict and assess the risks and consequences of an environmental disaster in the project</p> <p>5. An estimate of the likelihood and timing of environmental disasters in the project</p> <p>6. Review and the provision of environmental and management conditions before and after the onset of the crisis of the environmental disaster</p>	

Fifth five-year plan (2011 to 2015)	Description	Date of approval
Chapter 2. Science and Technology	Article 19. D. The Ministry of education is required to provide distance education and nutrition, media and finance, transportation, health and other affairs related to the boarding school in order to ensure equitable access to training opportunities to fit the gender and the need for less developed areas.	January, 5, 2011
Chapter 5. Economic	<p>Article 73. The government is bound to do legal actions to the end of the first year of the program, necessary to reform labor law and insurance law and labor relations with respect to the following:</p> <p>A. Settlement for workers and employers to create flexible and align the interests of both parties</p> <p>B. Strengthen the new situation with respect to changes in technology and the specific requirements of the production of goods and services</p>	January, 5, 2011
Chapter 5. Economic	<p>Article 80. In order to create sustainable employment, entrepreneurship development, reducing regional imbalances and the development of new jobs, the government is allowed to perform the following steps:</p> <p>B. Removing the problems and obstacles to the development of small and medium enterprises and help them to become mature, competitive and large enterprises</p> <p>C. Expanding home business and remote work from private and cooperative sectors of employment, especially in regions with unemployment rates above the national average unemployment rate</p> <p>E. Financial support from the private institutions to develop and expand business education, entrepreneurship, vocational, technical and scientific applications</p> <p>F. Applying stepped discounts or supply of premium contributions by employers for the workshops that employ new personals with the approval or introducing of the Ministry of Labor and Social Affairs, if the plant has been newly established or the year before that, there was no reduction in the labor force</p>	January, 5, 2011

Fifth five-year plan (2011 to 2015)	Description	Date of approval
Chapter 5. Economic	<p>Article 140. To Comprehensive management (contiguous) and sustainable development of water resources in the country:</p> <p>A. Ministry of Energy is required to implement measures to protect and prevent the unauthorized removal of groundwater resources within the rule of the wells without license</p> <p>D. Industrial, livestock, service and other plants that produce waste exceed the national standards are required to run facilities for wastewater collection, treatment and disposal of wastewater. Violator plants are fined.</p>	January, 5, 2011
Chapter 5. Economic	<p>Article 150. In order to achieve the objectives of Twenty Years Plan of the Islamic Republic of Iran and a strategy for industrial and mining development in coordination with the Deputy of Ministry in the selected subsection mining industry, Ministry of Industry and Mines is required to select a method that increases the growth rate of added value in industry and mining sector with respect to the following strategic guidelines:</p> <p>A. Promotion industrial competition with an emphasis on technology development and transfer capabilities based on the comparative advantages of raw materials and technological capabilities and create a competitive advantage</p>	January, 5, 2011
Chapter 5. Economic	<p>Article 155. All executive units responsible for the technical implementation of their project and its development regulations, rules and technical measures to comply with national standards.</p>	January, 5, 2011
Chapter 5. Economic	<p>Article 157. In order to promote the development of mining activities and mining role in the national economy, the government is required in the annual budget:</p> <p>A. Supply basic geological map, identify, track and general exploration and all of the country's mineral potential and after blocking range, transfers the operations to the private institution</p> <p>B. To organize the exploration sector of the country, run a comprehensive database of land use information to all relevant agencies up to the second year of the</p>	January, 5, 2011

Fifth five-year plan (2011 to 2015)	Description	Date of approval
	<p>program</p> <p>C. Help to complete infrastructure for large mines and mineral mining areas and energy industry</p>	
Chapter 5. Economic	<p>Article 170. To achieve sustainable development in urban and rural areas, Ministry of Housing and Urban Development is required to organize physical, economic and social interactions between cities with a population of over one hundred thousand with village located in its privacy through preparing and implementing a comprehensive and detailed set of urban plan with respect to the inner development of the cities, taking advantage of the development of agricultural lands, protection of agricultural lands and gardens located at the inside or the rim of the towns and villages.</p>	January, 5, 2011
Chapter 6. Regional Development	<p>Article 180. In line with the realization principle 4 of the Constitution, and in order to reach the country's facilities, fair distribution, non-discrimination, the promotion and realization of the less developed areas and to achieve progress and justice, the government is required to distribute public resources facilities and subsidize in such a way that the index distance of the towns with less than the national average at the end of the Fourth Plan in the case of economic, social, cultural, infrastructure and security in each year of the plan at least closes ten percent (10%) to the above level.</p>	January, 5, 2011
Chapter 6. Regional Development	<p>Article 187:</p> <p>A. In order to protect, sustainable restoration and exploitation of the environment, natural resources and biodiversity, the government is allowed to do the following legal actions mostly to the end of the second year of the plan:</p> <ol style="list-style-type: none"> 1. The development and implementation of integrated ecosystem management program and action plan for conservation and sustainable use of biodiversity and country fragile sensitive ecosystems 2. The amended statute of "National Environmental Fund" 	January, 5, 2011

Fifth five-year plan (2011 to 2015)	Description	Date of approval
Chapter 6. Regional Development	Article 188. In order to facilitate investment, Department of Environment in cooperation with the Ministry of Industries and Mines and Agriculture and in coordination with the Deputy is required to prepare environmental certain, clear and fixed regulations and standards consistent within the framework of laws for a period of five years. All production, industrial, construction, services and infrastructure plants are required to comply with regulations and standards.	January, 5, 2011
Chapter 6. Regional Development	Article 189. Department of Environment is required to: A. In order to promote public awareness and achieving sustainable development to protect the environment with emphasis on the impact and priority groups since the beginning of the Fifth Economic, Social and Cultural Development Plan of the Islamic Republic of Iran, the Department of Environment is required to get the relevant administrative regulations proposed by the Supreme Council of Environment approved by the Board of Ministers. All relevant agencies, governmental media and the Islamic Republic of Iran Broadcasting (IRIB) are required to implement the training program - the subject of this article- without any payment. B. Provides environmental information system in the country at the regional, national and provincial areas by the end of the Fifth Plan to make the monitoring, information and environmental assessment available	January, 5, 2011
Chapter 6. Regional Development	Article 192. In order to reduce pollution and harmful environmental factors, all large plants, industrial, construction, services and infrastructure required to: A. Large production, service and development projects evaluate themselves environmentally before running and at the stages of feasibility studies and positioning based on criteria approved by the Supreme Council of Environment B. Implement their sampling and measurement of environmental pollution and degradation and express them within the framework provided by the Department of Environment.	January, 5, 2011

Fifth five-year plan (2011 to 2015)	Description	Date of approval
	<p>Plants that feature and require the installation of the continuously monitoring system should install the mentioned system until the end of the third year of the Plan.</p> <p>C. Enhance their technical specifications in a way that adjust with regulations and standards of environment, reduce environmental pollution, especially degradation of natural resources and water</p>	
Chapter 6. Regional Development	<p>Article 193:</p> <p>B. The Environmental Protection Agency is required to provide the necessary measures to reduce air pollution to global standards with priority to identify aerosols releasing center and its inhibition, control and reduce greenhouse gas emissions.</p>	January, 5, 2011
Chapter 6. Regional Development	<p>Article 194. To improve the situation of rural policy, planning, managing, monitoring and coordinating the implementation, promotion and quality of life of the villagers and farmers' income and reduce inequalities between the rural, tribal and urban, the government is required to support the following actions necessarily:</p> <p>E. improvement, renovation, reconstruction and securing the physical and environmental structure of rural housing based on the Iranian Islamic architecture model in partnership with people, government and public institutions</p> <p>G. The organization and location of small and medium entrepreneurship of production and service activities in rural areas by offering financial incentives and credits</p> <p>I- Construction, repair, maintenance and secure of the rural road network</p> <p>K- financial support through giving loan, managed funds, interest subsidies for the development of rural and tribal families employment with respect to local and indigenous methods and also strengthen the integrated management of land through partnerships with legal entities in order to avoid fragmentation of agricultural land and aggregate management crushed lands</p>	January, 5, 2011

Fifth five-year plan (2011 to 2015)	Description	Date of approval
Chapter 7 Political, defensive and security issues	Article 204. To promote and strengthen the economy and livelihood of frontiersman by considerations of security and stability in border regions, the government should provide necessity financial and legal support for industries creation and the formation of cooperatives frontiersman and the right to exploit the potential of agricultural land and maximum use of natural resources and tourism in border areas	January, 5, 2011
Chapter 9 the budget and monitoring	Article 251. Note. Department of Environment is required to declare the environmental standards in the first half of the Plan to the Deputy, communicated to the Executives and engineering consultant companies to comply with the provisions of the design of its capital assets acquisition.	January, 5, 2011

2. Questionnaire No. 1 (QN1)

In 2012, a questionnaire containing 21 questions about Sangan Iron Ore Mines (SIOM) and the research topic was prepared and distributed among literate households as statistical population who lived in the area around SIOM. The main results of this survey have been presented in the sub-chapter 5.1.2; Results of Questionnaire No. 1. QN1 contained following questions:

2.1. Do you know SIOM (Sangan Iron Ore Mines)?

yes no somewhat no comment

2.2. Do you know SIMP (Sangan Iron Mines Project)?

yes no somewhat no comment

2.3. Do you know IMIDRO?

yes no somewhat no comment

2.4. How was SIMP function before 2006?

very good good middle weak

2.5. Has SIMP function improved from 2006?

yes somewhat no got worse

2.6. Are you aware of SIMP development programs to reach to 20 MTPY production capacities of iron ore concentrate and pellet?

yes no somewhat no comment

2.7. Do you agree with SIMP development programs to reach to 20 MTPY production capacities of iron ore concentrate and pellet?

yes no somewhat no comment

2.8. Are you satisfied with iron ore exploitation private companies active in the Sangan area?

yes no somewhat no comment

2.9. Mark the most important impacts of increasing mining activities & SIOM development from 1 to 4.

dust creation underground water level
 nonlocal entrance to the area rapid finishing of iron ore

2.10. Mark the most important advantages of increasing mining activities & SIOM development from 1 to 4.

occupation increase health & education level
 people's income and welfare criminal activities decrease

2.11. Do you know that a technical school and a high school have been made by SIMP and IEIOC in Sangon town? (these activities are called as social responsibilities)

yes no somewhat no comment

2.12. Are you satisfied with the SIMP and IEIOC social responsibilities activities?

yes no somewhat no comment

2.13. Do the iron ore exploitation private companies active in Sangon area make the social responsibilities activities, too?

yes no somewhat no comment

2.14. Are you satisfied with the social responsibilities activities of iron ore exploitation private companies active in Sangon area?

yes no somewhat no comment

2.15. Which sector was better in the field of social responsibilities activities?

SIMP & IEIOC private companies none of them

2.16. Which of the social responsibilities activities do you prefer in order? (Rank them from 1 to 4)

training center construction health care center
 sports complex construction water treatment construction

2.17. Which one do you prefer for the occupation? (Rank them from 1 to 3)

governmental private companies free job

2.18. What is the main reason for selecting your occupation?

job safety more income
 human rights consideration operation freedom

2.19. Which private sector do you prefer for occupation? (Rank them from 1 to 4)

placer private companies SIMP contractors and
 no difference none of them

2.20. Had all the SIMP activities been useful for you?

yes no somewhat no comment

2.21. What's your degree of education?

less than diploma diploma
 technician B.S and higher than B.S

3. Questionnaire No. 2 (QN2)

In 2014, based on the research necessity, Questionnaire No. 2 as the modified and improved version of QN1 with 31 questions was prepared and distributed among Khaf County residents for getting feedbacks and having realistic analysis for strategy development. The results of this survey have been presented in the sub-chapter 5.1.3; Results of Questionnaire No. 2 (QN2). The questions of QN2 are as follows:

3.1. Sex:

male female

3.2. What is your marital status?

single married but not started to live with spouse
 married divorced or widowed

3.3. What is your degree?

under diploma diploma B.Sc M.Sc or PhD

3.4. How many persons live together in the house you are living now?

1_2 3_4 5_6 more than 6

3.5. How many persons in your family are under 7 years?

1_2 3_4 5_6 more than 6

3.6. How many persons in your family are between 7-18 years?

1_2 3_4 5_6 more than 6

3.7. How many persons in your family are between 18-25 years old?

1_2 3_4 5_6 more than 6

3.8. How many persons in your family are uneducated?

1_2 3_4 5_6 more than 6

3.9. Does anyone in your family go to Technical school near Sangan mine?

yes no indifferent

3.10. Do you think that the implementation of SIOM projects effects on the level of education?

yes no indifferent

3.11. Do you know that a technical school and a high school were built by SIMP and IEIOC?

yes no indifferent

3.12. How many persons in your family are unemployed?

- 1_2 3_4 5_6 more than 6

3.13. Which of this occupation do you prefer?

- self-employed working for Iron ore mining project private sector
 working in a governmental sector working in other private sectors

3.14. How many persons in your family have university degrees?

- 1_2 3_4 5_6 more than 6

3.15. Which of the following items do you prefer? Please rank them from 1-5.

- building more building more hospitals and clinics
 building a university building water treatment facilities
 building parks and sport clubs

3.16. Are you interested to be employed in companies under SIOM projects?

- yes no indifferent

3.17. Do you think that SIOM projects have created more jobs for local people?

- yes no indifferent

3.18. Do you think SIOM can provide employment opportunities for your children in the future?

- yes no indifferent

3.19. What kind of transportation do you usually use in order to get other cities?

- by your own car taxi
 bus minibus
 train plane

3.20. What kind of transportation does you like the best for your city?

- plane taxi
 bus minibus
 train

3.21. What kind of transportation do you think should be improved?

- plane taxi
 bus minibus
 train

3.22. Are you satisfied with the number of clinics?

- yes no indifferent

3.23. Do you have to go to other clinics and hospitals in other cities for some illnesses?

If yes please mentioned here

- yes no indifferent

3.24. Has there been any problem with the air quality (dirty air, smog, etc.) before SIOM projects?

yes no indifferent

3.25. Do you think that SIOM projects have worsen the air quality?

yes no indifferent

3.26. Do you think that SIOM projects has effected on the local underground water level?

yes no indifferent

3.27. Do you think that SIOM projects have an effect on local soil condition?

yes no indifferent

3.28. How is the condition of social security after SIOM projects implementation?

decreased increased no difference

3.29. Do you think that SIOM projects have a positive effect on the technological development of the region?

yes no indifferent

3.30. Do you think that SIOM has a positive effect on the image of the region?

yes no indifferent

3.31. Do you think that SIOM projects should have high priority in the government development plan?

yes no indifferent

4. Fuzzy Delphi Method (FDM)

The creation of a large number of variables complicates the construction and assessment of models. The Delphi Method has been widely used to obtain a constant flow of expert opinions through survey. Questions come from related scientific literature and those recommended by experts. The Delphi approach has three characteristics: (a) anonymous responses, (b) interaction and controlled feedback, as well as (3) a statistical group response⁵⁹⁵. The questionnaire procedure requires asking the opinion of experts on multiple occasions, which results in certain difficulties, such as: (1) failure to take fuzziness into account leading to misinterpretation of the opinions; (2) systematic suppression of variables, i.e. sometimes the factors that are selected by at least 50% of the experts are retained; (3) process losses in coordination and communication; (4) repeatedly surveying the experts is more costly and time-consuming. Furthermore, there is a noteworthy problem to solve the fuzziness (expected ambiguity) of common understanding of expert opinions⁵⁹⁶.

To overcome these difficulties, it is proposed to apply the Fuzzy Delphi Method (FDM) to group decisions. This method is based on a similarity function to assess the level of agreement between experts. The Fuzzy Delphi Method assures no misinterpretation of expert opinions since it considers the fuzziness that every survey process has to deal with. Thus, more objective evaluation factors can be determined through statistical analysis since the efficiency and quality of questionnaires are enhanced. Some of the more representative strengths of the Fuzzy Delphi Method are:

- time saving,
- fewer surveys,
- increased recovery rate, and
- Guarantee of completeness and consistency of the group opinion⁵⁹⁷.

⁵⁹⁵ Y. L. Hsu, C. H. Lee and V. B. Kreng (2010), *The application of fuzzy Delphi method and fuzzy AHP in lubricant regenerative technology selection*, Expert Systems with Applications, 37/ 2010, p. 419- 425

⁵⁹⁶ B. Glumac, Q. Han, J. Smeets, and W. Schaefer (2011), *Brownfield redevelopment features: applying fuzzy Delphi*, Journal of European Real Estate Research, 4/2011, p.145- 159

⁵⁹⁷ A. P. Sanchez-Lezama, J. C. Arroyo and C. A. Hernandez, (2014), *Applying the fuzzy Delphi method for determining socio-ecological factors that influence adherence to mammography screening in rural areas of Mexico*, Methodological Issues, 30(2)/2014, p. 245-528

Below table compares traditional Delphi method and fuzzy Delphi method⁵⁹⁸. As can be seen, traditional fuzzy Delphi method has no specific strength over fuzzy Delphi method.

Method	Methodology	Weakness and Strength
Traditional Delphi Method	Experts give independent opinions; Data are analyzed statistically and are communicated to experts; Experts' reviews are analyzed and this process is repeated until convergence	<ul style="list-style-type: none"> • More time is needed to collate the expert opinion. • Higher cost • Survey questionnaire need to be administered repeatedly until consensus is reached. However, the survey recovery rate is low. • In the process of reaching consensus, researcher could risk misinterpret expert opinion.
Fuzzy Delphi Method	Experts give independent opinions; Subjective information are converted into objective data using fuzzy number; A fuzzy statistical analysis is done and are communicated to experts; Experts' reviews are analyzed and this process is repeated until outcome converges to a reasonable solution	<ul style="list-style-type: none"> • Survey time is reduced significantly. • Lower cost. • Reduces number of surveys, increases questionnaire recovery rate. • Experts can fully express their opinions, ensuring the completeness and consistency of the group opinion.

The FDM steps are as follows⁵⁹⁹:

1. Collecting opinions of decision group: find the evaluation score of each alternate indicator's significance given by each expert by using linguistic variables⁶⁰⁰ in questionnaires.
2. Setting up triangular fuzzy numbers⁶⁰¹: calculate the evaluation value of triangular fuzzy number of each alternate indicator given by experts, find out the

⁵⁹⁸ T. K. Roy and A. Garai (2012), *Institutional fuzzy Delphi method: more realistic and interactive forecasting tool*, Notes on Institutional Fuzzy Sets, 18(2)/2012, p. 37-50

⁵⁹⁹ Y. L. Hsu, C. H. Lee and V. B. Kreng (2010), *The application of fuzzy Delphi method and fuzzy AHP in lubricant regenerative technology selection*, Expert Systems with Applications, 37/ 2010, p. 419- 425

⁶⁰⁰ Linguistic variables are statements, based on opinions or preferences of experts, which can be used as recommendations when solving a problem; e.g. not important to very important.

⁶⁰¹ Among the various shapes of fuzzy number, triangular fuzzy number (TFN) is the most popular one. It is a fuzzy number represented with three points as follows: $A = (a_1, a_2, a_3)$

significance triangular fuzzy number of the alternate indicator. Importance of parameter i over parameter j according to the kth specialist:

$$\begin{aligned}
 a_{ij} &= (\alpha_{ij}, \delta_{ij}, \gamma_{ij}) \\
 \alpha_{ij} &= \min(\beta_{ijk}) \quad k=1,2,\dots,n \\
 \delta_{ij} &= \left(\prod_{k=1}^n \beta_{ijk} \right)^{1/n} \\
 \gamma_{ij} &= \max(\beta_{ijk}), \quad k=1,\dots,n
 \end{aligned} \tag{Eq. 1}$$

Where α_{ij}, γ_{ij} are the lowest and the highest importance value given by the answerers respectively, and δ_{ij} is the geometrical mean of the opinions. It is obvious that the Fuzzy components are defined so as $\alpha_{ij} \leq \delta_{ij} \leq \gamma_{ij}$.

The values of these components vary in $\{1/9, 9\}$. In this stage, the Fuzzy pairwise comparison matrix of different parameters is computed as below:

$$\tilde{A} = [\tilde{a}_{ij}]$$

Where

$$\tilde{a}_{ij} \times \tilde{a}_{ji} \approx 1 \quad \forall i, j = 1, 2, \dots, n$$

Or as follows:

$$\tilde{A} = \begin{bmatrix} (1,1,1) & (\alpha_{12}, \delta_{12}, \gamma_{12}) & (\alpha_{13}, \delta_{13}, \gamma_{13}) \\ (1/\gamma_{12}, 1/\delta_{12}, 1/\alpha_{12}) & (1,1,1) & (\alpha_{23}, \delta_{23}, \gamma_{23}) \\ (1/\gamma_{13}, 1/\delta_{13}, 1/\alpha_{13}) & (1/\gamma_{23}, 1/\delta_{23}, 1/\alpha_{23}) & (1,1,1) \end{bmatrix}$$

The relative weight of parameters is computed as follows:

$$\tilde{Z}_i = [\tilde{a}_{ij} \otimes \dots \otimes \tilde{a}_{in}]^{1/n} \tag{Eq. 2}$$

$$\tilde{W}_i = \tilde{Z}_i \otimes (\tilde{Z}_{i \oplus \dots \oplus n})^{-1} \tag{Eq. 3}$$

Where $\tilde{a}_1 \otimes \tilde{a}_2 = (a_1 \times a_2, \delta_1 \times \delta_2, \gamma_1 \times \gamma_2)$ and \tilde{W}_i is a linear vector showing the Fuzzy weight of ith parameter. In order to change the Fuzzy parameters into non-Fuzzy parameters, the geometric mean of Fuzzy parameters is computed and the weight of parameters is stated by a definite figure

$$W_i = \left(\prod_{j=1}^3 w_{ij} \right)^{1/3} \tag{Eq. 4}$$

5. Questionnaire for FDM

Following is the questionnaire distributed among 20 experts from different stakeholder groups of SIOM. They were requested to determine the relative importance of indicators in SIOM on a very low (1) to very high (9) scale.

Group	Indicator	Importance				
		Very Low	Low	Moderate	High	Very High
		1	3	5	7	9
Social	Access to primary sanitary facilities					
	Access to potable water					
	Access to electricity and other energy sources					
	Under-five mortality rate					
	Nutrition status of residents					
	Immunization against infectious childhood diseases					
	Net enrolment rate in primary education					
	Women net enrolment rate in high school					
	Adult illiteracy rate					
	Population growth rate					
	Emigration rate					
	Dependency rate					
	Telephone and internet users					
	Number of drug users					
Life expectancy						
Economic	Length of Roads					
	Length of Railway					
	Increase in family's income (per capita)					
	Farmers' income					
	Employment-population ratio					
	Share of women in wage direct employment in the mining sector					
	Ratio of annual electricity consumption in mining sector to total energy consumption in Khaf County					
Environmental	Water quality					
	Average depth of aquifers					
	Water consumption in Sangan mining complex					
	Wastewater production					
	Air quality					
	Solid waste production					
	Ratio of sanitary disposed solid waste to total solid waste produced					
	Protected areas					
	Endangered species					
Area of land assigned to mining activities						
Name:		Affiliation:			Date:	

6. Results of FDM

Conducting Fuzzy Delphi Method for selection of suitable sustainable development indicators to SIOM was a time-consuming procedure with numerous spread sheets. Hence, only main results of the calculations according to appendix 4 are presented here.

Indicators	Experts																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Access to primary sanitary facilities (APSF)	5	5	5	5	3	7	7	7	9	7	5	7	7	5	7	5	9	9	5	5
Access to potable water (APW)	5	5	5	7	5	7	9	7	9	5	5	5	5	5	9	3	7	9	1	5
Access to electricity and other energy sources (AE)	7	5	5	7	5	7	5	5	5	7	7	9	7	7	7	3	7	7	7	7
Under-five mortality rate (U5MR)	1	3	1	3	3	5	7	9	3	1	1	1	7	7	5	7	7	9	5	7
Nutrition status of residents (NSR)	5	7	5	5	3	5	7	7	7	7	5	7	7	5	7	7	7	9	7	7
Immunization against infectious childhood diseases (ICHD)	1	5	1	9	5	5	5	9	5	5	5	3	7	5	5	5	5	9	5	7
Net enrolment rate in primary education (NER)	9	5	9	7	7	3	7	9	5	9	5	9	9	5	5	5	7	9	5	7
Women net enrolment rate in high school (WNER)	9	3	9	7	7	5	7	7	7	7	1	9	9	3	5	7	7	9	3	5
Adult illiteracy rate (ALR)	1	7	1	5	5	3	7	7	5	3	1	3	9	3	7	7	5	7	3	7
Population growth rate (PGR)	5	5	5	9	7	5	5	9	5	5	3	5	5	5	3	7	7	5	7	3
Emigration rate (ER)	1	3	5	1	7	5	3	5	3	1	3	1	5	5	5	7	3	5	1	9
Dependency rate (DR)	3	7	1	7	7	3	5	5	5	7	5	3	5	7	3	7	9	7	5	7
Telephone and internet users (TEU)	7	7	3	7	3	7	3	7	3	7	7	7	7	7	5	9	9	5	7	9
Number of drug users (NDU)	9	7	7	3	3	7	7	9	7	5	3	7	7	5	7	5	5	3	7	3
Life expectancy (LE)	7	5	5	9	5	7	7	7	7	7	5	5	9	6	7	7	9	5	7	5
Length of roads (LRO)	9	5	9	7	3	9	5	8	5	5	9	9	7	3	5	5	7	5	7	7
Length of railway (LRW)	9	5	9	7	5	9	9	5	9	7	9	9	7	7	7	7	9	7	5	9
Increase in family's income (per capita) (IFI)	9	5	9	7	3	9	5	7	5	7	3	9	7	7	5	9	9	5	7	7
Farmers' income (FI)	5	3	5	5	3	1	7	5	7	3	1	5	7	7	3	7	7	3	1	7
Employment-population ratio (EPR)	9	7	9	5	3	7	5	7	3	5	5	9	5	7	5	7	9	5	5	7
Share of women in wage direct employment in the mining sector (WEM)	7	3	7	3	1	5	3	5	1	5	1	7	5	5	3	5	9	1	1	9
Ratio of annual electricity consumption in mining sector to total energy consumption in Khaf County (ECM)	9	9	9	5	3	9	5	7	3	7	9	9	5	9	7	7	7	5	9	7
Water quality (WQ)	5	3	5	7	3	9	9	7	9	1	3	5	5	5	7	7	7	7	5	7
Average depth of aquifers (DAQ)	9	7	9	5	7	7	7	9	7	1	5	9	5	9	5	9	5	7	3	7
Water consumption in Sangan mining complex (WCM)	9	7	9	9	7	9	7	7	7	7	7	9	7	9	7	9	7	7	9	7
Wastewater production (WWP)	9	7	9	5	5	9	5	7	5	7	1	9	5	7	7	7	7	3	7	3
Air quality (AQ)	7	9	7	5	3	5	7	9	7	5	1	7	9	9	7	9	5	5	1	9
Solid waste production (SWP)	9	3	9	7	5	5	7	7	5	7	1	9	5	7	7	7	5	5	7	7
Ratio of sanitary disposed solid waste to total solid waste produced (SDW)	9	5	9	5	3	7	5	9	5	9	3	9	9	3	7	7	7	5	3	3
Protected areas (PA)	5	7	5	9	5	1	9	3	9	9	5	5	7	7	3	7	7	7	3	3
Endangered species (ES)	7	7	7	1	1	3	9	7	7	5	9	7	7	7	3	5	5	7	9	3
Area of land assigned to mining activities (ASMA)	9	9	9	7	7	7	5	9	5	9	9	9	7	3	7	7	7	7	7	9

Rating of experts for each indicator

	APSF	APW	AE	USMR	NSR	ICHD	NER	WNER	ALR	PGR	ER	DR	TEU	NDU	LE	LRW	IFI	FI	EPR	WEM	ECM	WQ	DAQ	WCM	WWP	AQ	SWP	SDW	PA	ES	ASMA
APSF	1.00	1.00	1.00	1.67	0.71	1.00	1.00	1.67	0.71	1.00	1.67	0.71	0.71	0.71	1.00	1.00	1.00	1.67	0.71	1.67	0.56	1.67	0.71	0.71	0.71	1.67	1.00	0.71	0.71	0.56	
APW	1.00	1.00	1.00	1.67	0.71	1.00	1.00	1.67	0.71	1.00	1.67	0.71	0.71	0.71	1.00	1.00	1.00	1.67	0.71	1.67	0.56	1.67	0.71	0.71	0.71	1.67	1.00	0.71	0.71	0.56	
AE	1.00	1.00	1.00	1.67	0.71	1.00	1.00	1.67	0.71	1.00	1.67	0.71	0.71	0.71	1.00	1.00	1.00	1.67	0.71	1.67	0.56	1.67	0.71	0.71	0.71	1.67	1.00	0.71	0.71	0.56	
USMR	0.60	0.60	0.60	1.00	0.43	0.60	0.60	1.00	0.43	0.60	1.00	0.43	0.43	0.43	0.60	0.60	0.60	1.00	0.43	1.00	0.33	1.00	0.43	0.43	0.43	1.00	0.60	0.43	0.43	0.33	
NSR	1.40	1.40	1.40	2.33	1.00	1.40	1.40	2.33	1.00	1.40	2.33	1.00	1.00	1.00	1.40	1.40	1.40	2.33	1.00	2.33	0.78	2.33	1.00	1.00	1.00	2.33	1.40	1.00	1.00	0.78	
ICHD	1.00	1.00	1.00	1.67	0.71	1.00	1.00	1.67	0.71	1.00	1.67	0.71	0.71	0.71	1.00	1.00	1.00	1.67	0.71	1.67	0.56	1.67	0.71	0.71	0.71	1.67	1.00	0.71	0.71	0.56	
NER	1.00	1.00	1.00	1.67	0.71	1.00	1.00	1.67	0.71	1.00	1.67	0.71	0.71	0.71	1.00	1.00	1.00	1.67	0.71	1.67	0.56	1.67	0.71	0.71	0.71	1.67	1.00	0.71	0.71	0.56	
WNER	0.60	0.60	0.60	1.00	0.43	0.60	0.60	1.00	0.43	0.60	1.00	0.43	0.43	0.43	0.60	0.60	0.60	1.00	0.43	1.00	0.33	1.00	0.43	0.43	0.43	1.00	0.60	0.43	0.43	0.33	
ALR	1.40	1.40	1.40	2.33	1.00	1.40	1.40	2.33	1.00	1.40	2.33	1.00	1.00	1.00	1.40	1.40	1.40	2.33	1.00	2.33	0.78	2.33	1.00	1.00	1.00	2.33	1.40	1.00	1.00	0.78	
PGR	1.00	1.00	1.00	1.67	0.71	1.00	1.00	1.67	0.71	1.00	1.67	0.71	0.71	0.71	1.00	1.00	1.00	1.67	0.71	1.67	0.56	1.67	0.71	0.71	0.71	1.67	1.00	0.71	0.71	0.56	
ER	0.60	0.60	0.60	1.00	0.43	0.60	0.60	1.00	0.43	0.60	1.00	0.43	0.43	0.43	0.60	0.60	0.60	1.00	0.43	1.00	0.33	1.00	0.43	0.43	0.43	1.00	0.60	0.43	0.43	0.33	
DR	1.40	1.40	1.40	2.33	1.00	1.40	1.40	2.33	1.00	1.40	2.33	1.00	1.00	1.00	1.40	1.40	1.40	2.33	1.00	2.33	0.78	2.33	1.00	1.00	1.00	2.33	1.40	1.00	1.00	0.78	
TEU	1.40	1.40	1.40	2.33	1.00	1.40	1.40	2.33	1.00	1.40	2.33	1.00	1.00	1.00	1.40	1.40	1.40	2.33	1.00	2.33	0.78	2.33	1.00	1.00	1.00	2.33	1.40	1.00	1.00	0.78	
NDU	1.40	1.40	1.40	2.33	1.00	1.40	1.40	2.33	1.00	1.40	2.33	1.00	1.00	1.00	1.40	1.40	1.40	2.33	1.00	2.33	0.78	2.33	1.00	1.00	1.00	2.33	1.40	1.00	1.00	0.78	
LE	1.00	1.00	1.00	1.67	0.71	1.00	1.00	1.67	0.71	1.00	1.67	0.71	0.71	0.71	1.00	1.00	1.00	1.67	0.71	1.67	0.56	1.67	0.71	0.71	0.71	1.67	1.00	0.71	0.71	0.56	
LRO	1.00	1.00	1.00	1.67	0.71	1.00	1.00	1.67	0.71	1.00	1.67	0.71	0.71	0.71	1.00	1.00	1.00	1.67	0.71	1.67	0.56	1.67	0.71	0.71	0.71	1.67	1.00	0.71	0.71	0.56	
LRW	1.00	1.00	1.00	1.67	0.71	1.00	1.00	1.67	0.71	1.00	1.67	0.71	0.71	0.71	1.00	1.00	1.00	1.67	0.71	1.67	0.56	1.67	0.71	0.71	0.71	1.67	1.00	0.71	0.71	0.56	
IFI	1.00	1.00	1.00	1.67	0.71	1.00	1.00	1.67	0.71	1.00	1.67	0.71	0.71	0.71	1.00	1.00	1.00	1.67	0.71	1.67	0.56	1.67	0.71	0.71	0.71	1.67	1.00	0.71	0.71	0.56	
FI	0.60	0.60	0.60	1.00	0.43	0.60	0.60	1.00	0.43	0.60	1.00	0.43	0.43	0.43	0.60	0.60	0.60	1.00	0.43	1.00	0.33	1.00	0.43	0.43	0.43	1.00	0.60	0.43	0.43	0.33	
EPR	1.40	1.40	1.40	2.33	1.00	1.40	1.40	2.33	1.00	1.40	2.33	1.00	1.00	1.00	1.40	1.40	1.40	2.33	1.00	2.33	0.78	2.33	1.00	1.00	1.00	2.33	1.40	1.00	1.00	0.78	
WEM	0.60	0.60	0.60	1.00	0.43	0.60	0.60	1.00	0.43	0.60	1.00	0.43	0.43	0.43	0.60	0.60	0.60	1.00	0.43	1.00	0.33	1.00	0.43	0.43	0.43	1.00	0.60	0.43	0.43	0.33	
ECM	1.80	1.80	1.80	3.00	1.29	1.80	1.80	3.00	1.29	1.80	3.00	1.29	1.29	1.29	1.80	1.80	1.80	3.00	1.29	3.00	1.00	3.00	1.29	1.29	1.29	3.00	1.80	1.29	1.29	1.00	
WQ	0.60	0.60	0.60	1.00	0.43	0.60	0.60	1.00	0.43	0.60	1.00	0.43	0.43	0.43	0.60	0.60	0.60	1.00	0.43	1.00	0.33	1.00	0.43	0.43	0.43	1.00	0.60	0.43	0.43	0.33	
DAQ	1.40	1.40	1.40	2.33	1.00	1.40	1.40	2.33	1.00	1.40	2.33	1.00	1.00	1.00	1.40	1.40	1.40	2.33	1.00	2.33	0.78	2.33	1.00	1.00	1.00	2.33	1.40	1.00	1.00	0.78	
WCM	1.40	1.40	1.40	2.33	1.00	1.40	1.40	2.33	1.00	1.40	2.33	1.00	1.00	1.00	1.40	1.40	1.40	2.33	1.00	2.33	0.78	2.33	1.00	1.00	1.00	2.33	1.40	1.00	1.00	0.78	
WWP	1.40	1.40	1.40	2.33	1.00	1.40	1.40	2.33	1.00	1.40	2.33	1.00	1.00	1.00	1.40	1.40	1.40	2.33	1.00	2.33	0.78	2.33	1.00	1.00	1.00	2.33	1.40	1.00	1.00	0.78	
AQ	1.80	1.80	1.80	3.00	1.29	1.80	1.80	3.00	1.29	1.80	3.00	1.29	1.29	1.29	1.80	1.80	1.80	3.00	1.29	3.00	1.00	3.00	1.29	1.29	1.29	3.00	1.80	1.29	1.29	1.00	
SWP	0.60	0.60	0.60	1.00	0.43	0.60	0.60	1.00	0.43	0.60	1.00	0.43	0.43	0.43	0.60	0.60	0.60	1.00	0.43	1.00	0.33	1.00	0.43	0.43	0.43	1.00	0.60	0.43	0.43	0.33	
SDW	1.00	1.00	1.00	1.67	0.71	1.00	1.00	1.67	0.71	1.00	1.67	0.71	0.71	0.71	1.00	1.00	1.00	1.67	0.71	1.67	0.56	1.67	0.71	0.71	0.71	1.67	1.00	0.71	0.71	0.56	
PA	1.40	1.40	1.40	2.33	1.00	1.40	1.40	2.33	1.00	1.40	2.33	1.00	1.00	1.00	1.40	1.40	1.40	2.33	1.00	2.33	0.78	2.33	1.00	1.00	1.00	2.33	1.40	1.00	1.00	0.78	
ES	1.40	1.40	1.40	2.33	1.00	1.40	1.40	2.33	1.00	1.40	2.33	1.00	1.00	1.00	1.40	1.40	1.40	2.33	1.00	2.33	0.78	2.33	1.00	1.00	1.00	2.33	1.40	1.00	1.00	0.78	
ASMA	1.80	1.80	1.80	3.00	1.29	1.80	1.80	3.00	1.29	1.80	3.00	1.29	1.29	1.29	1.80	1.80	1.80	3.00	1.29	3.00	1.00	3.00	1.29	1.29	1.29	3.00	1.80	1.29	1.29	1.00	

The Fuzzy pair-wise comparison matrix according to the second expert's opinion (the same matrix is calculated for the other nineteen experts)

Indicators	Z		
Access to primary sanitary facilities	0.551195	1.117481	3.364915
Access to potable water	0.213001	1.009569	3.311196
Access to electricity and other energy sources	0.457357	1.146159	3.568672
Under-five mortality rate	0.146432	0.660922	2.372023
Nutrition status of residents	0.559921	1.146159	3.401354
Immunization against infectious childhood diseases	0.166231	0.874603	3.024428
Net enrolment rate in primary education	0.487016	1.215296	3.818884
Women net enrolment rate in high school	0.249612	1.056673	3.309513
Adult illiteracy rate	0.153518	0.747305	2.287636
Population growth rate	0.41025	1.009569	3.445136
Emigration rate	0.13496	0.584883	2.760806
Dependency rate	0.174318	0.915785	3.219411
Telephone and internet users	0.395402	1.107104	3.58359
Number of drug users	0.383174	1.013257	3.223859
Life expectancy	0.593157	1.196477	3.599055
Length of roads	0.469213	1.143584	4.016288
Length of railway	0.669863	1.367459	4.365484
Increase in family's income (per capita)	0.515331	1.189703	3.601778
Farmers` income	0.158417	0.725661	2.419092
Employment-population ratio	0.496361	1.103075	3.400912
Share of women in wage direct employment in the mining sector	0.146451	0.628393	2.384672
Ratio of annual electricity consumption in mining sector to total energy consumption in Khaf County	0.502816	1.240679	4.329115
Water quality	0.195616	0.979731	3.017555
Average depth of aquifers	0.200306	1.126115	3.584494
Water consumption in Sangam mining complex	0.808927	1.444384	4.460545
Wastewater production	0.238001	1.052614	3.355549
Air quality	0.20102	1.02171	3.214467
Solid waste production	0.257776	1.066362	3.338171
Ratio of sanitary disposed solid waste to total solid waste produced	0.39425	1.004253	3.127266
Protected areas	0.172822	0.9671	3.601309
Endangered species	0.179789	0.934913	3.947724
Area of land assigned to mining activities	0.513046	1.338663	4.412758

The fuzzy numbers of parameters

Indicators	Fuzzy weights		Non-Fuzzy weights		Rank
Access to primary sanitary facilities	0.049	0.034	0.031	0.037	10
Access to potable water	0.019	0.030	0.030	0.026	21
Access to electricity and other energy sources	0.041	0.035	0.033	0.036	11
Under-five mortality rate	0.013	0.020	0.022	0.018	30
Nutrition status of residents	0.050	0.035	0.031	0.038	8
Immunization against infectious childhood diseases	0.015	0.026	0.028	0.022	27
Net enrolment rate in primary education	0.044	0.037	0.035	0.038	6
Women net enrolment rate in high school	0.022	0.032	0.030	0.028	18
Adult illiteracy rate	0.014	0.023	0.021	0.019	29
Population growth rate	0.037	0.030	0.032	0.033	14
Emigration rate	0.012	0.018	0.025	0.018	32
Dependency rate	0.016	0.028	0.030	0.023	26
Telephone and internet users	0.035	0.033	0.033	0.034	13
Number of drug users	0.034	0.031	0.030	0.031	15
Life expectancy	0.053	0.036	0.033	0.040	5
Length of Roads	0.042	0.035	0.037	0.038	9
Length of Railway	0.060	0.041	0.040	0.046	2
Increase in family`s income (per capita)	0.046	0.036	0.033	0.038	7
Farmers` income	0.014	0.022	0.022	0.019	28
Employment-population ratio	0.044	0.033	0.031	0.036	12
Share of women in wage direct employment in the mining sector	0.013	0.019	0.022	0.018	31
Ratio of annual electricity consumption in mining sector to total energy consumption in Khaf County	0.045	0.037	0.040	0.041	4
Water quality	0.017	0.030	0.028	0.024	25
Average depth of aquifers	0.018	0.034	0.033	0.027	20
Water consumption in Sangan mining complex	0.072	0.044	0.041	0.051	1
Wastewater production	0.021	0.032	0.031	0.028	19
Air quality	0.018	0.031	0.030	0.025	23
Solid waste production	0.023	0.032	0.031	0.028	17
Ratio of sanitary disposed solid waste to total solid waste produced	0.035	0.030	0.029	0.031	16
Protected areas	0.015	0.029	0.033	0.025	24
Endangered species	0.016	0.028	0.036	0.025	22
Area of land assigned to mining activities	0.046	0.040	0.041	0.042	3

Fuzzy and non- fuzzy weights of parameters and the final rankings

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<http://www.lmoiran.ir/>

Website of Organization of the petroleum exporting countries (OPEC)

<http://www.opec.org/>

https://www.opec.org/opec_web/static_files_project/media/downloads/publications/ASB2014.pdf

Website of United Nations Convention to Combat Desertification

<http://www.unccd.int>

Website of United Nations Framework Convention on Climate Change

<http://www.unfccc.int/>

Website of Iranian Social Security Organization

<http://www.markazi.sso.ir/web/sso-en>

Website of Business Balls: ethical learning and development resource

<http://www.businessballs.com/>

www.businessballs.com/portersfiveforcesofcompetition.htm

Website of Green Party of Iran

<http://www.iran-e-sabz.org/>

Website of Civil Society in Iran

<http://www.arshsevom.net/>

Website of Sustainable Development Knowledge Platform

<https://sustainabledevelopment.un.org/>

<http://sustainabledevelopment.un.org/index.php?menu=200>

Website of Mashhad Municipal Development

https://amar.mashhad.ir/portal_content/16925-

[%D8%A7%D8%B7%D9%84%D8%A7%D8%B9%D8%A7%D8%AA-](https://amar.mashhad.ir/portal_content/16925-%D8%A7%D8%B7%D9%84%D8%A7%D8%B9%D8%A7%D8%AA-)

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[http://www.slideshare.net/moreonislam/islam-solution-to-climate-change-global-warming.](http://www.slideshare.net/moreonislam/islam-solution-to-climate-change-global-warming)

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ABSTRACT

The Sangan Iron Ore Mine (SIOM) is one of the largest iron ore mines in Iran and one of the Middle East's richest deposits. It contains a total geological resource of 1.2 billion tons of mostly magnetite with a Fe grade ranging from 27 to 61%. The deposit is located 300 km southeast from Mashhad, the capital of Khorasan-e-Razavi Province, and 18 km northeast of Sangan town, in Khaf County. Today SIOM is owned by the Iranian Mines and Mining Industries Development & Renovation Organization (IMIDRO). This estate owner organization intends to develop an open pit mine complex and supporting facilities and supervise development projects in SIOM for the final production of about 20 million tons per year including iron ore fine, lump, oxide concentrate and pellets in cooperation with private institutions to satisfy the growing demand of the Iranian steel industry.

This study presents a development strategy for SIOM to demonstrate possible measures that ensure economic growth, prosperity of neighbouring communities and the sustainability of environment.

To define the objectives of the research question, the history and current situation of Iranian mining and minerals industries with a special focus on SIOM was outlined. Additionally the implications of sustainable development were analysed on an international and national level. Sustainable development indicators were identified, and finally the advantages of sustainable mining were reviewed. To have a better idea of the case study, the status of sustainable development in SIOM was assessed with a special emphasis on social, economic, and environmental aspects. According to the results of this assessment, SIOM contributes to the development of the region by increasing the employment rate, improving the education status, decreasing the criminal activities and enhancing the transportation connections in the Khaf County.

To formulate realistic sustainable strategies, the principles of strategic planning and its tools were reviewed. Besides, the ranking of Iran in sustainable development indexes was presented. Moreover, the Iranian rules and regulation and Islamic thoughts were assessed to present the approaches that affect strategy planning in Iran. To ensure the sustainability of corporate governance, external and internal stakeholders were also identified and their expectations were considered in the

strategy planning process. Using the SWOT analysis, the strengths, weaknesses, opportunities and threats in SIOM were recognized, the related matrix was prepared, an internal-external analysis was done and then after the decision making stage the four high-ranked strategies were suggested for future development of SIOM.

Along with the research, two structured surveys were conducted among local stakeholders. The questionnaires comprised various aspects including health, education, job creation, transportation and environmental pollution. According to the results, local people were generally satisfied with the SIOM projects and its development; however they were concerned about environmental pollution and a lack of infrastructure. The results of the interviews have been anticipated as similar concerns of the stakeholder were recognized by the SWOT analysis. This shows the credibility of applied methodology in formulating sustainable strategies.

The Fuzzy Delphi Methodology (FDM) was utilized to choose the applicable indicators from social, economic and environmental pillars to SIOM. Then the indicators were calculated. The results of this section enable decision makers and strategy planners to act appropriately to secure the sustainable development of the SIOM mining area.

The outputs of the current study benefit not only Iran but also all countries that mainly or partly depend on the mining industry. Selecting the sustainable development indicators by FDM, tracking the progress of sustainable development realization quantitatively, identification of main stakeholders and their expectations, reviewing religious issues, legal rules and regulations and finally determining the backbones and drawbacks of the system by SWOT analysis are all measures that help to implement sustainable strategic management in SIOM and make this approach a role model for other countries - specially Islamic ones - to have comprehensive perspectives while deciding about resources exploitation.

ZUSAMMENFASSUNG

Der Sangan Iron Ores Bergwerkskomplex (SIOM) ist eine der größten Eisenerzminen Irans und wird außerdem als eine der reichsten Lagerstätten im Mittleren Osten angesehen. Das Gesamtvolumen der Lagerstätte beläuft sich auf 1,2 Milliarden Tonnen, wobei der förderungswürdige Eisenerzanteil des Magnetits zwischen 27 und 61% variiert. Die Minen befindet sich 300km südöstlich von Mashhad, der Hauptstadt der Khorasam-e-Razavi Provinz und 18km nordöstlich des Dorfes Sagan, im Khaf Bezirk. Der Bergwerkskomplex gehört der Iranian Mines and Mining Industries Development & Renovation Organization (IMIDRO). Für die finale Produktionsstufe plant der staatliche IMIDRO Konzern in Zusammenarbeit mit privaten Firmen einen Tagebau und die Produktion und Vermarktung von ca. 20 Millionen Tonnen an Feinerz, Stückerz, Eisenoxidkonzentrat und Pellets pro Jahr, um die steigende Nachfrage der Iranischen Stahlindustrie zu decken.

Die Fragestellung dieser Arbeit zielt darauf ab, eine nachhaltige Entwicklungsstrategie für den SIOM zu formulieren, um einerseits das Wirtschaftswachstum in der Region zu fördern und gleichzeitig einen Beitrag zur nachhaltigen Entwicklung der Umwelt zu leisten.

Zur Beantwortung der Fragestellung wird im ersten Teil der Arbeit die Geschichte und aktuellen Situation der iranischen Bergbauindustrie mit einem Fokus auf SIOM vorgestellt. Anschließend wird die Bedeutung einer nachhaltigen Entwicklung auf internationaler und nationaler Ebene beleuchtet, um anhand von Indikatoren zur nachhaltigen Entwicklung auf die Möglichkeiten eines nachhaltigen Bergbaus zuzuschließen.

Die Beurteilung des Status der nachhaltigen Entwicklung in SIOM erfolgte auf Grundlage von sozialen, ökonomischen und ökologischen Aspekten. Als Ergebnis dieser Beurteilung lässt sich festhalten, dass SIOM zu einer positiven Entwicklung im Khaf Bezirk beigetragen hat. Herausragende Beispiele dieser Entwicklung sind unter anderen die Steigerung der Beschäftigungsquote, eine grundlegende Verbesserung des Bildungsniveaus, ein Rückgang der Kriminalität sowie ein starker Ausbau der Verkehrsinfrastruktur.

Bei der Formulierung einer realistischen Nachhaltigkeitsstrategie wurden die Prinzipien der strategischen Planung herangezogen sowie die Platzierung Irans in unterschiedlichen internationalen Indexen zur nachhaltigen Entwicklung. Darüber hinaus wurden Iranische Gesetze und Verordnungen sowie Islamische Glaubensgrundsätze ausgewertet, um einen Anhaltspunkt dafür zu bekommen welche Faktoren strategische Planung im Iran beeinflussen könnten. Im Zuge der vorliegende Arbeit wurden intern und externe Stakeholder in der Region identifiziert, so dass deren Interessen während des strategischen Planungsprozesses berücksichtigt werden konnten. Mit Hilfe einer SWOT Analyse wurden die Stärken, Schwächen, Chancen und Bedrohungen der SIOM identifiziert und mit Hilfe einer Matrix

dargestellt. Dazu wurden eine Umwelt- und Unternehmensanalyse (Internal&External analysis) durchgeführt, um anhand der Ergebnisse die vier wichtigsten Punkte eine zukunftsfähigen nachhaltige Entwicklungsstrategie für SIOM zu identifizieren.

Im Zuge der Forschungen wurden zwei Befragungen der lokalen Stakeholder durchgeführt, der dabei verwendete Fragebogen umfasste folgende Aspekte: Gesundheit, Bildung, Schaffung von Arbeitsplätzen, Verkehrsinfrastruktur und Umweltbelastung. Die Auswertung ergab, dass die lokale Bevölkerung generell zufrieden mit der Entwicklung des SIOM Projektes ist, jedoch Bedenken bezüglich der verursachten Umweltbelastung sowie nicht vollendeter Infrastrukturprojekte bestehen. Diese Ergebnisse wurden bereits mit der SWOT Analyse antizipiert, was die Zuverlässigkeit der angewandten Methode zur Formulierung einer Nachhaltigkeitsstrategie unterstreicht.

Die Fuzzy Delphi Methodology (FDM) wurde verwendet, um soziale, ökonomische und ökologische Indikatoren auszuwählen und zu berechnen, die auf die SIOM angewandt werden können. Die Ergebnisse dieser Analyse ermöglichen den Verantwortlichen und Entscheidungsträgern in der SIOM Bergbauregion eine nachhaltige Entwicklung zu gewährleisten.

Insgesamt leisten die Forschungsergebnisse dieser wissenschaftlichen Arbeit nicht nur einen Beitrag zur Verbesserung der Situation im Iran, sondern können auch auf andere Länder, die ganz oder zum Teil, vom Bergbau abhängig sind, angewandt werden. Die Ergebnisse zeigen auch, dass zur Implementierung einer nachhaltigen Entwicklungsstrategie in einer Region eine Kombination der FDM mit der SWOT Analyse sehr effektiv sein kann. Zunächst sollte anhand der FDM eine Auswahl der Indikatoren für eine nachhaltige Entwicklung getroffen werden, welche dann im Anschluss mit der SWOT Analyse auf Ihre Stärken, Schwächen, Chancen und Bedrohungen hin untersucht werden können.

Der in dieser Arbeit beschriebene Ansatz zeigt die Möglichkeiten des nachhaltigen strategischen Managements auf und kann als ein Vorbild für andere – insbesondere Islamisch geprägte – Länder dienen, um einen nachhaltigen Ressourcengewinnung von der Planung eines Bergwerkes bis hin zu seiner Schließung zu gestalten.