Bulgarian Chemical Communications, Volume 47, Special Issue D (pp.274- 287) 2015

Development of environmental management strategies for thermal power plant wastes in Iran through strategic analysis method (SWOT)

R. Samadi[1], J. Nouri*[1], A.R. Karbassi[2], R. Arjomandi[1]

[1] *Department of Environmental Management, Science and Research Branch, Islamic Azad University, Tehran, Iran*
[2] *Graduate Faculty of Environment, University of Tehran, Tehran, Iran*

Received June 26, 2015, Revised September 10, 2015

Thermal power plant is one of the most important and fundamental industries in Iran that provides required power for industry, household and commercial sectors through consuming different kinds of fossil fuels. During the process of generating electricity, power plants emission different kinds of environmental pollutants which one of them is solid waste. Generally power plant wastes can be divided into three categories of ordinary, industrial and hazardous waste. The goal of this research is finding suitable strategies with Iran's conditions in order to plant's waste management. Different methods such as library, website of the electrical industry and power plants and completing questionnaire have been used in this paper to collect data and interviewing with chemistry and environmental experts have been also done. For determining power plants' waste management strategies, SWOT has been used. So that using subject's literature in managing plants' waste and questionnaire survey which is done by 40 experts, strengths, weakness, opportunities and threats are extracted and related strategies are determined. Considering environmental situation of country's power plants, establishing an appropriate management system for organizing industrial waste and preventing environmental pollution seem necessary. One of the most important functional strategies for Iran's electricity industry is planning integrated solid waste management and also programming in order to building power plants with high efficiency using natural gas fuel.

Key words: solid waste, management strategy, SWOT, thermal power plant, environmental pollution

INTRODUCTION

Electricity industry as a fundamental and main industry is considered as the most important required infrastructures for developing economical activities. Many power plants are working in the process of generating electrical energy, one of these plants which are used in our country and other ones that have cheap fossil resources is thermal power plant. Fossil fuels are considered as the most important sources of plants' fuel production in order to generating electrical energy which under the influence of combustion publish different kinds of pollutants and dangerous industrial waste [6-8].

In our country Iran also about 90% of whole generated electricity (263 billion kWh in 2013) is provided by different kinds of thermal power plants (steam, gas and combined cycle) [2,3]. Power generation process and combustion of different kinds of fossil fuels in plants units cause producing and publishinga variety pollution of air, water and even sound to the environemnt which has been always paid attention by environmental and energy experts and even general public [4,9].

The subject which is less paid attention among these is producing solid and semi-solid waste which is produced directly or indirectly as the result of combustion, water supply system and wastewater treatment plant. Quality and quantity of solid wastes depend on various factors such as the kind of power plant and the kind of consuming fuel [10].

Steam thermal power plants, considering the kind of consuming fuel (mainly oil furnace) and the process of generating electricity, have the most amount of producing solid wastes [11,12]. Then there are combined cycle power plantsthat considering gasoline consumption or natural gas and having higher efficency, produce less and low risk wastes. Finally, gas power plants with natural gas consumption and less share of these power plants in country's electricity production don't have considerable environmental problems in solid wastes' production point of view.

Plants' wastes include sludge, ash and health & administrative trashes. There has been administrative trash in all power plants and most of the time there are recyclable, the other wastes of industrial processes such as wastewater treatment, often are delivered to contractors. Reusing plants' wastes in industries which are close to these plants will reduce pollutents' publishing to environment as well as minimizing the volume of waste [13-15].

Hazardous wastes of power plants considering hazardous waste management regulations EPA and definition of hazardous waste are:

- Sludge from waste water treatment of washings outer surfaces of the boiler and air pre-heaters

To whom all correspondence should be sent.

E-mail: nourijafar@gmail.com

- Sludge from waste water treatment of chemical washing of boiler
- A variety of waste and ash into the furnace and combustion chamber

These wastes' being dangerous is because of high concentrations of heavy metals and the possibility of their leakage, cf. Saeidi et al. [1].

Non-hazardous waste of power plants are also:

- Clarifiers' sludge and sediments and dehydrated wastes of these sludges
- Human waste and human waste sludge.

Organizations and institutes which have to compete and try for survival in highly turbulent, non-stable and developing environments, face with two main management approchas for dealing effective environmental events and factors. One is school of adaptation depiction which has reactive and requirements attitude with these developments and the other is the school of pre-contraption which prescribes an active attitude with environmental factors.

Strategic analysis method (SWOT) is used as the recommendation of pre-contraption school and for identifying and codification optimal strategies for organizations that its result is 4 categories of strategy: opportunity-strengths, opportunity-weakness, threat-strengths and threat-weakness.

In these schools, strategy means decision making process, which during that, organization's internal factors (weaknesses and strengths) are related with external factors (opportunities and threats) in a way that the value of each one is clarified well in realizing organization's goals.

Investigating SWOT matrix is considered as effective factor in advancing the goals of an organization. Providing existing weaknesses and strengths in organization as internal factors and opportunities and threats as external factors helps determining chosen strategy in order to achieving an organization's goals in competitive environment and general attitude toward this issue in different conditions can play an important role in an organization's success in various conditions [5].

MATERIALS AND METHODS

As first phase, general situation of 68 existing thermal power plant in the country and environmental conditions of them were investigated through library studies and interviewing environmental correspondent expert of power plants. In Table 1 some technical information and the amount of consuming fuel in plants affiliated to the power ministry are proposed to separation of a variety of thermal power plants for 2013 [2].

Then we interviewed some experts of electricity industry in environmental issues and based on that SWOT matrix questionnaire was designed for effective internal factor evaluation (IFE) and external factor evaluation (EFE) inenvironmental management of power plant's waste and was sent for 40 related experts (statistic population) for poll. Internal factors must include existing strengths and weakness in country's thermal power plant waste management. Providing this matrix includes below phases:

1- First strengths and then weaknesses are written.

2- These factors are given coefficient. From one (very unimportant) to five (very important) given coefficient represent the relative importance of each factor in success. Regardless of whether the mentioned factor is considered as internal strengths and weakness, the factor which has had the highest effect in performance, is given the highest coefficient.

Then each one of these factors is given scores from 1 to 4. Score 1 represents the lack of strengths or weakness, score 2 represents usual strengths or weakness, score 3 shows high strengths and weakness and score 4 shows very high strengths or weaknesses of mentioned factor. Scores are based on status of area and coefficients (which are given in second phase) and the kind of activity.

Table 1: Information of thermal power plants affiliated to the ministry of Energy in 2013.

Type of Power plant	Number of Power plant	Nominal capacity (MW)	Annual production (Million KWH)	The average efficiency (Percentage)	Fuel Consumption		
					Furnace Oil Million) (liters	Gas oil Million) (liters	Natural Gas (MCM)
Steam	19	14951	87205	37	15308	261	7119
Gas	34	11860	35412	30	-	377	8054
Combined Cycle	15	15913	83986	45	-	5262	13315

3- For determining final score of each factor, each factor's coefficient is multiplied in its score.

4- The sum of final scores of each factor is calculated and the final score is determined.

All phases are true for external factors' matrix as well. In this matrix just instead of strengths and weakness (internal factors), external factors mean threats and opportunities of expanding and developing country's thermal power plant wastes are listed.

Following that obtained results of analyzing SWOT questionnaire which are gathered using the ideas of 31 experts are proposed in results section.

SWOT analysis has been used for identifying and investigating effective internal factors (strengths and weaknesses) and area's effective external factors (opportunities and threats) for investigating effective factors on creating wastes in Iran's thermal power plants. In fact this method is used as a tool for identifying strategic problems and proposing appropriate functions and strategies. First using region's internal and external environment, strengths, weaknesses, opportunities and threats are identified and a list of them is provided and then with asking experts for their ideas and weighting, calculating and analyzing each one of these problems, priorities are clarified and for removing or minimizing weaknesses and threats and improving strengths and existing opportunities in plants' wastes in Iran, appropriate strategies are proposed.

Considering SWOT matrix outputs, another questionnaire named" quantitative strategic planning matrix (QSPM) was designed in order to determining appropriate strategies for environmental management of plants' wastes and was surveyed. Using quantitative strategic planning matrix (QSPM) designed strategies are optimized prioritized and finally the best and most attractive ones are chosen for organization. QSPM is used for evaluating possibility and stability of proposed strategies in facing environmental conditions and current situation of organization. In this evaluation if one strategy cannot face inside or outside conditions of organization, must be removed from the list of prioritized strategies.

RESULTS AND FINDINGS

SWOT analysis is considered as an important part in process of strategy formation. Analyzing external opportunities and threats is mainly used for investigating this problem that if organization can use opportunities and minimize threats and this analysis also is important for analyzing weaknesses for investigating company's internal performance is very important. The quantitative analysis method of SWOT provides more detailed data for SWOT analysis. Data analysis is also done through obtained results of internal factors evaluation matrix and external factors evaluation matrix and SWOT matrix.

The goal of analytical method is determining strengths, weaknesses, opportunities and threats in environment. For determining basic information and providing required matrixes for SWOT analysis, questionnaire is used in this research and matrix evaluation of external factors, internal factors analysis, opportunities, threats, strengths and weaknesses' matrix and quantitative strategy planning matrix (QSPM) country's thermal power plant wastes environmental management are provided.

The obtained results of analyzing experts' ideas and completed questionnaires by them are proposed for identifying strengths in Table 2, weaknesses in Table 3, opportunities in Table 4 and threats in Table 5.

For proposing strategies and policies in order to investigating effective factors on creation of waste in Iran's thermal power plant, identifying quartet factors are unavoidable case for removing weaknesses and threats and improving strengths and opportunities. In fact it has been tried to investigate these factors with questionnaire as main advantages and limitations in Iran's power plants for prioritizing options from experts' point of view to be able to quantitative result and obtain more logic and fundamental results. There for considering experts' ideas and performed calculations on these ideas for prioritizing them, below tables were provided that the mean of given weights and the average rank of each of the strengths, weaknesses, opportunities and threats from experts' attitude are shown in tables 6, 7, 8 and 9 respectively.

Then factors which weighted less than 20% were removed from the rest of studies. These factors which are highlighted with gray color are: S4, S5, W7, O5, T6, and T7. So based on summing of obtained results from experts' ideas and prioritizing internal factors including strength and weakness and external factors including opportunity and threat, SWOT matrix based on obtained priorities in each one of. internal or external factors that are effective in thermal power plants of Iran will be according to Figure 1.

PROVIDING SWOT MATRIX

After evaluating internal or external factors which is called input phase, required data for developing strategies are clarified. In second phase

Table 2: IEF matrix- strengths

Row	Factor	Importance degrees(weight) of factor					Weight calculation				Current actual factor points				Calculate the points				Overall points (Weight * points)	
	(Strengths)	Very unim-portant	Unim-portant	Moderate importance	Important	Very Important	Count	Sum	Average	Weighted average	Not strength	Normal strength	High strength	Very high strength	Count	Sum	Average	Weighted average	Coefficient	Weighted points
		1	2	3	4	5					1	2	3	4						
1	The ability of using natural gas in most thermal power plant of country	0	1	7	13	10	31	125	4.03	0.76	1	10	15	5	31	86	2.77	0.40	11.19	0.68
2	Existing strong internal experts	0	6	11	8	6	31	107	3.45	0.32	1	12	13	5	31	84	2.71	0.00	9.35	0.18
3	Existing vast areas for waste management projects	3	8	7	11	2	31	94	3.03	0.00	1	10	12	8	31	89	2.87	1.00	8.71	0.00
4	Existing vast resources for waste management(there are history)	0	4	9	10	9	31	120	3.87	0.63	1	11	12	7	31	87	2.81	0.60	10.86	0.59
5	Existing environmental rules and standards	0	0	5	10	16	31	135	4.35	1.00	0	10	16	5	31	88	2.84	0.80	12.36	1.00

Table 3: IEF matrix- weaknesses

Row	Factor	Importance degrees(weight) of factor					Weight calculation				Current actual factor points				Calculate the points				Overall points (Weight * points)	
	(Weaknesses)	Very unim-portant	Unim-portant	Moderate importance	Important	Very Important	Count	Sum	Average	Weighted average	Not strength	Normal strength	High strength	Very high strength	Count	Sum	Average	Weighted average	Coefficient	Weighted points
		1	2	3	4	5					1	2	3	4						
1	The low quality of fuel	2	3	10	11	5	31	107	3.45	0.54	3	8	13	7	31	86	2.77	0.59	9.58	0.52
2	Lack of natural gas, especially in winter	0	4	9	11	7	31	114	3.68	0.71	0	8	13	10	31	95	3.06	1.00	11.27	0.80
3	The low efficiency of the power industry	1	3	9	11	7	31	113	3.65	0.68	0	11	14	6	31	88	2.84	0.68	10.35	0.65
4	Low water quality in some areas of the country	6	7	9	7	2	31	85	2.74	0.00	4	14	11	2	31	73	2.35	0.00	6.46	0.00
5	Lack of awareness and attention of executives to environmental issues of power industry	0	1	6	14	10	31	126	4.06	1.00	0	7	15	9	31	95	3.06	1.00	12.46	1.00
6	Lack of sufficient resources in the environmental	0	0	3	13	13	31	126	4.06	1.00	2	6	11	10	31	87	2.81	0.64	11.41	0.83
7	Lack of appropriate infrastructure for waste plant management	1	2	9	11	6	31	106	3.42	0.51	0	12	11	6	31	81	2.61	0.36	8.93	0.41

Table 4: EFE matrix- opportunities

Row	Factor	Importance degrees(weight) of factor					Weight calculation				Current actual factor points				Calculate the points				Overall points (Weight * points)	
	((Opportunities))	Very unim-portant	Unim-portant	Moderate importance	Important	Very Important	Count	Sum	Average	Weighted average	Not strength	Normal strength	High strength	Very high strength	Count	Sum	Average	Weighted average	Coefficient	Weighted points
		1	2	3	4	5					1	2	3	4						
1	The strategic location of the country	10	10	5	5	1	31	70	2.26	0.00	9	14	7	1	31	62	2.00	0.00	4.52	0.00
2	The beginning privatization of the electricity industry (Delegating power plants to the private sector)	0	2	9	13	7	31	118	3.81	0.80	0	10	14	7	31	90	2.90	0.68	11.05	0.69
3	The low cost of energy in the country	1	4	8	13	5	31	110	3.55	0.67	10	9	9	3	31	67	2.16	0.12	7.67	0.33
4	Existing huge reserves of natural gas in the country	0	0	7	13	11	31	128	4.13	0.97	0	8	12	11	31	96	3.10	0.83	12.79	0.88
5	The importance and necessity of environmental issues in national and international communities	0	2	3	13	13	31	130	4.19	1.00	0	5	11	15	31	103	3.32	1.00	13.93	1.00

Table 5: EFE matrix- threats

Row	Factor	Importance degrees(weight) of factor					Weight calculation				Current actual factor points				Calculate the points				Overall points (Weight * points)	
	((Threats)	Very unim-portant	Unim-portant	Moderate importance	Important	Very Important	Count	Sum	Average	Weighted average	Not strength	Normal strength	High strength	Very high strength	Count	Sum	Average	Weighted average	Coefficient	Weighted points
		1	2	3	4	5					1	2	3	4						
1	Government structure in the power industry	0	0	7	14	10	31	127	4.10	1.00	0	6	13	12	31	99	3.19	1.00	13.08	1.00
2	Lack of access to innovative technologies and advanced of power generation and power Plant	0	3	11	10	7	31	114	3.68	0.68	4	14	11	2	31	73	2.35	0.00	8.66	0.32
3	The impossibility of import high-quality fuel	7	6	9	5	4	31	86	2.77	0.00	6	10	13	2	31	73	2.35	0.00	6.53	0.00
4	Iran is one the arid and dry country	3	8	9	8	3	31	93	3.00	0.17	3	11	13	3	31	76	2.45	0.12	7.35	0.13
5	The lack of prioritize in environmental issues	0	2	5	14	10	31	125	4.03	0.95	0	8	12	11	31	96	3.10	0.88	12.49	0.91
6	Low electricity costs (Not being real price of electricity)	0	5	12	9	5	31	107	3.45	0.51	2	11	12	6	31	84	2.71	0.42	9.35	0.43
7	weakness of administrative in the Environmental Protection Agency	0	3	5	12	9	31	114	3.68	0.68	4	4	15	8	31	89	2.87	0.62	10.56	0.61

Table 6: Effective internal factors on waste management in country's thermal power plant – **Strengths**

Row	(Strengths)	Weighted Points	Priority
5	Existing environmental rules and standards	**1.00**	1
1	The ability of using natural gas in most thermal power plant of country	**0.68**	2
4	Existing vast resources for waste management(there are history)	**0.59**	3
2	Existing strong internal experts	**0.18**	4
3	Existing vast areas for waste management projects	**0.00**	5

Table 7: Effective internal factors on waste management in country's thermal power plant – **Weaknesses**

Row	(weaknesses)	Weighted Points	Priority
5	Lack of awareness and attention of executives to environmental issues of power industry	1.00	1
6	Lack of sufficient resources in the environmental	0.83	2
2	Lack of natural gas, especially in winter	0.80	3
3	The low efficiency of the power industry	0.65	4
1	The low quality of fuel	0.52	5
7	Lack of appropriate infrastructure for waste plant management	0.41	6
4	Low water quality in some areas of the country	0.00	7

Table 8: Effective external factors on waste management in country's thermal power plant – **Opportunities**

Row	(Opportunities)	Weighted Points	Priority
5	The importance and necessity of environmental issues in national and international communities	**1.00**	**1**
1	Existing huge reserves of natural gas in the country	**0.88**	**2**
2	The beginning privatization of the electricity industry (Delegating power plants to the private sector)	**0.69**	**3**
3	The low cost of energy in the country	**0.33**	**4**
4	The strategic location of the country	**0.00**	**5**

Table 9: Effective external factors on waste management in country's thermal power plant –**Threats**

Row	(Threats)	Weighted Points	Priority
7	Government structure in the power industry	**1.00**	**1**
1	The lack of prioritize in environmental issues	**0.91**	**2**
2	weakness of administrative in the Environmental Protection Agency	**0.61**	**3**
3	Low electricity costs (Not being real price of electricity)	**0.43**	**4**
4	Lack of access to innovative technologies and advanced of power generation and power Plant	**0.32**	**5**
5	Iran is one the arid and dry country	**0.13**	**6**
6	The impossibility of import high-quality fuel	**0.00**	**7**

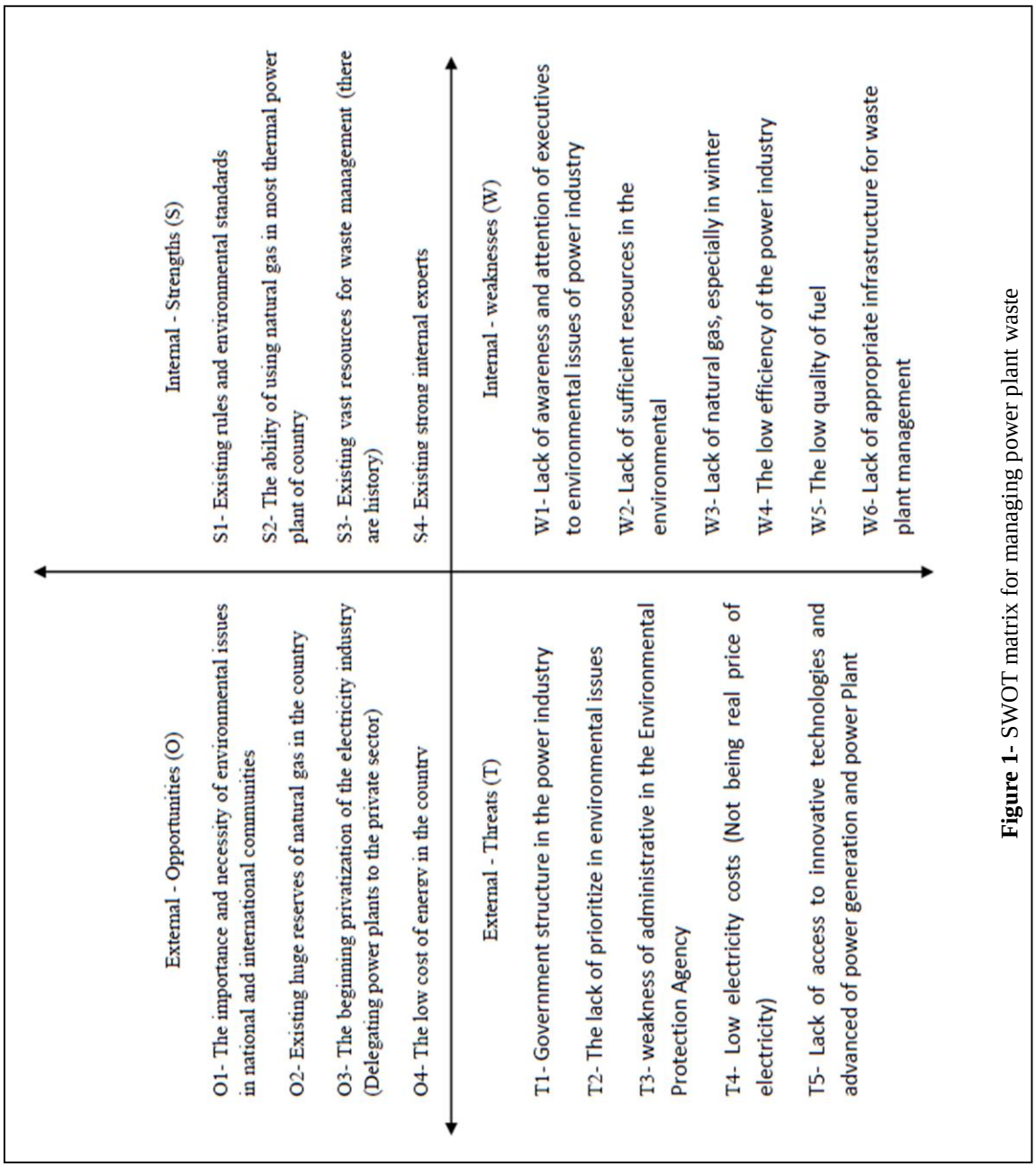

Figure 1- SWOT matrix for managing power plant waste

which is comparison one, variety of possible strategies are, paid attention through providing SWOT matrix. In SWOT matrix a kind of balance is established between main internal and external factors. Strategists can propose four strategies using this matrix: strategies SO, strategies WO, strategies ST and strategies WT.

In performing strategies SO using internal strengths, it is tried to take advantage of external opportunities. The goal of strategies WO is that with exploitation of existing opportunities in outdoor, internal weaknesses can be improved. In performing strategies ST, using its strengths minimize the effects of existing threats outdoor or remove them. Performing strategies WT is in defensive mode and its goal is minimizing internal weaknesses and avoiding threats of outdoor. The obtained result of experts' survey for determining power plant waste management in the country is proposed in table 10.

QUANTITATIVE STRATEGIC PLANNING MATRIX (QSPM)

In next phase, using quantitative strategic planning matrix (QSPM) designed strategies are optimized prioritized and finally choosing the best and most attractive ones are for thermal power plants of Iran. Choosing appropriate strategy is a comprehensive and broad subject because strategy has complex and different aspects that being familiar with that is required to have service and economic development. QSPM is used for prioritizing strategies. If in this evaluation a strategy isn't able to face internal or external conditions of thermal power plant must be removed from the list of prioritized strategies. According to obtained strategies from SWOT which is shown in table 11, QSPM is used for evaluating strategic items and relative attractiveness of used strategies in decision making phase. This method decides that which one of these items is possible to prioritize them. Of course this method requires good judgment and expertise combined with knowledge which is appropriate for evaluating the possibility and stability of proposed strategies in facing environmental situations and current condition of organization.

Proposed coefficient in second column of table 12 is provided based on weighting the coefficients of matrixes IFE and EFE. Scores are given as no attractiveness (1), somewhat attractive (2), reasonable attractiveness (3) and very attractive (4) for determining the score of attractiveness with investigating internal and external factors of this question that if this factor has an important role in the process of choosing or selecting strategies then score of attractiveness in each factor compared to each of the strategies is determined and the sum of scores is obtained for each strategy from multiplying coefficient in Score of attractiveness. The way of scoring to 15 strategies by one of experts which is close to statistical population and related calculations are proposed in Table 12.

Table 10- SWOT matrix strategies

SWOT	Strengths **(S)** S1, S2, S3	Weaknesses **(W)** W1, W2, W3, W4, W5, W6
Opportunities **(O)** O1 O2 O3 O4	* Planning for using natural gas as a clean fuel in thermal power plants * Develop operating procedures to build power plants with high efficiency and compliance with environmental standards (Prohibition of creating low-efficiency and pollutants power plants) * Developing a comprehensive program of environmental management of waste	* Planning power exchange with neighboring countries for peak shaving * Allocation of identified and approved funds to environmental activities * Planning to develop the country's gas refineries and solve its shortage * Use of international opportunities and facilities for environmental education the personnel of power industry
Threats **(T)** T1 T2 T3 T4 T5	* planning in order to accelerate the privatization * Implementation of environmental awareness and sensitization at various levels of expertise and managers * Planning for using new and clean technologies of power generation in the country	• * Creating and strengthening environmental sector in power plants and electricity industry • * Specialized environmental training at various levels of electricity industry • * Realize price of electricity by considering the social costs • * Planning and policy for the development of international relations in power plant industry • * Doing applied research on high-efficiency and clean fuels production

Table 11: obtained strategies of SWOT method

Strategy No.	Strategy name	Strategy title
1	**SO1**	Planning for using natural gas as a clean fuel in thermal power plants
2	**SO2**	Develop operating procedures to build power plants with high efficiency and compliance with environmental standards
3	**SO3**	Developing a comprehensive program of environmental management of waste
4	**ST1**	planning in order to accelerate the privatization
5	**ST2**	Implementation of environmental awareness and sensitization at various levels of expertise and managers
6	**ST3**	Planning for using new and clean technologies of power generation in the country
7	**WO1**	Planning power exchange with neighboring countries for peak shaving
8	**WO2**	Allocation of identified and approved funds to environmental activities
9	**WO3**	Planning to develop the country's gas refineries and solve its shortage
10	**WO4**	Use of international opportunities and facilities for environmental education the personnel of power industry
11	**WT1**	Creating and strengthening environmental sector in power plants and electricity industry
12	**WT2**	Specialized environmental training at various levels of electricity industry
13	**WT3**	Realize price of electricity by considering the social costs
14	**WT4**	• Planning and policymaking for the development of international relations in power plant industry
15	**WT5**	Doing applied research on high-efficiency and clean fuels production

Table 12: the sample matrix of QSPM (the way of scoring strategies)

Determining factors		Coefficient	Strategy SO1		Strategy SO2		Strategy SO3		Strategy ST1		Strategy ST2	
			Point	Attraction	Point	Attraction	Point	Attraction	Point	Attraction	Point	Attraction
Strengths	S1	6.2	2	12.4	4	24.8	3	18.6	3	18.6	3	18.6
	S2	5.7	4	22.8	3	17.1	1	5.7	1	5.7	1	5.7
	S3	5.5	1	5.5	2	11	4	22	2	11	2	11
weaknesses	W1	6.3	2	12.6	3	18.9	3	18.9	1	6.3	2	12.6
	W2	5.8	3	17.4	2	11.6	4	23.2	2	11.6	4	23.2
	W3	5.7	4	22.8	3	17.1	2	11.4	1	5.7	1	5.7
	W4	4.8	3	14.4	4	19.2	4	19.2	2	9.6	1	4.8
	W5	5.2	4	20.8	2	10.4	3	15.6	1	5.2	1	5.2
	W6	4.5	4	18	2	9	4	18	3	13.5	3	13.5
Opportunities	O1	7.0	2	14	3	21	3	21	2	14	3	28
	O2	6.4	4	25.6	4	25.6	3	19.2	1	6.4	1	6.4
	O3	5.6	2	11.2	4	22.4	3	16.8	3	22.4	2	11.2
	O4	3.9	3	11.7	3	11.7	2	7.8	1	3.9	1	3.9
Threats	T1	6.6	2	13.2	3	19.8	3	19.8	4	26.4	2	13.2
	T2	6.3	2	12.6	3	18.9	4	25.2	2	12.6	4	25.2
	T3	5.4	3	16.2	3	16.2	3	16.2	2	10.8	2	10.8
	T4	4.7	3	14.1	2	9.4	2	9.4	1	4.7	1	4.7
	T5	4.4	2	8.8	4	17.6	2	8.8	2	8.8	1	4.4
	total	100		274.1		301.7		296.8		197.2		208.1

DISCUSSION AND CONCLUSION

Generally solid waste management includes phases of reduction in source, collecting, storing in place, process, recycle and reusing, transportation, excretion and care after excretion. Methods of solid waste management considering the regulation of wastes' management divided into three categories of hazardous, industrial and normal.

Based on mentioned information, the most important solid and semi-solid waste of power plants can be divided into four main categories:

- wastes associated with combustion
- wastes associated with circulation system and water treatment
- wastes associated with human waste
- wastes of sludge from sanitary wastewater treatment

The third and fourth categories have been known in terms of nature, quantity and quality and there are the methods of their management and excretion in country. Especially human waste of power plants that their trustee are municipals of power plants' nearby cities. The wastes of first and second categories have had heavy and poisonous metals and are considered as hazardous industrial wastes and require its special management (DOE, 2011). Generally speaking, solid waste management includes phases of reduction in source, collecting, storing in place, process, recycle and reusing, transportation, excretion and care after excretion.

Strategies of waste management in country's thermal power plant after analyzing internal and external environment of power plants and obtained results of using SWOT method attractiveness scores were determined as it is shown in table 13. For calculating final attractiveness of strategies the fifteen, obtained attractiveness for each strategy has been averaged in 31 completed questionnaires.

Final prioritizing of these strategies which is has been done based on experts' ideas and using QSPM matrix is proposed in table 13. Then strategies' scores were taken to diagram and four strategies of WT5, WT4, WT3 and WO4 were eliminated from proposed strategies because of having fewer score than other strategies.

In the end, it is concluded that based on electricity industry's experts' ideas, planning in order to establishing power plants with high efficiency, using low polluting fuels such as natural gas, integrated solid waste management program with the operating instructions and also strengthening the body of expertise the section of power plant environment in terms of technical and financial are the most important and effective factors in improving power plants' environmental management.

Table 13: Waste management strategies in thermal power plant in order of preference (attractiveness)

Priority	Strategy	Strategy title	Attraction
1	**SO2**	Develop operating procedures to build power plants with high efficiency and compliance with environmental standards	**301.3**
2	**SO3**	Developing a comprehensive program of environmental management of waste	**295.6**
3	**SO1**	Planning for using natural gas as a clean fuel in thermal power plants	**261.0**
4	**WT1**	Creating and strengthening environmental sector in power plants and electricity industry	**223.1**
5	**ST3**	Planning for using new and clean technologies of power generation in the country	**215.4**
6	**WO3**	Planning to develop the country's gas refineries and solve its shortage	**201.8**
7	**ST2**	Implementation of environmental awareness and sensitization at various levels of expertise and managers	**196.4**
8	**WO2**	Allocation of identified and approved funds to environmental activities	**192.5**
9	**ST1**	Planning in order to accelerate the privatization	**191.1**
10	**WT2**	Specialized environmental training at various levels of electricity industry	**182.8**
11	**WT5**	Doing applied research on high-efficiency and clean fuels production	**179.2**
12	**WO4**	Use of international opportunities and facilities for environmental education the personnel of power industry	**168.5**
13	**WT3**	Realize price of electricity by considering the social costs	**164.9**
14	**WT4**	Planning and policy making for the development of international relations in power plant industry	**159.1**
15	**WT5**	Planning power exchange with neighboring countries for peak shaving	**150.3**

.

REFERENCES

1. M. Saeedi, A. Karbasi, T. Sohrab, R. Samadi. Environmental management of power plants, Ministry of Energy, Iran Energy Efficiency Organization (2005). ISBN:964-6553-25.
2. Tavanir, Detailed stats of Iran's electricity industry for managers at 2013 ", Company of production, distribution and transfer of electric power of Iran (2014).
3. MOE, Energy balance 1391, planning office, Department of Electrical Energy, Ministry of Energy (2013).
4. M. Khalili Araghi, G.H. Sharzehi, S. Barkhordari, *Journal of Ecology*, **38**, 93 (2012).
5. N. Moharram, "Environmental management and planning", ISBN: 964-06-9353-7 (2006).
6. A. Ataei, Z. Iranmanesh, Int. J. Enviornment.Res., **6**, 3 (2012).
7. A.R. Karbassi, M.A. Abduli, E. Abdollahzadeh, *Energy Policy*, **35**, 5171 (2007).
8. M.M. Shafipour, M. M. Farsiabi, *Int. J. Environ. Res.*, **1**, 150 (2007).
9. IL&FS. Technical EIA guidance manual for thermal power plants. IL&FS Ecosmart Limited, Hyderabad, India, 2010.
10. WEC., 2008. "Implementation of an effective Waste Management System Into The Thermal Power Plants". WEC Regional Energy Forum.
11. A. Choban, I. Winkler, Analysis of influence of the thermal power plant waste waters discharge on natural water objects. Water treatment technologies for the removal of high-toxicity pollutants. NATO Science for Peace and Security Series C: Environmental Security 2010, pp 225-234
12. WB. 1998." Thermal Power: Guidelines for New Plants. Pollution prevention and abatement handbook", World Bank Group.
13. Zh. Rashidi, A.R. Karbassi, A. Ataei, P. Ifaei, R. Samiee-Zafarghandi, M.J. Mohammadizadeh, *Int. J. Environ. Res*., **6**, 875 (2012).
14. M.A. Abduli, A.R. Karbassi, R. Samiee-Zafarghandi, Zh. Rashidi, S. Gitipour, M. Pazoki, *Int. J. Environ. Res.*, **6**, 493 (2012).
15. PSC. WI., 2010." Environmental Impacts of Power Plants". Public Service Commission of Wisconsin.
16. M.R. Senapati, *Current science*, **100**, 1791 (2011).
17. Iran DOE. 2011. "Laws and executive regulations in waste management. Iran department of environment", ISBN: 9789641741510 (in Persian).