Towards an effective environmental impact assessment (EIA) in the industrial sector of Bahrain, Arabian Gulf

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ABSTRACT

Rapid economic and industrial developments and population growth in Bahrain are associated with increases in energy demand and greenhouse gas emissions. An Environmental Impact Assessment (EIA) process has been adopted in the country to address environmental aspects within energy intensive projects such as oil and petrochemical industries. The quality of EIA reports with respect to energy conservation and gas emissions was investigated in this study. The results obtained showed that aspects of gas emissions received more attention than energy conservation. The reports reflected a good (75%) and satisfactory (25%) consideration of air quality. Considering the efficiency and energy consumption aspects, the reports were assessed as satisfactory (25%), borderline (50%) and poor (25%) quality. A framework to be used as a platform to integrate the EIA process, environmental management systems (EMS) and energy management systems (EnMS) was suggested. Enforcement of legislations to ensure efficient use of energy within the industrial sector, adopting strategic environmental assessment (SEA) practice in the country and linking it to energy planning, and encouraging industrial firms to adopt EnMS to play the role of adhering to EIA mitigation measures were recommended.

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1. Introduction

The Arabian Gulf countries are witnessing rapid economic, industrial and social developments associated with population growth (Naser, 2013). The rising trend of both population and urbanization in these countries increases energy demand, which results in an increase in greenhouse gas (GHG) emissions. The energy sector is considered the main contributor to GHG emissions in the Arabian Gulf countries, which accounts for more than 90% of the emissions (Asif, Sharma, & Adow, 2015; Khondaker et al., 2016; Khondaker et al., 2015). Energy use per capita in the Arabian Gulf countries is considered among the highest in the world (Alshehry & Belloumi, 2015; Reiche, 2010).

Although Bahrain has started to diversify its economy over recent decades, the energy sector is still the major contributor to the national economy, where oil and gas, representing 20% of gross domestic product (GDP), provide about 80% of government income (BEDB, Bahrain Economic Development Board, 2013). Increasing energy demand in Bahrain imposes pressure on the energy resources and contributes to increase in the release of GHG such as CO₂ (Abdelaziz, Saidur, & Mekhilef, 2011). For instance, production of electricity between 2000 and 2011 rose from 5.5 to 12.3 TWh. The industrial sector has the largest share of Bahrain’s total consumption of energy, which accounts for 59% of total consumption (BER, Bahrain Energy Report, 2013). Additionally, around 89% of the total CO₂ emissions in the country comes from both the energy and industrial sectors (Alnaser et al., 2012). Jafari, Ismail, Othman, & Mawar (2015) investigated the relationship between economic growth, energy consumption and CO₂ emissions in Bahrain for the period from 1980 to 2007. This study revealed a direct relationship between energy consumption and CO₂ emissions. Thus, lowering energy consumption is essential in order to reduce CO₂ emissions, which could be achieved by adopting energy conservation strategies and emission reduction policy in the long term without impeding economic growth (Abdelaziz et al., 2011).

Environmental Impact Assessment (EIA) is considered one of the management tools to achieve a balance between industrial development and protection of the environment (Wang, Zhao, & Zhang, 2016).
EIA is defined as the process of identifying, predicting, evaluating and mitigating the biophysical, social and other relevant factors of development proposals prior to making major decisions and commitments (IAIA, 2015). Generally, use of EIA could minimise or avoid the adverse effects of a proposed development on the environment, by addressing effective designs, alternatives, mitigations, cumulative impacts, and monitoring (Gibson, Kundu, & Satish, 2013).

Recognizing the role of EIA in protecting the environment from degradation and pollution, Bahrain has formally adopted the EIA process to tackle the environmental aspects of major industrial projects. Bahrain has set regulations and institutional arrangements which facilitate EIA practice. Regulatory framework for conducting the EIA in Bahrain is provided by both Legislative Decree No. 21 of 1996 with respect to the Environment and Ministerial Order No. 1 of 1998 regarding the environmental evaluation of projects. The latter order explains the procedures of EIA and outlines the responsibilities and duties of the concerned bodies in the EIA process (Naser, 2012). The Supreme Council for Environment (SCE) is the responsible authority for screening, scoping, reviewing and evaluating EIA studies before approval of the proposed projects.

In many parts of the world, the effectiveness of EIA in protecting the environment and promoting the principles of sustainable development might be constrained by shortcomings in the legal and regulatory frameworks, inadequate systematic guidelines on procedural EIA for different sectors, and lack of provisions related to cumulative impacts and strategic environmental assessment (SEA). (Aung, 2017; Wang, Zhao, & Zhang, 2016; Zvijakova, Zelenakova, & Purcz, 2014).

Several studies have investigated the quality of EIA reports in relation to industrial projects. For instance, Sandham et al. (2013) evaluated the performance of managing the environmental impacts resulting from a specific industrial activity by looking at the quality of EIA reports of explosives manufacturing projects in South Africa. This study highlighted several shortcomings, which could be overcome by improved training, quality review, development of guidelines and the use of operational risk assessment. De Montis (2014) studied SEA of the energy planning tools (i.e. Regional Energy Plan, Provincial Energy Plan, and Municipal Energy Plan) in Italy. Nine SEA reports were reviewed and the results revealed that baseline description, and identification of key environmental issues can be considered as strengths. In contrast, both consideration of reasonable alternatives and the impact of public participation on SEA efficiency were unsatisfactory. Saif, Mehmood, Chaudhry, and Akhtar (2015) reviewed the quality of 100 EIA reports in Pakistan, including industrial projects. This study showed that the EIA reports prepared for international funding agencies have better quality than those carried out by local consultants. Anifowose, Lawler, van der Horst, and Chapman (2016) assessed the quality of 19 EIA reports for oil and gas projects in Nigeria and showed that project description and communication of results were the main areas of strength while environmental impact prediction and project decommissioning were among the key areas that needed improvement.

EMS aid organizations aimed to identify, manage, monitor and control their environmental issues in a holistic manner (Jovanovic & Filipovic, 2016). The pressure is mounting for businesses to align operational processes with the objectives of sustainable development. Therefore, current project management frameworks need revision to ensure alignment and incorporation of sustainability aspects as well as life cycle management principles (Labuschagne & Brent, 2005).

Alignment between environmental tools such as EIA and EMS with a project cycle can contribute positively to the practice of EIA and preserve the integrity of the environment (Brent & Petrick, 2007; Brown & Hill, 1995; Hollands & Palframan, 2014; Ridgway, 1999).

The objectives of the present study were 1) to investigate the current application of the EIA system in the industrial sector of Bahrain by evaluating EIA reports with respect to energy conservation and gas emissions; 2) to propose a framework to enhance the efficiency of EIA in the industrial sector by aligning the EIA process with the management of project life cycle in the oil and gas sector in Bahrain.

2. Methods

2.1. Evaluating the quality of industrial EIA reports

Evaluating the quality of EIA reports is one of the main approaches followed to investigate the practice and performance of the EIA process (Loomis & Dziedzic, 2018). This approach provides insights into the performance of specific procedures or measures within the EIA process as well as information on the adherence to environmental regulations (De Montis, 2014). Eight EIA reports concerned with energy intensive projects, electrical power plants, chemical process units, aluminum plant, and steel plant, were obtained officially from the SCE and Bahrain Petroleum Company (Bapco). These reports illustrate the main industrial projects carried out in Bahrain during the last ten years. Criteria to systematically
Table 1. Evaluation criteria for the role of EIA in energy conservation and emission reduction.

| Area of evaluation | Emissions questions | Energy questions |
|--------------------|---------------------|------------------|
| 1. Description of the project | 1.1. Are the types and quantities of gaseous and particulate emissions associated with energy use by the project identified? (emissions from combustion of fossil fuels in stationary and mobile plant, emissions from traffic) during construction during operation during decommissioning | 1.1. Are the types of energy sources and quantities of energy required by the project identified? during construction during operation during decommissioning |
|                     | 1.2. Are the locations for discharge of all emissions to air identified and the characteristics of the discharges identified? (e.g., height of stack, velocity and temperature of release) | 1.2. Are all the energy consumption processes involved in operating the Project described? (e.g., manufacturing or engineering processes, primary raw material production) |
|                     | 1.3. Are the quantities of emissions associated with energy consumption per unit of outputs produced by the project described and benchmarked with national or international standard? (Presented in terms of kg or ppm per unit mass or volume, etc.) (emission intensity index) | 1.3. Are the quantities of energy per unit of outputs produced by the project described and benchmarked with national or international standard? (Presented in terms of energy per unit mass or volume, etc.) (energy intensity index) |
|                     | 1.4. Are the methods for collecting, treating and finally discharging these emissions to air described? | 1.4. Is the potential for resource recovery from wastes and residues discussed? (including re-use, recycling or energy recovery process or heat integration) |
|                     | 1.5. Are the methods for estimating the quantities and composition of all residues and emissions identified and any difficulties discussed? | 1.5. Is efficiency in use of energy and raw materials discussed? |
| 2. Consideration of alternatives | 2.1. Are the emissions associated with energy use considered as one of the criteria for choosing between alternatives? | 2.1. Are energy type and quantity considered as one of the criteria for choosing between alternatives? |
| 3. Description of environment likely to be affected by the project | 3.1. Have all relevant national and local agencies been contacted to collect information about the baseline of air emissions? | 3.1. Is the current energy use within the area of project described? |
|                     | 3.2. Have all relevant national and local agencies been contacted to collect information about the baseline of air emissions? | 3.2. Have all relevant national and local agencies been contacted to collect information about the baseline of energy use? |
|                     | 3.3. Where surveys have been undertaken to characterize the air quality baseline, are the methods used, any difficulties encountered and any uncertainties in the data described? | 3.3. Where surveys have been undertaken to characterize the baseline of energy use, are the methods used, any difficulties encountered and any uncertainties in the data described? |
|                     | 3.4. Were the methods used appropriate for the purpose? | 3.4. Were the methods used appropriate for the purpose? |
|                     | 3.5. Are any important gaps in the data on the existing air quality identified, and the means used to deal with these gaps during the assessment explained? | 3.5. Are any important gaps in the data on the existing energy use identified, and the means used to deal with these gaps during the assessment explained? |
|                     | 3.6. If surveys would be required to adequately characterize the baseline of air quality but they have not been practicable for any reason, are the reasons explained and proposals set out for the surveys to be undertaken at a later stage? | 3.6. If surveys would be required to adequately characterize the baseline of energy use but they have not been practicable for any reason, are the reasons explained and proposals set out for the surveys to be undertaken at a later stage? |
| 4. Description of the likely significant effects of the project | 4.1. Are direct, primary effects on air quality described and where appropriate quantified? | 4.1. Are direct, primary effects on energy use described and where appropriate quantified? |
|                     | 4.2. Where effects are evaluated against legal standards or requirements, are appropriate local, national or international standards used and relevant guidance followed? | 4.2. Where effects are evaluated against legal standards or requirements, are appropriate local, national or international standards used and relevant guidance followed? |
|                     | 4.3. Are positive effects on the environment described as well as negative effects? | 4.3. Are positive effects on the environment described as well as negative effects? |
|                     | 4.4. Are the methods used to predict effects described, and are the reasons for their choice, any difficulties encountered and uncertainties in the results discussed? | 4.4. Are the methods used to predict effects described, and are the reasons for their choice, any difficulties encountered and uncertainties in the results discussed? |
|                     | 4.5. Where there is uncertainty about the precise details of the project and its impact on the environment are worst case predictions described? | 4.5. Where there is uncertainty about the precise details of the project and its impact on the environment are worst case predictions described? |
|                     | 4.6. Is the basis for evaluating the significance or importance of impacts clearly described? | 4.6. Is the basis for evaluating the significance or importance of impacts clearly described? |
|                     | 4.7. Are cumulative effects on the environment of the project together with other existing or planned developments in the locality described? | 4.7. Are cumulative effects on the environment of the project together with other existing or planned developments in the locality described? |

(continued)
review the EIA reports in respect of energy saving were based on the three main environmental statement review packages; namely environmental statement review package by Lee, Colley, Bonde, and Simpson (1999), the guidance on environmental statement review by EC (European Union) Guidance on EIA (2001), and the environmental statement review package by Oxford Brookes University (Glasson, Therivel, & Chadwick, 2005). Questions for the evaluation criteria were developed to address both energy and emission aspects according to the main five review areas; namely description of the project, consideration of alternatives, description of the environment likely to be affected by the project, description of the possible significant effects of the project, and mitigation and monitoring. These areas were subdivided into 28 review questions for the emission aspects and 29 for energy aspects as shown in Table 1.

Quantification of the quality of EIA reports can assist decision-makers, stakeholders and the public by providing the necessary information related to the EIA practice and effectiveness (Chang, Nielsen, Auberle, & Solop, 2013). The present study adopted a quality index to enable the quantification of the qualitative answers to the review questions. Soderman (2005), Khera and Kumar (2010) and Naser (2015) applied quality indices to rate the quality of the EIA reports in different areas. The quality index was calculated for each category of equations (i.e. energy and emissions) based on the averaged evaluation of two reviewers. The quality index is identified by Equation (1):

$$ QI = \frac{A + 0.5B}{Q - NA} \quad (1) $$

where QI is quality index, A is number of review questions fully met, B is number of review questions partially met, Q is total number of review questions, and NA is not applicable questions. The value of the used quality index becomes zero (0) if none of the review check list questions was met and one (1) if all review questions were fully met. The reviewed EIA reports were grouped based on the scores of the quality index as follows: QI between 0.0 and 0.25 (poor), 0.26 and 0.50 (borderline), 0.51 and 0.70 (satisfactory), and 0.71 and 1.00 (good) (Khera & Kumar, 2010). The calculated indices reflect the overall quality of a report in documenting energy consumption and gas emissions.

### 2.2. Aligning the EIA process with the management of oil and gas projects

The Bahrain Petroleum Company (Bapco) is the national oil and gas company, responsible for major activities within this sector. Therefore, the project
management model of this company was selected for the alignment process. Bapco follows the project management process developed by Chevron (Karim, 2014). Chevron Project Development and Execution Process (CPDEP) aims to determine the required steps to move from the current state to the desired state in the future. CPDEP is widely implemented by national oil and gas companies that have mutual agreements with Chevron.

The procedural steps of EIA in Bahrain were based on legal regulations and published studies (Brent & Petrick, 2007; Brown & Hill, 1995; Naser, 2012; Ridgway, 1999). The major stages of EIA process were converted into process flow chart to illustrate each stage aligned with project management process (CPDEP). The developed flow chart was used to introduce a framework for incorporating environmental tools (EIA, EMS and EnMS) with oil and gas projects cycles in Bahrain.

3. Results and discussion

3.1. Quality indices of EIA reports

The overall quality of evaluated EIA reports, based on air quality aspects and emissions reduction is shown in Figure 1. The majority of the reports (6) reflected a good consideration of air quality in the environmental studies whereas two reports were categorized as satisfactory. Figure 2 represents the overall quality of evaluated EIA reports in considering the efficiency and energy consumption aspects. Half of the reports were assessed as borderline. Two reports were categorized as satisfactory compared with two of poor quality. Generally, emissions and air quality aspects were covered and discussed in more detail, whereas energy aspects attracted less attention. All evaluated reports allocated a separate section for air quality assessment, whereas only two reports devoted special sections to cover efficient operation and energy consumption matters.

3.2. Description of the project

The main purpose of this section in the EIA report is to give the decision makers a clear idea about the details of the proposed development project. The scope of the majority of evaluated EIA reports was to study the environmental impacts in both construction and operation phases. Only one report covered the decommissioning environmental impact while others stated that the decommissioning phase would need a standalone environmental study.

The majority of the reports (75%) were useful in identifying types and quantities of gaseous and particulate emissions associated with energy use or originating from the processes of the project. Air emissions were listed in tables together with the predicted quantities for different operational scenarios. There were some limitations in the other reports (25%) in description of the amount of emissions due to energy usage of the industrial facility.

All of the reports described the methods for collecting, treating and finally discharging emissions to air. In addition, the locations for emission’s discharges to air were identified. The characteristics of the discharges were identified as well (e.g. height of stack, velocity and temperature of release) and they were used for dispersion models.

Although all of the reports specified the types of fuel to be used, there were gaps in quantifying the amount of energy needed during the construction phase. Five of the evaluated reports described very well the energy consumption processes involved in operating the project. For instance, one of the reports listed all process units and gave precise numbers about required energy quantities and fuel gas rates before and after project execution. On the other hand, the other three reports provided general description with less detail of quantities.

Energy intensity index is a measure of the energy efficiency and can be used as an indicator to establish benchmarking, which is one of the tools for an
energy audit (Klemes, Friedler, Bulatov, & Varbanov, 2010). In the same context, emission intensity index is an indicator of how environmentally friendly the project is (IChemE, 2002). Six of the evaluated reports failed to quantify energy and emissions per unit of outputs produced by the project. Only three provided the necessary information (i.e. production rate, energy consumption rate, and emissions rates) to estimate such indexes. Only two reports provided good examples of utilizing either energy or emission intensity indexes to evaluate the efficiency of the project and benchmark it with those from other regions.

Efficiency of the use of energy and raw materials was discussed to some extent in most of the reports (88%). These discussions varied from simple energy conservation measures such as switching off unwanted lighting, to engineering configuration of the plants which included type of technology, overall efficiency of the plant, potential of heat recovery, and use of low NOx burners.

Methods for estimating the quantities and composition of all residues and emissions were identified and discussed in all of the reports. Moreover, six of the reports conducted dispersion models to characterize the quantities and direction of emitted air pollutants i.e. NOx, SOx, gashouse fluoride, etc. One of the reports stated that air dispersion modelling should be conducted before starting plant operation. Unlike emissions, methods for estimating the quantities of energy consumption were not discussed in all of the reports. Material and energy balance approaches were not covered but only figures of the required materials and energy were provided.

### 3.3. Consideration of alternatives

Consideration of alternatives is an essential part of the EIA procedure. At this stage, a comprehensive approach has to be followed to investigate the most appropriate technology, design, process and location for a proposed project.

Seven of the evaluated projects used natural gas as a source of energy and one of them utilized electricity from the national grid. Half of the reports considered energy as a criterion for choosing between alternatives, which included technologies, plant designs or equipment selection. In this context, 75% of the reports took into account emissions as evaluation criteria as well. The results showed that two reports did not cover energy or emission aspects while judging the alternatives.

As reported by Naser (2015), most of the projects in Bahrain were in the final stages of implementation and their sites were allocated or purchased by the project proponents before the EIA commenced. This situation was reflected in one of the reports where the cumulative impact of that project is likely to cause exceedance of the annual mean standard for a major pollutant but the decision was made to proceed with the project.

### 3.4. Description of the environment likely to be affected by the project

The main purpose of the description of the likely affected environment is to establish a baseline that could be used as a reference when evaluating the significance of the effects. Eventually, all EIA reports addressed the current emissions conditions with some differences.

Half of the reviewed reports included new meteorological surveys. Details of surveying and sampling methods were presented adequately, and were justified to suit the purpose of the investigation. Furthermore, encountered difficulties were discussed most of the time. For example, one of the EIA reports presented the results of a short-term survey and stated that these data were not enough to characterize the baseline environment, so further
3.5. Description of the likely significant effects of the project

All reports provided adequate description of the primary effect on air quality and seven of them presented quantified estimations of the effect. Dispersion modelling is a predictive tool used to calculate the concentration of pollutants at sensitive receptors resulting from known sources of air pollution. Six of the evaluated reports performed such modelling to characterize the primary impact on air quality. Four reports carried out the modelling using an advanced dispersion modelling software called AERMOD, which was developed by the US Environmental Protection Agency (Gibson et al., 2013). One report used ADMS Urban software while another did not mention the software used to perform the dispersion modelling.

Input data to dispersion models were clearly presented in tables for different operation scenarios including the worst case. Consequently, the results were illustrated using aerial maps, which gave clear ideas about the dispersion behaviour of the emitted air pollutants.

Methods used to predict effects on air quality were described in all the reports. The commonly used approach was to sum background pollution concentrations with anticipated emissions from the proposed project.

In many cases uncertainty about the precise details of the project impact on the environment was faced. Therefore, the worst case scenarios are assumed to predict the most conservative impact on air quality. Four of the evaluated reports presented the effects in different scenarios and handled the predictions of the worst cases.

All of the reports evaluated the effects of air quality against Ministerial Order No. 2 of 2001 Amendments to Ministerial Order No. 10 of 1999 with respect to Environmental Standards (Air and Water). Fifty percent of the reports went further and made comparisons with other international standards such as the World Bank standards for air quality.

The bases for evaluating the significance of impacts on air quality were described in all the reports. Clear presentations were made in six of these reports whereas only partial elaboration was given in another two reports.

According to the conducted review, half of the proposed projects would have positive impact on the environment. This is due to either the purpose of the project or retrofit of the existing facility, which would contribute to the reduction in the current rate of emissions.

Energy-wise five of the evaluated reports failed to describe the primary effect on energy usage. On the other hand, only two reports were able to give quantitative impact assessment of the project on energy demand. Moreover, none of the reports referred to appropriate local, national or international standards or relevant guidance to evaluate the effect of energy usage.

Only one report scored well in terms of clearly describing the basis for evaluating the remarkable impacts of energy usage regarding duration, intensity, probability, and significance.

An EIA study should include all remarkable impact interactions and particular care may be necessary in identifying cumulative effects (Abaza, Bisset, & Sadler, 2004). The majority (75%) of the reports covered clearly the cumulative effects on air quality together with other existing developments in the locality, where the current concentrations of air pollutants were summed to the anticipated amount from the proposed projects. In addition, a lack of considering possible future projects was noted while covering the cumulative impact assessment. On the other hand, the majority (88%) of the reports failed to evaluate the cumulative impact of energy usage. Only one report tackled this issue but it was limited to the effect of the proposed development on the overall energy demand of the company.

3.6. Mitigation and monitoring

Both mitigation of adverse effects and monitoring of residual impacts are crucial steps in the EIA process.
Figure 3. A proposed framework of environmental management tools and project cycle for Oil and Gas Sector in Bahrain.
All of the reports discussed mitigation measures to minimize the impact on air quality whereas four of them were not clear in terms of the effect of these measures on the magnitude and the significance of impacts. The majority (75%) of the reports justified proposed mitigations.

Mitigation measures include several aspects such as improved ventilation system, better stack designs, commitment to operate according to the principles of best available techniques and considering opportunities for cost-effective improvement.

The proposed arrangements to monitor and manage residual impacts were described in most of the reports (88%). These arrangements included implementation of continuous emission monitoring systems, which will give real time data about emitted pollutants. Such systems ensure compliance with specific stack emission limit values.

Most of the reports (88%) included mitigation measures to minimize energy consumption. The measures were considered at the early stage of technology selection such as the production method, the use of ultra NOx burners, combined cycle power plant configuration, or the use of heat recovery systems.

3.7. Environmental management plan

Integration of EIA with EMS can achieve the environmental quality goals of both EIA and EMS since it ensures that adverse impacts are anticipated and controlled, and any remaining significant impacts may be reduced or eliminated through a continuous improvement cycle. Integrated process should help to improve environmental quality and sustainable development (Eccleston & Smythe, 2002).

One of the EIA requirements by the SCE guidelines is to provide information about an environmental management plan and procedures. This requirement was reflected positively in the evaluated reports with six of them provided the proposed management plans that were linked to mitigation measures. Two of these reports were for companies that already have established EMS and which are certified with the internationally recognized environmental management system ISO14001.

On the other hand, one of the reports discussed the environmental management plan but it was not included in the EIA study. Only one report failed to link between EIA and environmental management plan.

In contrast to air quality, there is no legal requirement that enforces a project proponent to include an energy management plan within the EIA report. Consequently, none of the evaluated reports linked mitigation measures to an energy management plan. Only one of the reports suggested developing and implementing an energy management programme to reduce the amount of energy consumed by the plant and to ensure that the equipment efficiency was optimized.

3.8. Framework of sustainable project management in oil and gas sector in Bahrain

The alignment between project life cycle for oil and gas projects and EIA process in Bahrain is illustrated in Figure 3. This framework reflects a thorough consideration of environmental aspects throughout projects’ life cycle of the oil and gas sector in Bahrain. Oil and gas activities have been regulated with legislation and quality standards that ensure the consideration of environmental aspects and guide both companies and the environmental executive body (i.e. SCE). The framework presented here showed that the second phase of the project cycle is parallel to the scoping phase of the EIA process, which reflects good potential to empower consideration and discussion about possible alternatives. This helps to achieve development objectives taking into consideration environmental aspects.

It has been proposed that linkage between EMS and EIA enables a more comprehensive approach to environmental management where shortcomings in the EIA process can be addressed by the EMS process and vice versa. Additionally, EMS can fulfil the role of EIA follow-up (Hollands & Palframan, 2014). The framework represents clearly that mitigation measures should be translated into management plans, which are prepared at the stage of EIA and enforced at the stage of execution.

Most oil and gas projects are energy intensive and require specific attention to both energy consumption and associated emissions. Although ministerial order No.1 of 1998 stated that the EIA report should include a description of any possible increase in the demand of non-renewable resources, there are no specific legal instruments addressing the efficient use of energy for the proposed projects. This clearly indicates an area for improvement within the environmental legislation in Bahrain. This gap could be bridged through cooperation between relevant official authorities by setting up legislation and guidelines to ensure the efficient use of energy within industrial premises. In contrast, air emissions that are associated with the use of fossil fuel are covered legally by ministerial Order No. 10 of 1999 with respect to the environmental standards (air and water) and its subsequent amendments.

4. Conclusions and recommendations

EIA reports related to projects that involve intensive use of energy and have the potential for air emissions
were selected for the evaluation based on adopted criteria. The main findings of the evaluation revealed that more emphasis is given to aspects of air quality over energy aspects in the present practice of EIA in Bahrain. Shortcomings were identified in the consideration of energy aspects. Limitations were observed in the main parts of EIA reports i.e. descriptions of the project, the environment likely to be affected, and the primary environmental impact, and monitoring of residual impact.

Environmental regulations have an important role in enhancing EIA practice and maintaining environmental resources. Bahrain has achieved significant progress in developing a legal framework for the EIA system that specifies duties and responsibilities of relevant bodies involved in the EIA process (Naser, 2015). Bahraini environmental law requires the monitoring of air emissions, which is reflected positively in the evaluated reports. However, lack of legislation on energy aspects and their efficient use limit the weight of this aspect within the evaluated reports. Enactment of legislation or setting guidelines for monitoring energy consumption in industrial activities would contribute to better consideration of efficient energy use in EIA studies.

The proposed framework, which provides an important platform for integrating EIA and project management process, has a potential to enhance the practice of generating and selecting alternatives based on the environmental and energy criteria. Additionally, the framework proposes implementing EMS and EnMS to play the role of following up EIA mitigation measures.

The current EIA practice in Bahrain reveals a strong link between EIA reports and environmental management plans. Although the energy aspects were not translated to management plans, this reflects an area of improvement, where adopting EnMS is an effective measure to properly improve energy management and enhance the conservation of energy within industrial premises (Dorr, Wahren, & Bauernhansl, 2013). EnMS ISO 50001 is an internationally recognized system implementing measures for effective energy management and conservation of energy within such industrial premises (Ates & Durakbasa, 2012; Dorr et al., 2013; Dzene, Polikarpova, Zogla, & Rosa, 2015; Hollands & Palframan, 2014; Jovanovic & Filipovic, 2016). In general, an EnMS should consist of energy policy with strategic and operational energy goals by evaluating the progress and taking corrective actions towards these goals. Management review should be performed periodically to ensure the continuous improvement and efficient utilization of energy sources.

EIA is provided for the individual projects addressing significant environmental issues with a higher level of planning (Jay, 2010). The interlink between energy conservation and emissions reduction could be addressed through strategic management tools, including SEA. All evaluated EIA reports focused on environmental aspects for the level of individual projects only, and none of them was linked to strategic planning levels. SEA is a powerful tool that can be applied for energy planning (De Montis, 2014; Pardo & Moya, 2013). This highlights the need for adopting SEA principles in Bahrain and linking them to energy strategic planning. For instance, a cooperation between major companies in the field of oil, petrochemical, and gas industries has been established to adopt measures to reduce CO2 emissions in Bahrain (Abdmouleh, Alammari, & Gastli, 2015).

The EIA process contributes to the overall environmental situation and the sustainable development in Bahrain positively. However, there is a need to integrate the principles of EIA, EMS, EnMS and SEA in the industrial sector of the country.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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