Asian Journal of Water, Environment and Pollution, Vol. 15, No. 4 (2018), pp. 57–68.
DOI 10.3233/AJW-180058

Identification of Effective Components for Increasing the Sustainable Efficiency of Thermal Power Plants (with emphasis on Air Pollution) Using the SBSC Technique

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Received March 12, 2018; revised and accepted August 9, 2018

Abstract: Increasing the efficiency of the electric power industry is extremely important, leading to lower costs, higher profitability, possibility of proper output, efficient use of resources, reduction of pollutants and, ultimately, environmental protection. In this regard, identification of effective indicators for the sustainable operation of thermal power plants is essential, which has the largest share in the country's electricity production and one of the most important air pollutant industries. Using the Sustainable Balanced Score Card (SBSC) technique is a powerful way to design indicators for assessing the organization's sustainability performance (efficiency). The purpose of this research is to identify the effective components on performance evaluation in thermal power plants (with emphasis on air pollution) with respect to the Sustainable Balanced Score Card approach. In this research, the statistical population consisted of experts and managers of Tavanir Company and senior managers of power plants. A questionnaire was used to collect data. The reliability of the results of the questionnaires evaluation was estimated 0.84 using Cronbach's alpha. The results of this research showed that thermal power plants can be evaluated based on Sustainable Balanced Score Card model with five economic indicators (3 criteria), environmental (4 criteria), internal processes (4 criteria), growth and learning (5 criteria), sustainability (2 criteria), and while monitoring of their main processes; it can be identified as efficient units with maximum efficiency and the least pollutants.

Key words: Thermal power plants, efficiency, air pollution, sustainable balanced score card (SBSC).

Introduction

It is indicated from the review in development of country's power plant section over the past three decades, during which time the average annual growth of nominal installed capacity and the average annual GDP growth in electricity were 7% and 8% respectively. As production grows, the total consumption of fossil fuel carriers including natural gas, mazut and gas oil in the power plant section (based on the energy unit) and the greenhouse gas emissions increased by 8.5% and 8.3% per annum respectively (MOE, 2015). Increasing the efficiency and productivity of power industry is of paramount importance. Generally, at the macro level, increased productivity leads to lower costs, increased profitability, production possibility of proper output, optimal use of resources, reduction of pollutants and ultimately environmental protection (Sadeghi et al., 2013).

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The share of power generation by steam, 31%, combined cycle, 36%, gas power plants 26%, and atomic, hydropower, diesel, wind and new power plants were 6.2% totallly, indicating that electricity generation in the country was mainly driven by power plants. According to Energy Balance Sheet, thermal power efficiency has increased by only 1% in 2015 compared to last year (Energy balance sheet, 2015). Efficiency is one of the indicators used to evaluate the performance of each organization, and this indicator outlines the overall capability of each unit to convert data into outputs. By assessing the efficiency of a unit, its capabilities are reflected in the use of economical scarce resources. If the inefficiency is observed, then it is possible to carry out the necessary studies to improve the efficiency of such institutions (Babaee, 2007).

The main issue in all organizational analyzes is performance, and its improvement requires measurement, and therefore an organization without a performance evaluation system cannot be imagined. Performance evaluation is to measure performance by comparing the status quo with an ideal based on predetermined indicators that themselves have certain characteristics. Evaluation and measurement of performance lead to system intelligence and motivate individuals for the desired behaviour, and the main component is compilation and implementation of organizational policy (Rahimi, 2006). Organizational managers need to evaluate the performance of their organization to understand the status quo and the strengths and weaknesses of their organization, as well as to know about the strategies (Moradi et al., 2015). The use of Sustainable Balanced Score Card (SBSC) method based on sustainable development parameters is a powerful way to evaluate the sustainable performance of the organization, which is used as a tool for designing performance evaluation indicators (Rabbani et al., 2014). Indicators are a proper tool for identifying, managing, and improving the organization and providing the information they need to make informed decisions about the performances.

Performance indicators provide managers with an opportunity to examine the realization of the organization's goals (Arash Atoor et al., 2014). The objectives of this study include studying and recognizing the process of sustainable balance evaluation pattern, compiling performance assessment measures based on the sustainable balance evaluation pattern and compiling evaluation indicators from the perspective of economic, environmental, sustainability of domestic processes and learning growth in Iran's thermal power plants.

For this purpose, studies reviewed to evaluate the performance of various industries, and in particular the power plant industries after describing the SBSC method, and a checklist of performance evaluation indicators provided according to the macro strategies of the development of the electrical industry and the placement of indicators in five perspectives based on the SBSC technique, then, using experts survey methodology, the final performance evaluation indicators were determined based on the SBSC technique and finally a framework was developed for assessing the performance of the power plants.

Methodology

In order to achieve an effective pattern for evaluating the performance of thermal power plants (with emphasis on air pollution), the following steps were taken in this study. First, the upstream documents were examined which include the Fifth Development Plan, the Tenth Government Objectives in the Electricity Division (First Book), the Ministry of Energy Strategies, the Water and Power Industry Task Strategies, the Targeted Subsidies Law, the Consumption Pattern Reform Law, the Resistance Economics Strategies, the five-year strategic vision of Tavanir (Vice-production co-ordination) and finally, the sum of the expectations of stakeholders in the management of power generation company and strategic issues were identified at the meeting of senior executives of the company (Figure 2). Considering the macro strategies and upstream documents in the country's power industry and reviewing studies (related papers, reports and researches), the checklist of performance evaluation indicators was determined and it was set according to the SBSC technique in four perspectives of economics, sustainability, environmental, internal processes and Growth and Learning.

Sub criteria were considered to be researchable and in order to ensure the effectiveness of the identified indicators in the process of performance, evaluation was determined according to experts' opinion. For this purpose, the questionnaires were distributed between 30 experts including power plants managers, employees of Energy Ministry, environmentalists and economics experts, and management of executive agencies with a good work experience and in relation to effective indicators in this field with experience and expertise. After collecting the views of the experts, the average score of their comments was calculated in each dimension. According to the theoretical framework, if there was no agreement, the average calculated as the controlled feedback with the questionnaire was provided to the experts again. After the various rounds, when the opinion unity was obtained, the average of the final turn was made on the selection of the items. The Likert scale used in this study was 5 degrees and the mean below 3 was the criterion for eliminating factors. Table (1) represents the 5-degree Likert scale and the corresponding terms.

Table 1: 5-point Likert scale

5	4	3	2	1
Very high	High	Medium	Low	Very low

The experts' survey continued in three rounds and stopped in the fourth round by reaching the final agreement. To examine the experts' consensus and the reliability of the questionnaire, Kendall and Cronbach's alpha coefficients were used in each of the three rounds, respectively.

Cronbach's alpha is generally calculated using the following equation:

$$\alpha = \frac{k}{k-1}\left(1-\frac{\sum_{i=1}^{k} S_i^2}{\sigma^2}\right) \quad (1)$$

In the above equation, variables are k, the number of questions, S_i^2, the variance of the i-th question and σ^2 the variance of total questions (Payandeh et al., 2009). In this research, the Cronbach's alpha coefficient was calculated by SPSS software for the whole questionnaire. Figure 1 shows the stages of the research.

Sustainable Balanced Score Card

Balanced Score Card (BSC) is a technique that is used extensively to measure the performance of an organization. The BSC approach by Kaplan and Norton was introduced to address the deficiencies of traditional performance evaluation patterns that emphasized on financial criteria. Balanced Score Card provides a conceptual framework for translating corporate strategic goals into a set of functional indicators among four

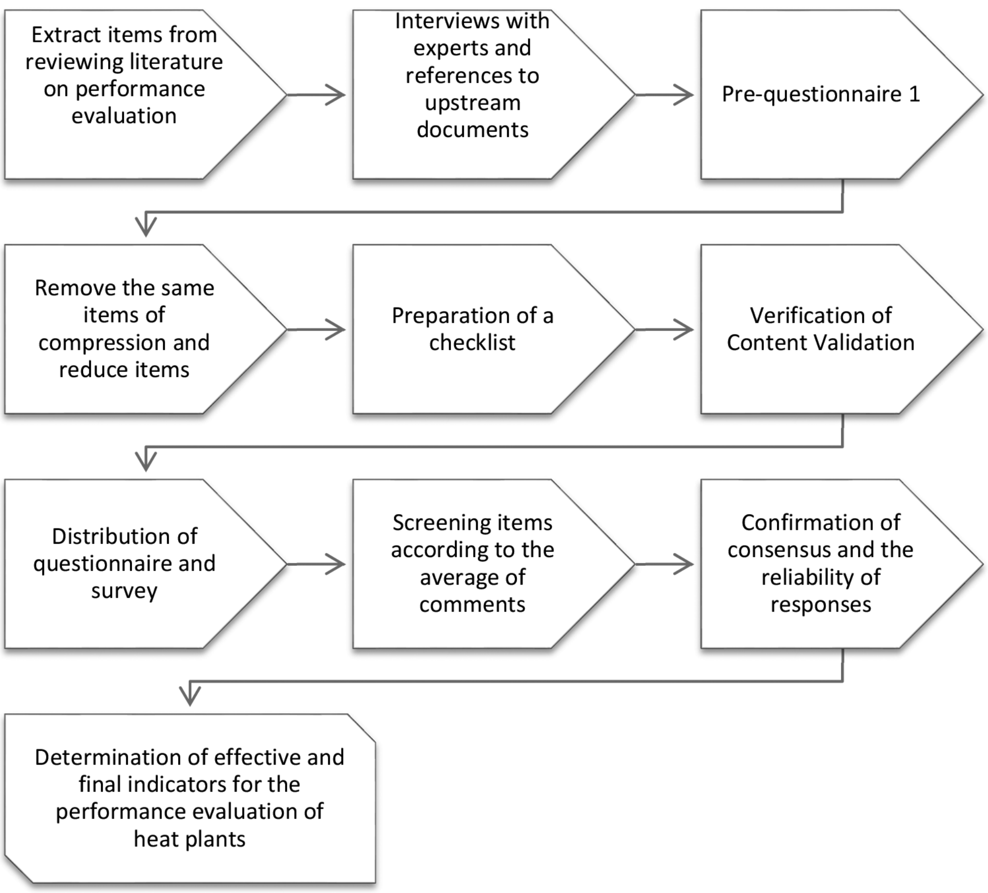

Figure 1: Flow diagram of the research processes.

perspectives: financial, internal process, customer, growth and learning. Research has been conducted on the Microsoft Research website, which shows growth in the use of a balanced scorecard in various scientific journals from 1985 to today. Between 1985 and 2013, we saw 7,369 articles and 56,962 citations on the use of the BSC (Kadarova et al., 2014). German scientists like Figge, Hahn, Schaltegger and Wagner (2002) believe that the BSC can contribute to all aspects related to achieving sustainability simultaneously and in a balanced way. Since BSC has a high potential for integrating environmental and social aspects into a public management system, it is combined with sustainability parameters to provide meaningful tools for sustainability management (Chai, 2009).

Figge et al. proposed a new approach called the Sustainable Balanced Score Card (SBSC) to address the BSC's problem in neglecting environmental and social aspects as the cornerstone of a sustainable business. The goal of the new approach is to manage sustainability in achieving the simultaneous environmental, social and economic objectives (Figge et al., 2001). This approach suggests that organizations, in addition to economic performance, need to participate in activities that have a positive impact on society and the environment. In fact, it is argued that the long-term profitability and survival of the organization are based on the balance between environmental and social goals. Sustainable Balanced Score Card has five components—economic, environmental, internal processes, growth and learning, and sustainability of the organization. It is essential that strategic goals, critical success factors, measures and action plans are determined for each perspective and the causal relationship is created between them.

Economic Perspectives

The economic perspective is at the focus of management and control activities due to direct connection with the demands of interest groups (owners, shareholders, banks, government, etc.). Although process indicators, and sometimes employee-related indicators, included topics such as economic perspectives, but the impact on the organization's economic goals has been less widely considered. Financial measures are important components of a balanced assessment system. In fact, the economic perspective is the starting point for identifying the economic goals of other perspectives (the environmental perspective, the internal processes perspective, the organization's sustainability perspective, and the perspective of growth and learning) and the extent to which other perspectives are measured through an economic perspective. The achievement level to aims of other perspectives is measured by the economic perspective. But according to the SBSC approach, the importance of the environmental perspective is the same with the economic perspective and it is better than economic perspective in the long time. Scenarios tell us that the successful implementation of goals set in four different perspectives will ultimately lead to what results and financial achievements (Kaplan and Norton, 1996). Each of the measurement indicators is part of the cause and effect chain, which should be positioned in line with economic goals and also be the estimator of a part of the strategic goals of the organization (Nils, 2005).

Environmental Perspective

The environmental perspective in the SBSC approach is in fact evolved of customer perspective in the BSC approach. Customer satisfaction is the main theme of most management systems because, in these systems, customers are at the beginning and end of the process. On the one hand, the systematic identification of customer requirements is a definite requirement, and on the other hand, the information related to customer satisfaction is a variable that in this regard, it has been emphasized to the responsibility and accountability of senior management of the organization compared to customer satisfaction. Therefore, it is necessary to use and pay attention to the identification dimensions of pollutants, environmental protection and sustainable development in defining indicators related to the environmental perspective.

Internal Process Perspective

Organizations often focus on processes within the organization to control their process improvement, but for comprehensive process control, it is necessary to pay attention to the whole chain of evaluation process, the outlooks, perspectives and requirements of customers and process owners.

Investigating processes, along with clear communication between environmental and customer orientations conditions, is closely related to quality management systems. For example, the process of producing and serving a service as a process in organization involves increasing value from the receipt time of order to the delivery of product or service. Therefore, it is necessary to use and pay attention to the focus on clean production, direction of production time based on consumption peak and the costs direction based on the demand level in defining the indicators of all the sub-processes.

Sustainability Perspective of Organization
In order to maintain their competitive advantage, and perhaps in the not too distant future, organizations must pay more attention to this concept in order to maintain their survival. The objectives of this perspective depend on the consideration of other perspectives, especially environmental and economic perspectives. It should be noted that the sustainability perspective of the organization is in fact limited by the dimension of sustainable development because here the economic and environmental perspective has been addressed separately.

Growth and Learning Perspective
Achieving the ambitious goals set in the perspectives of internal processes, environmental and, ultimately, economic lies in goals and measures of the growth and learning perspective. In fact, these goals and measures are empowering the goals set in three different perspectives (Kaplan and Norton, 1996). Growth and learning measures are substructure and foundation for establishing a balanced assessment system. The goals of the growth and learning perspective should be set to fill and cover the gaps and distances and develop appropriate measures to control their progress.

In the SBSC technique, the economic dimension is related to economic growth and other economic parameters, in which the well-being of individual and societies must be maximized through the optimal use and efficiency of natural resources and the fair distribution of benefits. Next, internal processes focus on processes within the organization. Next, growth and learning are related to human-human relationship, the excellence of people's well-being, health, and educational services. The environmental dimension is linked to the conservation and strengthening of the basis of physical, biological and ecosystem resources, and relates to the relationship between nature and man (UN, 2005).

Results and Discussion

Determination of Macro-strategies
Considering the upstream documents in the country's electricity industry and the expectations of the stakeholders in the management of power generation company, macro strategies were identified in the power industry and power plant of the country (Figure 2).

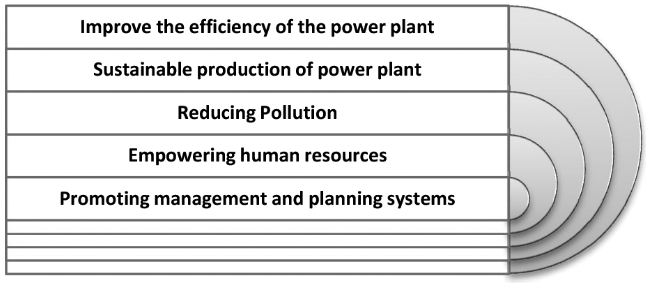

Figure 2: The macro strategies of the power industry in the country's thermal power plants.

Review of Studies on Performance Evaluation and SBSC Indicators in Thermal Power Plants
Several studies have been conducted in the field of performance evaluation in different areas, including thermal power plants, with different techniques, which are referred to in Tables 2 and 3.

Preparation of a Checklist of the Performance Evaluation Indicators of Thermal Power Plants
Considering the macro strategies and upstream documents in the country's electricity industry and the review of related studies, the checklist of performance evaluation indicators was determined and it was adjusted according to the SBSC technique in economical, sustainability, environmental, internal processes and growth and learning perspectives (Table 4).

Determination of Final Indicators of the Performance Evaluation of Thermal Power Plants in the Final Round
The most important point to be taken into consideration in the strategy monitoring organization is that strategy control should be pursued in a manner that takes a minimum of time from senior executives and, at the same time, has the necessary effectiveness in monitoring strategic goals. According to most experts in the field of performance evaluation, one can summarize the features of a good performance evaluation system: to support strategic objectives, to balance, and to consider all aspects of the organization's success, to stand against optimization, the number of performance indicators is limited to avoid waste of time, become easy access and include comprehensive performance indicators (Tavalayi, 2007).

The checklist for indicators of performance evaluation of thermal power plants was provided to experts by questionnaires with a 5-point Likert scale. During the three rounds of the survey, the final indicators of the performance evaluation of the thermal power plants were finalized in accordance with Table 5.

Based on the results, the Kendall coefficient in the first round of the Delphi technique was found 0.316,

Table 2: Summary of some studies on performance evaluation in thermal power plants

Criteria		*Method*	*Researcher*
Fuel cost Initial investment cost Access coefficient efficiency	External costs Maintenance cost Capacity coefficient Ratio of resources to primary energy production	AHP	Athanasios (2009)
Social acceptability Land needed Initial investment Side fees efficiency The ratio of resources to consumption	Employment Casualty events Radioactive contaminants release fuel cost Coefficient of maintenance Access coefficient Capacity coefficient	ANP	Atmaca and Burak (2012)
Compensation Land needed Casualty events	Social acceptability Employment Radioactive contaminant release Non-radioactive contaminant release	PROMETEE	Athanasios (2012)
Efficiency maintenance cost	Lifetime of the power plant Growth of cumulative production of power plant		Sadeghi et al. (1392)
Air consumption rate Carbon dioxide emission rate The rate of cooling water Boiler water pump outlet pressure Net thermal efficiency	Coal consumption rate Floating gas consumption rate Steam production rate Density or condensation Reheated load temperature	Stochastic response surface	Hanak et al. (2015)
Network power generation	Fuel consumption Auxiliary power consumption Power plant capacity Consumption of coal Auxiliary power consumption Lost electricity when servicing Power outage The lost forced output power	DEA	Nag (2006)
Power generation		DEA	Behera et al. (2011)
Power generation (MWh) Emissions of carbon dioxide, methane and nitrogen dioxide	Number of employees Construction cost Maintenance cost Fuel consumption (1000 tons)	DEA	Sueyoshi and Goto (2013)
Electricity (GWh) Carbon dioxide emissions	Fuel consumption	DEA	Sueyoshi and Goto (2015)
Power generation (MWh) Release of carbon dioxide, sulfur dioxide, methane and nitrous oxide	Power generation capacity (MW) Annual heating of input	DEA	Sueyoshi and Goto (2015)
Power Generation Absolute amount of carbon dioxide emissions	Installation capacity Consumption of coal	DEA	Yadav et al. (2014)

Table 3: Some studies in the use of the BSC, SBSC method

Sustainability	*Growth and learning*	*Customer*	*Internal*	*Economical*	*Author*
	• The number of employees with environmental requirements in their job description • Stability improvement solutions created by workers • Surveys the results of staff on sustainability issues related to existing knowledge • The average hours of training each employee	• Occupational health and safety incidents • Internal or external audit, and confirmation of it • Compliance with the regulations • Shareholders complaints • The results of the survey of customer satisfaction measurement	• Specific consumption of diesel fuel • The remaining sludge and produced water • Water consumption per megawatt of electricity • Noise level • Greenhouse gas emissions	• The cost of electricity production • Investment in the triple bottom line • Special and non-monetary sanctions • The cost related to the triple bottom line	Medel-Gonzále et al. (2012)
• Annual electricity generation • The average growth rate of electricity revenue • Investing in innovation and green technology • The rate of reuse of industrial water	• Improved efficiency • Release monitoring system • Upper skills of the work force • Research and Development • Employer training • Circular economy • Application of equipment for clean development • Recycling equipment		• Amount of fuel consumed • Type of fuel consumed • Water consumption • Steam consumption • Workforce productivity • The amount of pollutant production • Risk assessment	-Total value of industrial productions -Energy consumption (fuel cost price) -The profit ratio of the sale	Zhao et al. (2015
• Annual electricity generation • The average growth rate of electricity revenue • Investing in innovation and green technology • The rate of reuse of industrial water	• Information system development • Improvement of human capital • Improvement of information capital • Improvement of corporate capital		• Timely and quality production • Improving the environmental system	• Income growth • Financing • Targeted cost management • Profitable • Efficiency	Nikkhah and Nikkhah (2013)
	• Human capital • Enterprise capital • Information capital	• Product specifications • Communi-cation with customer • Company image	• Operations management process • Customer management process • Innovation process	• Cost structure • Efficiency • Increase income	Ing-Long, and Jian-Liang (2014)

Table 4: Checklist for performance evaluation indicators for thermal power plants

Growth and learning	*Internal*	*Sustainability*	*Environmental*	*Economical*
• Number of employees	• Fuel consumption and type	• Annual power generation	• CO_2 emission	• The cost of electricity production
• Employees satisfaction	• Fuel quality	• Reliability of supply	• NO_x emission	• Energy consumption (fuel price)
• Average training hours	• The amount of water consumed per megawatt of generated electricity	• Development cost	• N_2O release	• Efficiency
• Access to information and knowledge sharing	• Capacity of the power plant	• Financial support	• Release factor	• Profitability
• Employer training	• Lifetime of the power plant	• The average growth rate of electricity revenue	• VOC	• GDP
• Application of equipment for clean development	• Growth of cumulative production of power plants	• Investing in innovation and green technology	• Noise level	• External costs
• Application of equipment for recycling	• Internal consumption of power plant	• Industrial water reuse rates	• Sewage volume	• Maintenance and repair costs
• Improved efficiency	• Technical capability	• Supply chain co-level	• Logistics incidents	• Inventory turnover
• Circular economy	• Net thermal efficiency (HHV)	• Consider the standards	• Health and safety	• Tax rate
• Establishment of an IMS system	• Steam production rate (kg/s)	• Impact on other industries	• Internal and external audits	• Special penalties and non-monetary sanctions
• Establishment of Project Management System	• Density rate or condensation (kg/s)	• Social acceptability	• Energy efficiency	
• Occupational safety and health	• Air consumption rate (kg/s)		• Release monitoring system	
	• Cooling water rate (kg/s)			
	• Output pressure of boiler water pump (bar)			
	• Staff salaries			
	• Workforce productivity			
	• Wastewater and waste management			
	• Managing periodic changes			

which shows the unity of opinion between the views of the experts is moderate. As a result, regardless of the criteria that earned the score below 3, other indicators have been used for studying in the second round. The Kendall coefficient in the second round of the Delphi technique is 0.489, which shows that the unity of opinion between the experts' views is good. The Kendall coefficient in the third round of the Delphi technique is 0.496, which shows that the unity of opinion between the views of the experts is good. Finally, the 18 remaining indicators in the third round have all again won upper score of 7 in the fourth round. The Kendall consensus coefficient has also improved, as well as the average score of all indices of about 7, indicating close attitudes. Therefore, Delphi technique was stopped and final indicators were identified (Table 6). The Kendall consensus coefficient has also improved, as well as the average scores of all indices has been achieved about 7, indicating close attitudes. Therefore, Delphi technique was stopped and final indicators were identified (Table 6). Therefore, in order to check the achievement amount of power generation plants to sustainable development strategies, reducing pollution and improving the efficiency of power plants, a framework was set up as shown in Figure 3.

Discussion and Conclusion

The purpose of this study was to identify the effective factors on performance evaluation in thermal power plants (with emphasis on air pollution) with regard to the Sustainable Balanced Score Card approach. The strategic objectives of the organization include reducing pollution, sustainable development and increasing efficiency based on these objectives; the findings of this research showed that thermal power plants can be assessed based on Sustainable Balanced Score Card with five economic indicators (3 criteria), environmental (4 criteria), internal processes (4 criteria), growth and learning (5 criteria), sustainability (2 criteria). In addition to monitoring their main processes, efficient units with the highest efficiency and the least pollution can be identified.

By reviewing the sub-criteria for every aspect of the SBSC perspectives at the country's power plants level, we can examine the performance of the plants at the levels of environmental, sustainability, growth and learning, internal processes along with the economic perspective, and indicate the importance of other levels in achieving economic growth of organization and ultimately protecting the environment. In general, achieving sustainable development requires

Table 5: Final indicators of performance evaluation of thermal power plants in the final round

Average	*Sub-criteria*	*Criteria*
3.404	The cost of electricity production	Economical
3.069	Energy consumption (fuel price)	
3.039	Maintenance costs	
3.214	CO_2 emissions	Environmental
3.313	NO_x emissions	
3.098	SO_2 emissions	
3.158	Emission monitoring system	
3.669	Annual electricity generation	Sustainability
3.366	Investing in innovation and green technology	
3.276	Fuel consumption rate	Internal
3.098	Fuel type	
2.964	Power plant capacity	
3.016	Lifetime of the power plant	
3.171	Net Thermal Efficiency (HHV)	
3.117	Access to information and knowledge sharing	Growth and Learning
3.470	Application of equipment for clean development	
3.270	Establishment of IMS	
3.178	Occupational health and safety	

Table 6: Delphi test reliability (Cronbach's alpha-Kendal agreement coefficient)

Significant value	*Degree of freedom*	*Kendall coefficient*	*Cronbach's alpha*	*Number of experts*	*Number of items*	
0.000	54	0.316	0.744	30	55	First Round
0.000	30	0.489	0.754	30	31	Second Round
0.000	17	0.496	0.848	30	18	Third Round

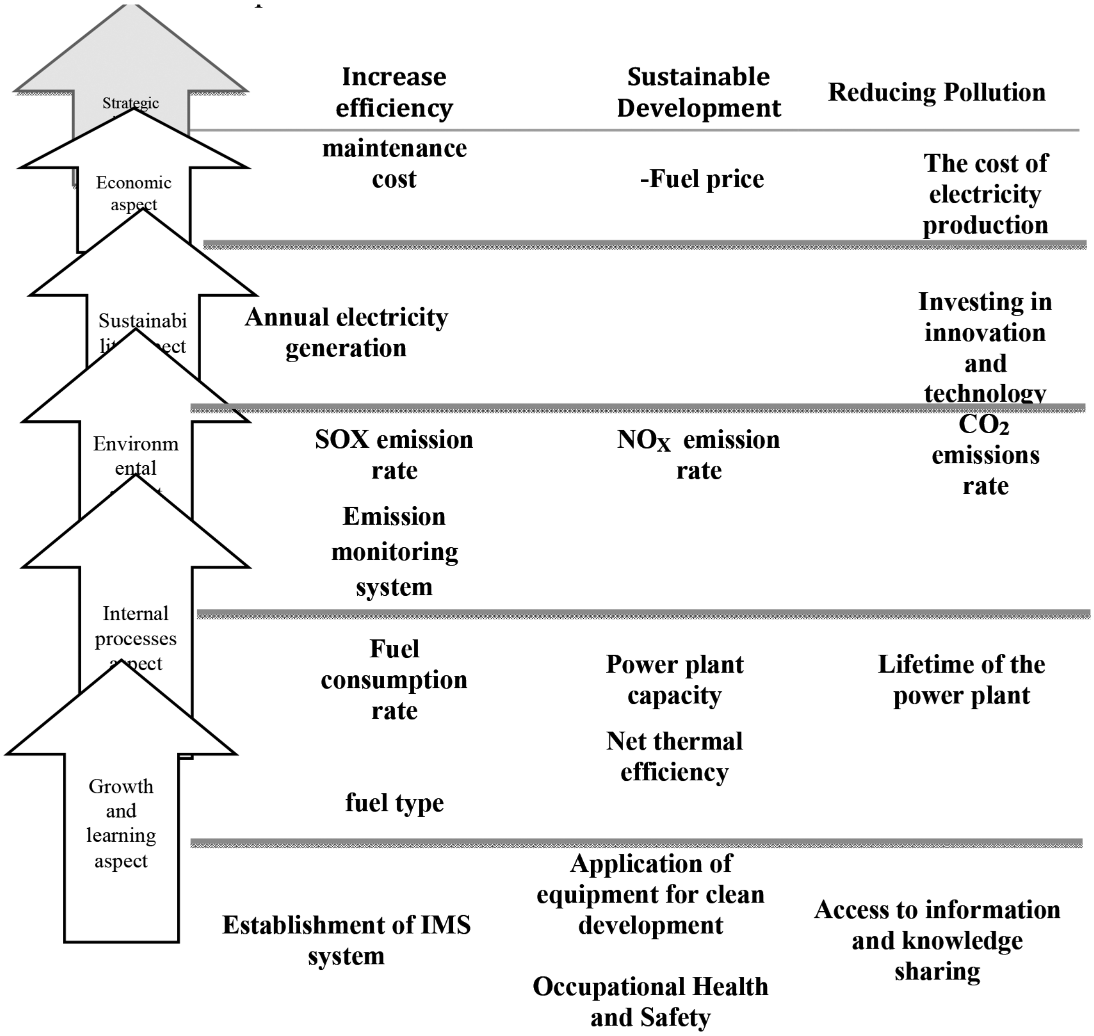

Figure 3: Conceptual framework for assessing the efficiency of thermal power plants according to the SBSC technique.

consideration of all environmental, economic, growth and learning and internal processes parameters. In the SBSC technique, the economic dimension is related to economic growth and other economic parameters, in which the well-being of individual and society must be maximized through the optimal use and efficiency of natural resources and the fair distribution of benefits.

Next, internal processes focus on processes within the organization. Growth and learning dimension are related to human-human relationship, the excellence of people's well-being, health, and educational services. The environmental dimension is linked to the conservation and strengthening of the basis of physical, biological and ecosystem resources, and relates to the relationship between nature and man. Each of the measurement indicators is part of the cause and effect chain, which should position itself in line with economic goals as the most tangible and traditional indicator of performance, and also to be a part of the strategic goals of the organization. The cost of power generation, fuel cost and maintenance cost were determined as performance components in the economic index. Fuel cost and maintenance are the central components at the heart of the cost of generating electricity. But one cannot afford to ignore the effects alone, because the cost of fuel indirectly affects the amount of contaminant. Maintenance cost is also affected by internal processes and growth and learning perspectives.

Effective environmental components were determined due to our emphasis on reducing air pollution, emissions of CO_2, SO_x, NO_x and emission monitoring system. The reduction of these pollutants would represent the effective environmental performance of the plant. The life of the power plant, the capacity of the power plant, fuel consumption rate, net thermal efficiency and fuel type were determined as the components of the internal processes. Certainly, whatever the power plant life time may be, the new technology will affect its operation. Power plant capacity and net thermal efficiency also play an important role in generating electricity. Fuel consumption rate and fuel type will have a direct impact on costs and emissions. Two components were determined for the sustainability of the organization. Investing in innovation and technology as an effective prospective component of the system's sustainability and annual electricity production rate were identified as an explicit component in assessing the power plant performance.

Finally, the components of growth and learning perspective were determined as the most basic perspective. Access to information and knowledge sharing, the application of equipment for sustainable development, occupational health and safety, and the establishment of the IMS system were identified as effective components in this regard. In fact, these objectives and measures are the enablers of the goals set in three other perspectives and if these components are improved and developed, achieving macro goals will be easier. Compared with the results of previous studies, the results of this study were most consistent with Soyoushi and Goto (2015) researches. Out of the 18 components identified in this study, there are eleven components in previous researches either inside or outside the country. The difference between this research and previous studies is that the components are comprehensive and complete, which have obtained through interview and through qualitative research. In the previous researches, there is no structure with the title of considering all dimensions and focusing on air pollution. It was also found that in order to achieve organizational strategic goals, attention to all dimensions of growth and learning, internal processes, environmental, sustainability and economic was necessary for each other.

With regard to identifying components, it is suggested that power plants authorities develop the operational programme to improve the components affecting project performance. Also, it is suggested that power plants authorities evaluate the current status of power plants performance in the organization and plan to improve and achieve higher levels. The conceptual model shows that senior management of the organization should consider and implement an improvement program for each of these components.

In future research, considering other environmental impacts of thermal power plants such as water and soil pollution, we can determine different and effective indices for the efficiency of thermal power plants.

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