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To identify the critical success factors of sustainable supply chain management practices in the context of oil and gas industries: ISM approach

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ABSTRACT

The concept of sustainable supply chain management (SSCM) has been considered as an important organizational philosophy to achieve profits by reducing environmental risk and impact while improving the economic and social efficiency factors (ESEF). The objective of this paper is to present an approach to identify the critical success factors (CSFs) of motivation and encouragement, for the successful implementation of SSCM practices in Indian oil and gas industries. 32 CSFs were identified from the literature and opinions of academicians and industry practitioners. The Interpretive Structural Modeling (ISM) methodology was used for establishing the mutual relationships among the drivers, which not only helps in understanding the relative relationship between the CSFs but also in determining their interdependence while implementing sustainability. Further, the importance of CSFs with respect to sustainability was identified based on their driving and dependence power by using MICMAC analysis. “Global Climatic Pressure and Ecological Scarcity of Resources” was determined to be the most influential criterion that may force industries to implement sustainable practices. An example of Indian oil and gas industry has been presented to show the real-world applicability of the proposed model. This study may help academicians, government regulators, and practitioners to emphasize their efforts towards implementation of SSCM at various levels of organization.

1. Introduction

The World Commission on Environment and Development (1987) defined sustainable development as “the development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs” [1]. Sustainable development is a process, which tries to maintain a dynamic balance state in the long run [2]. It demands the human, financial and environmental concerns to work together to ensure ‘unending life for the human race’ in the global ecological system [3].

The term sustainable development in the oil and gas industry should not refer to indefinite production of oil and gas. The term refers to sustainability of human existence by carefully balancing social, economic and environmental capital in a continuously changing world [4]. In the past, supply chain management (SCM) mostly dealt with the responsive and efficient system of production and delivery from raw material state to final state of the component. However, these days, environmental issues in a supply chain are assumed of having immense significance [5]. The concept of sustainable development has been considered important in terms of policy and research [6]. In the next few decades, it will become one of the biggest opportunities in the history of commerce [7]. As income increases, there will be a rise in the environmental standards and people will become more sensitive and concerned towards environmental deterioration [8]. Unless the society accumulates some amount of wealth to fulfill the basic needs of human, it will not allot substantial resources towards sustainability. Sustainable practices are more likely to get implemented if there are noticeable benefits such as cost savings or product/market differentiation or risks from its inaction like reputational damage and loss of market share [9].

Today, we face two major global threats, which are related, and both are due to overpopulation. The first threat is the peaking of the production (tons per year) of fossil fuels [10]. The peak of petroleum production in the U.S occurred in the year 1971 [11]. From the year

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1973, oil became costly and in the October month of the same year, oil prices increased very rapidly, causing a massive energy crisis around the globe. It was then that the governments of all the nations took this issue very seriously and a need for identifying and exploring alternate sources was observed. Enormous funds were allotted for the development of these resources. Thus, this year is considered as the year of the first oil shock. In the same decade, in 1979, one more oil shock shook the world. By the end of the year 1980, the price of crude oil increased by 19 times in a span of 10 years [12].

Global energy demand will rise by 1.2% a year through 2030 and the world will be using almost 35% more energy than it used in 2005. Also, there is a continuous increase in the prices of crude oil over the years [13]. Supplies are decreasing, but demand is increasing and industrial society depends almost completely on petroleum. Hence, peak petroleum will quickly cause everything to peak [14]. It may be noted that modern agriculture is totally dependent on petroleum, so the peak of world petroleum production would definitely affect the world food production adversely. At the same time, population of the world will increase, creating a tough situation for the society [11]. As Heinberg [14] states, “the passing of the world peak of petroleum production will be a big milestone for the human race on the earth because it means that the tons per year of petroleum being produced all over the world will start to deplete to zero while the world population is expected to increase along with the demand for petroleum.” This process will push energy prices higher, until sustainable sources replace dependency on fossil fuels as the major source of energy [15].

The second threat is the rapidly changing global climate. The world's population has increased from 3 billion in 1950 to 6 billion today and is expected to reach 9 billion in 2050. The projections based on the present report of birth rates indicate that the population will stabilize somewhere around 11 billion by 2100 [16]. Sustainable practices are the solution for the two above-mentioned global threats. New strategies will be implemented in order to gain competitive advantage in the coming years by minimizing waste and promoting green design [17]. The main reason for the change of climate is the tremendous growth rate of population, which in turn increases the consumption of the world's resources. The past research did not throw much light on the potential benefits of gaining competitive advantage using sustainable supply chain practices [18]. From the literature, it may be noted that the implementation of sustainable practices may solve the ecological, economical and social problems or reduce the same to a larger extent.

The research paper focuses on the following objectives: to determine the critical success factors (CSFs) to implement sustainability from the industrial perspective; to determine the contextual relationships between the CSFs; to suggest a hierarchy structural model (ISM) of CSFs to implement sustainability in organizations; and suggest the managerial implications of critical driving forces/criteria for the implementation of sustainable practices. The implementation of sustainable practices guides in the efficient exploration and production, distribution, and reduces the ratio of energy input per unit output of the oil and gas. The venting and flaring get reduced which yields to less atmospheric pollution and saving of precious energy. It will reduce accidents (on shore and off shore), reduces oil spills, increases production, and profits, and adds an enormous value the oil and gas supply chain.

This paper is presented in the following sequence: Section 2 is a literature review, which presents the information on sustainability in the oil and gas industries and identifies the CSFs for its implementation. In Section 3, the methodology used for the study is presented. Section 4 discusses the problem statement, which describes the problem under study, and the findings of the study are summarized. Also, influencing CSFs and the structure of the model is discussed in the results and discussion section (Section 5) and conclusions are drawn in the penultimate section (Section 6). The last section (Section 7) covers the managerial implications.

2. Literature review

The oil and gas sector is classified into three sections: upstream, midstream, and downstream. The upstream consists of exploration and production. The midstream is the distribution system, consisting of tankers and pipelines that carry crude oil to refineries. The downstream includes refining, marketing, and retail distribution, through gasoline stations and convenience stores [19]. All these sectors have shown tremendous potential for the implementation of sustainable practices. The oil and gas industry has made significant progress in decreasing the impact of its operations on the environment [20]. The highest contributor of oil entering the global oceans is from natural seeps (46%), followed by consumers of oil by way of sewers, storm drains and water vehicles (37%), transportation of petroleum (11%) and oil and gas exploration and production (3%) [21]. The oil and gas industries are presently implementing the following practices towards sustainability-1. Improvement of energy efficiency in all the operations 2. Eliminating venting and flaring 3. Developing and implementing the proper technology for reducing CO_2 emissions, 4. Developing trading procedures for greenhouse gases [20].

The oil and gas industry is addressing the issue of habitat loss by the following practices- 1. Using technology to reduce the primary affects associated with oil and gas development, e. g. using inclined drilling from a central pad to decrease the footprint of the facility. 2. Reducing deforestation when making seismic surveys and constructing pipeline right of ways. 3. Restricting human use of new areas through control on access. 4. Developing best practices and tools with other stakeholders.

A sustainable organization contributes towards sustainable development by providing economical or financial, social, and environmental benefits [22]. Increasing global concerns about environmental issues such as climatic change, pollution and biodiversity loss and about social issues related to poverty, health, working circumstances, safety and inequity, have encouraged industry inclination towards sustainability [23].

2.1. Sustainable supply chain management (SSCM)

In the area of sustainable practices, Mukherjee and Mandal [24] examined relevant issues in managing the photocopier remanufacturing industry with the help of Interpretive Structural Modeling (ISM) methodology. Impact of workplace environment and use pattern of returns and issues related to marketing of remanufactured product were found to have the highest driving power. Product design issues relevant to remanufacturing process, level of technology and tools for remanufacturing, issues relevant to successful disassembly and reassembly planning, and role of skill and expertise of workforce had the highest dependence power. Faisal [25] presented an approach to effectively adapt sustainable practices in a supply chain by analyzing the dynamics between various enablers that help transform a supply chain into a truly sustainable entity. ISM approach was used to present a hierarchy-based model. Consumer concern towards sustainable practices, regulatory framework, awareness about sustainable practices in a supply chain and metrics to quantify sustainability benefits in a supply chain were found to have the highest driving and dependence power. Grzybowska [26] identified the enablers to sustainability in the supply chains (SC) and explored their mutual relationships. 16 enablers were identified out of which commitment from top management, and adequate adoption of reverse logistic practice (Environmental performance) had the highest driving and dependence power.

Hussain [27] presented a modeling framework of different enablers for sustainable supply chains and analyzed their inter-relationships and proposed alternatives for sustainable supply chain development. Enablers were identified and insights on the triple bottom line concept (environment, social, economic) of sustainability were provided. An

ISM approach was used to establish the relationship among various enablers for each dimension of sustainability and the results of ISM were used as an input to analytic network process (ANP) along with a potential list of alternatives to determine the best alternative(s) for developing sustainable supply chains. Voice of customer, governmental regulations, and risk management were found to have the highest driving and dependence power. Diabat and Kannan [28] developed a model of the drivers affecting the implementation of green supply chain management (GSCM) practices in organizations using an ISM methodology. Government regulation and legislation, reverse logistics and green design, and integrating quality had the highest driving and highest dependence power. Mathiyazhagan et al. [29] analyzed the barriers for the implementation of GSCM concepts, which was divided into two phases - identification of barriers and qualitative analysis. 26 barriers were identified based on literature and in consultation with industrial experts and academicians, and ISM analysis was used to understand the mutual influences amongst them. Dashore and Sohani [30] presented a hierarchical sustainable framework for evaluating the barriers to the implementation of GSCM in an organization. A total of 14 barriers were identified and ISM technique was applied to develop a structural model. Lack of government initiative system for GSCM practitioners and supplier's flexibility to change towards GSCM were the barriers with highest driving and dependence power. Muduli et al. [31] explored various behavioral factors affecting GCSM practices and their interactions, which help attain green-enabled needs of Indian mining industries. An ISM approach was employed to extract the interrelationships among the identified behavioral factors. Top management support and green innovation were identified as the factors having the highest driving and dependence power. Luthra et al. [32] identified various factors important for implementing GSCM relevant to Indian manufacturing industries. A contextual relationship among these factors was established using the ISM technique. Out of the ten identified factors, international environmental agreements and innovative green practice factors had the highest driving and dependence power. Kumar et al. [33] contributed towards an empirical research approach and collected primary data to rank different variables for effective customer involvement in green concept implementation in a supply chain. An ISM-based model was deployed to establish contextual relationships among the variables. For the research purpose, ten variables were identified, out of which green labeling and awareness level of customers were having the highest driving and dependence power. Sharma et al. [34] analyzed 12 barriers hindering the successful implementation of reverse logistics (RL). An ISM methodology was used to understand the mutual influences among the barriers. Lack of awareness and limited forecasting and planning had the highest driving and dependence power.

Kannan et al. [35] developed a multi-criteria group decision making (MCGDM) model in fuzzy environment to guide the selection process of best third party reverse logistics provider (3PRLP). The analysis was done through the ISM methodology and fuzzy technique for order preference by similarity to ideal solution (TOPSIS). Technical/engineering capability criteria had the highest driving power while reverse logistics cost had the highest dependence power. Kannan et al. [36] used ISM methodology for identifying and summarizing the relationships among specific attributes for selecting the best third party reverse logistics provider. It was concluded that attributes, namely reverse logistics functions and third party logistics services had the highest driving and dependence power.

Sarkis et al. [37] analyzed 11 barriers in the adoption of environmentally conscious manufacturing (ECM) practices with an ISM approach. Inappropriate evaluation and appraisal approaches and poor design-for-environment (DFE) interfaces had the highest driving and dependence power. Ojo et al. [38] identified drivers and barriers of GSCM practices adoption in Nigerian construction firms by using the ISM approach. The study showed that the lack of public awareness, lack of knowledge and environmental impacts, poor commitment by the top management and lack of legal enforcement and government represented the main barriers facing adoption of GSCM practices. Balasubramanian [39] presented a hierarchical sustainability framework by using ISM technique for evaluating the 12 barriers to the adoption of GSCM in the United Arab Emirates (UAE) construction sector. Shortage of resources and lack of understanding among stakeholders were found to have the highest driving dependence power. Luthra et al. [40] identified 11 barriers in implementing GSCM practices in Indian automobile industries and contextual relationship among these barriers was established. A hierarchy structural model was prepared using the ISM technique, lack of government support policies, and market competition and uncertainty had the highest driving and dependence power. Sandeep et al. [41] identified 15 important enablers to implement green concepts in the Indian automobile supply chain by using ISM. Government support and regulation and relative advantage had the highest driving and dependence power. In the area of implementation of renewable energy projects, Eswarlal et al. [42] analyzed 14 critical factors associated with sustainable development in India, using the ISM methodology. Leadership and sustainable growth and return on investment had the highest driving and dependence power. Eswarlal et al. [43] determined the 14 key CSFs of renewable energy implementation for sustainable development, and it was found that sustainable growth and return and public awareness were having the highest driving and dependence power. Kang et al. [44] developed a comprehensive evaluation model to select a suitable location for developing a wind farm. The factors to be considered were identified and by adopting the ISM technique, the interrelationships among the criteria under each merit were determined. A fuzzy analytic network process was used to calculate the importance of the criteria and to evaluate the expected overall performance of the wind farm projects. Muduli and Barve [45] identified potential barriers that hinder greening effort in the Indian mining industry by using an ISM approach. Lack of top management commitment, and waste management operational strategy had the highest driving and dependence power. Kholil and Tangian [46] chose ISM methodology to design the institutional model appropriate for the conditions surrounding the coral reefs, turtles and diversity of pelagic fish of Bunaken Marine Park to manage it as a sustainable tourist attraction. Nine main criteria and 15 sub-criteria were identified for the research work. Setting the number of visitors and increasing community involvement in the aspects of control were found to have the highest driving power and the highest dependence power. In the case of sub-criteria, national parks board had the highest driving power and two enablers, namely environmental and marine NGOs and the general public that had the highest dependence power. Muduli et al. [31] quoted that GSCM success in the mining industry has influenced human behaviors, and in their study, such behavioral factors were identified and ranked. Balaji et al. [47] explored ten barriers in the adoption of GSCM practices in the foundry sector and an ISM methodology was used to establish the interrelationship between the barriers. Lack of government regulation and legislation had the highest driving power and lack of acceptance of advancement in new technology had the highest dependence power.

Wang et al. [48] investigated the interactions between the 13 major barriers that prevent the practice of energy saving in China. Lack of awareness of energy saving, and lack of experience in technology had the highest driving and dependence power. Tseng and Lin [49] proposed 18 criteria on Taipei metropolitan municipal solid waste management (MSWM) activities to reduce air pollution. It was found that fuel or non-renewable energy consumption, atmospheric emissions and waste production had the highest driving and dependence power. Kumar et al. [50] identified the nine prime issues that underscore the selection of a supplier based on corporate social responsibility (CSR) and was validated using an ISM approach. It was found that safeguarding mechanism and underage labor had the highest driving and dependence power. Mangla et al. [51] identified different performance-focused criteria to GSCM implementation in their business. Mohanty and Prakash [52] empirically examined the GSCM practices in the Micro, Small and Medium enterprises in India and proposed that Indian MSMEs are facing significant pressures from external stakeholders to adopt GSCM practices. Muduli et al. [53] identified and quantified the adverse impact of barriers hindering GSCM implementation by using the literature review approach, graph theoretic and matrix approach. Luthra et al. [54] analyzed the key success factors behind successful achievement of environment sustainability in the Indian automobile industry supply chains. Six CSFs to implement GSCM for achieving sustainability and four expected performance measures of GSCM practices implementation were extracted using factor analysis. Further, interpretive ranking process modeling approach was employed to examine the contextual relationships among CSFs and to rank them with respect to performance measures. Luthra et al. [55] empirically analyzed the impact on expected organizational performance outcomes by current GSCM practices adopted by the Indian automobile industry. The results of this study suggested that environmental, economic, social and operational performances are improving with the implementation of GSCM practices. Mangla et al. [56] identified and analyzed several attributes for improving performance in GSCM adoption and implementation in the Indian context.

Table 1 enlists the papers published in the areas of sustainable practices using ISM methodology.

The organizations will implement GSCM practices if they identify that this will result in specific financial and operational gains [57]. If sustainable practices are more expensive, then they will not be implemented unless they are made mandatory by the government regulations or by customers or community. Regulations should consider changes in the tax code to encourage the organizations for the implementation of sustainable practices [58].

There are various barriers to the successful implementation of SSCM and all the barriers do not carry an equivalent impact on SSCM practices. Therefore, there is a strong need to determine the dominant factors required to adopt the SSCM practices and their impacts [59].

From the above literature review, it may be summarized that the past research studies on implementation of sustainable practices has been conducted in different countries as well as industries. Not many studies have covered the importance of SSCM implementation practices/issues in the Indian oil and gas industries. Very few research studies have been carried out in the area of oil and gas industries, and still fewer dealt with sustainable implementation practices. It shows that there is a research gap in the implementation of sustainable practices in the oil and gas sector. Hence, to deal with this issue, this research paper has attempted to identify the numerous CSFs to implement SSCM practices, and to explore the interdependency between them. The objective of this study is to develop a structural model of CSFs to implement SSCM on the sustainable driving and dependency forces in Indian oil and gas industries.

3. Research methodology

The objective of this paper is to develop a new conceptual framework for understanding the sustainability in the context of the oil and gas supply chains. Not much research work has been carried out in this area, and hence, the findings of this research will guide the organizations to re-consider their framework towards sustainable programs. The Interpretive Structural Modeling (ISM) methodology has been used in this study to establish the interrelationships between the identified CSFs for the sustainable supply chains and to identify the CSFs with the maximum driving and dependence power. The introduction to ISM methodology and steps involved in the approach are discussed in the following sections of the paper.

3.1. Introduction to ISM methodology

Interpretive Structural Modeling (ISM) is an interactive learning process in which a set of different and directly related elements are structured into a comprehensive systematic model. It is a suitable modeling technique for analyzing the influence of one variable on the other variables. The ISM model is an effective tool to identify and impose the relationships among specific elements within a system [60].

Table 1
Papers published in the areas of sustainable practices using ISM methodology.

SN	Author(s)	Year	Country	Problem/application area
1	Faisal [25]	2010	India	Dynamics for adapting sustainable practices in a supply chain
2	Grzybowska [26]	2012	Poland	Enablers to sustainability in the manufacturing industries SC
3	Hussain et al. [27]	2011	Canada	Enablers and alternatives to the sustainable supply chains
4	Diabat and Kannan [28]	2011	India	Drivers affecting the implementation of GSCM practices
5	Mathiyazhagan et al. [29]	2013	India	Barriers in the implementation of GSCM in the auto industries
6	Dashore and Sohani [30]	2013	India	A hierarchical framework for barriers in the adoption of GSCM
7	Muduli et al. [31]	2013	India	Behavioral factors affecting GCSM practices
8	Luthra et al. [32]	2012	India	Factors important to implement GSCM practices
9	Kumar et al. [33]	2013	India	Customer involvement in green concept implementation in a SC
10	Sharma et al. [34]	2011	India	Barriers hindering in the successful implementation of RL
11	Kannan et al. [36]	2012	India	Attributes for selecting the best 3PRLP
12	Sarkis et al. [37]	2006	UK	Barriers in the adoption of ECM
13	Ojo et al. [38]	2014	Nigeria	Barriers in implementing GSCM practices in Nigeria
14	Balasubramanian [39]	2012	UAE	Barriers in implementing GSCM practices in the UAE
15	Luthra et al. [40]	2011	India	Barriers in implementing GSCM practices in auto industries
16	Sandeep et al. [41]	2013	India	Enablers of green concept implementation in an automobile SC
17	Eswarlal et al. [42]	2011	India	Renewable energy adoption for sustainable development
18	Eswarlal et al. [43]	2011	India	Interactions among variables of renewable projects
19	Kang et al. [44]	2011	Taiwan	Wind farm performance evaluation
20	Muduli and Barve [45]	2012	India	Barriers to green practices in the health care waste sector
21	Kannan et al. [35]	2009	India	Selection of reverse logistics provider
22	Mukherjee and Mandal [24]	2009	India	Issues relating to remanufacturing technology
23	Kholil and Tangian [46]	2012	Indonesia	Ecological and economic functions of Bunaken national park
24	Balaji et al. [47]	2014	India	Barriers in implementing the GSCM practices
25	Wang et al. [48]	2008	China	Interactions among the barriers to energy saving
26	Tseng and Lin [49]	2011	Taiwan	Hierarchical structure of municipal solid waste management
27	Kumar et al. [50]	2014	India	Analyzing the CSR issues behind the supplier selection process

It is a well-established methodology for identifying relationships among specific items, which define a problem or an issue [61]. Researchers use this methodology for understanding direct and indirect relationships among the various variables in different industries [62].

In the ISM methodology, a systematic application of some elementary notions of graph theory are used in such a way that conceptual, theoretical and computational leverage are exploited to explain the complex pattern of contextual relationship among the set of variables [63]. It is primarily intended as a group learning process, but can also be used individually. The ISM process transforms unclear, poorly articulated mental models of systems into visible, well-defined models useful for many purposes. It can act as a tool for imposing order and direction on the complexity of relationships among the variables [61]. The advantages and disadvantages of this methodology are explained below.

Advantages of ISM methodology-

1. It helps in presenting a complicated system in a simplified way.
2. It provides an interpretation of the fixed object.
3. It facilitates the identification of the structure within a system.

Limitations of ISM methodology-

1. The ISM tool can be used only by the persons who possess knowledge about the ISM methodology and are trained to interpret the data.
2. Use of computers is necessary and the technique may be difficult to apply if computer facilities are not available.
3. The interpretation of links is partial, thereby exposing the model to multiple interpretations by the user.
4. It remains silent on the causality of links and, thus, poses limitations in answering why in theory building [64].
5. The relation among the variables always depends on the person's knowledge and the bias of the person who is judging the variables and their familiarity with the firm, its operations, and its industry [65].

In order to overcome the limitations of this methodology and to get accurate solutions of a problem or for the validation purpose, an integrated ISM methodology can be used.

The steps involved in the ISM approach [35,65] are given below-

Step 1: The CSFs of sustainability in Indian oil and gas industries are identified and listed.
Step 2: A contextual relationship is established between each pair of the CSFs identified in step 1.
Step 3: A structural self-interaction matrix (SSIM) of CSFs is formulated; this indicates pair-wise relationship between CSFs of the system.
Step 4: A reachability matrix is formulated from the SSIM and the same is checked for transitivity of the contextual relation. This is an elementary supposition in the ISM technique, which states that if a driver 'X' is related to 'Y' and 'Y' is related to 'Z', then 'X' is related to 'Z'.
Step 5: The final reachability matrix obtained in step 4 is partitioned into different levels.
Step 6: A directed graph is drawn based on the relationships of the final reachability matrix, and the transitive links are removed.
Step 7: The resulting digraph is converted into an ISM model by replacing the element nodes with the statements.
Step 8: The ISM model developed in step 7 is reviewed to check for conceptual inconsistencies, and necessary modifications are made.
All the above steps are shown in Fig. 1.

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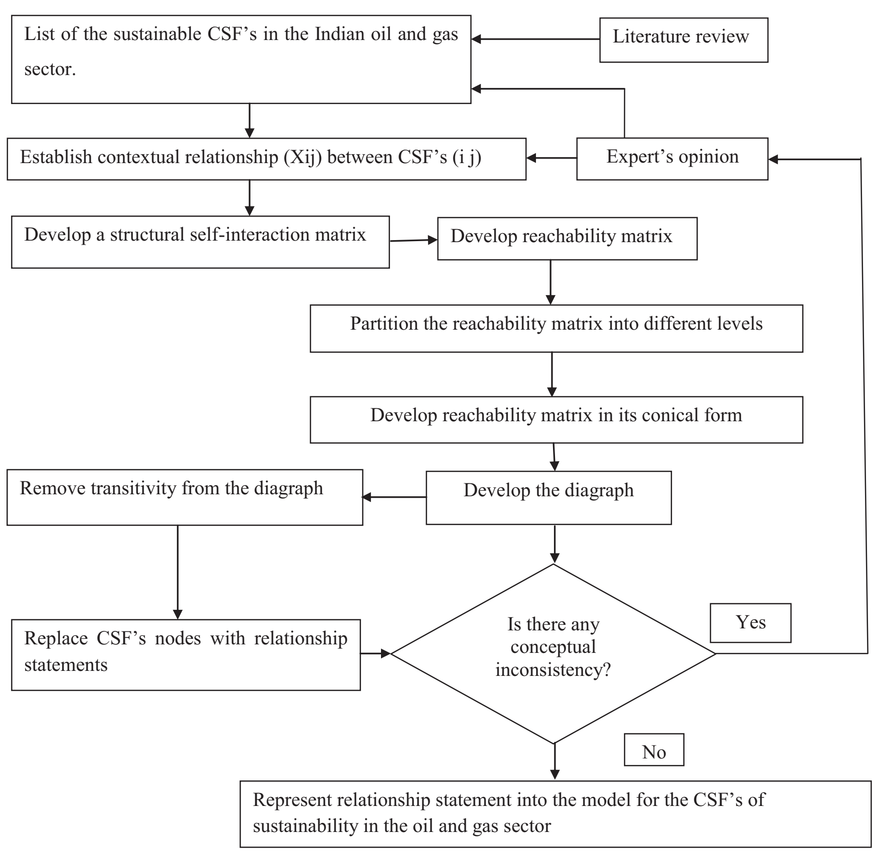

Fig. 1. Flow chart for preparing the ISM model of CSF's for sustainability analysis [modified from 29,35,65].

Table 2
The CSF's for sustainability in the oil and gas industries.

S.N	CSF's	Brief description	Author's
I	**Environmental factors**		
1	Hazardous materials	Sustainable practices in an organization reduce the consumption of hazardous/harmful/toxic materials which have a very bad affect on the environment and mankind.	[66–70]
2	Environmental disasters	As the sustainable practices include environmental friendly activities, therefore, it reduces the frequency of environmental disasters; it also reduces the pollution of all types and categories, reduces waste generation and solves the problem of waste disposal effectively.	[66–72]
3	Energy consumption	This is achieved by the green design and green practices in the organization. It gives in better usage of financial resources of an organization.	[28,73–76]
4	Reverse logistics	It deals with the operations related to the reuse of the products. Refurbishing and remanufacturing activities are also included in the reverse logistics.	[28,73–75,77–83]
5	Global climatic pressure and ecological scarcity of resources	Some of the resources are limited; hence use of these types of resources should be optimized in order to save resources for the future use.	[67,69,72,82,84–93]
6	Green design	Green design saves the material and its cost, reduces emissions, accidents, energy consumption, waste. It satisfies the customers and gives competitive advantage to the firm.	[28,81,82,94–96]
7	Green purchasing	Green purchasing is a process which consists of activities involving reduction, reuse and recycling of materials.	[66,97]
8	Green Manufacturing	It comprises of the sustainable principles, techniques and operations for the manufacturing of a product, which will consume less energy and utilizes inputs with low environmental impact, as well as processes which pollute less and produce zero waste and contamination.	[98]
II	**Economic factors**		
9	Cost reduction	Sustainable practices include reduction, reuse and recycling of the materials, which in turn reduces the cost of purchasing materials, manufacturing of components, time required for the manufacturing, energy consumption, waste treatment, waste discharge and logistics.	[40,66,67,69,70,72,77,91,99,100]
10	Reduction of fine for environmental disasters	Because of implementation of the sustainable practices, safety increases and decreases the probability of environmental disasters.	[66]
11	Financial incentives	Giving financial incentives or rewards or tax rebate or soft loans will encourage the companies for Implementing sustainable practices.	[98]
III	**Regulatory factors**		
12	Environmental regulations	Government formulates environmental guidelines (e.g. hazardous and toxic regulation) to be followed by the organizations and there is always a threat of penalty to the organizations for not obeying the laws.	[40,85,101–109]
13	Corporate Social Responsibility (CSR)	It is an integral part of the wealth creation process, even though it doesn't provide an immediate financial benefit to the company, if managed properly it will enhance the competitiveness of business and maximize the returns.	[85]
14	Regulations and standards (e.g. ISO 14000 and eco labeling)	Certifications boost organizations towards quality improvement, with an eco-friendly approach. ISO 14000 has a vital role to play in the environmental friendly activities between supplier & customer.	[28,73,74,80,82,95,96]
IV	**Social factors**		
15	Environmental friendly products	These days' customers are very demanding for the high quality and environmentally friendly products because of the general awareness.	[85,110]
16	Customers awareness to green initiatives	The contributions which they can make towards the sustainability can be made understand, like proper and efficient use of a particular component.	[28,77,111,112]
17	Community pressure	Community groups are not essentially included in the company's group of partners, but they are familiar with the company and the community.	[85,98,113,114]
18	Environmental collaboration with customers	Customers should be encouraged to gain the knowledge on sustainability and they should be the motivated to use environmentally friendly products and services.	[28,74,75,80,91,102,115,116]
19	Employability	As the implementation of sustainable practices at various stages in an organization requires positive changes to be made in all the procedures and processes, which demands good infrastructure and trained man power.	[108,111,117–122]
V	**Knowledge factors**		
20	Training and education	The awareness among the members of top management about the benefits of sustainability will help them to take eco-friendly decisions.	[40,77,97,98,120,123,124]
21	Availability of information	Without the sufficient knowledge and information on green practices it becomes very difficult to implement the same.	[98,125–129]
VI	**Business environmental factors**		
22	Brand image and market share	Green image of a company gives a positive brand image, helps to increase the market share and profitability.	[28,67,68,72,73,77,85,115,130–132]
23	Global marketing	Companies can advertise their products on the basis of green image of a company, which gives a competitive edge in the global marketing space and since the companies are following the environmental standards new markets are open to them.	[85]
24	Competitive advantage	Companies which have implemented sustainable practices have a very good competitive advantage over the other companies not practicing it, which ultimately gives financial gains to the organization. Global competitiveness is a very important driver for the sustainable practices in an organization.	[73,77,83,85,102,133–135]
25	Investors and shareholders pressure	A shareholders or investors have a stake in the organization. They also have a right to receive dividends which the company declares.	[85,136]
26	Competitors pressures towards greening	Competitors having environmental management system will get benefited by the competitive advantage, positive brand image and there will be monetary gains for the	[98,137]

(continued on next page)

Table 2 *(continued)*

S.N	CSF's	Brief description	Author's
		competitors.	
27	Business to business pressure	Large organization as per their organizations green policies, may give assignments to the small organizations only if they are green certified organizations.	[98]
28	Suppliers pressure and willingness	Suppliers can provide valuable ideas and suggestions which can be implemented for the sustainability, it may be noted that this CSF doesn't act as a direct driving force, but, cooperation and integration in supply chains can support more effectively towards sustainability.	[85,138–140]
29	Environmental collaboration with suppliers	Collaborations can be made with the eco-friendly suppliers in order to have good relationship with them and to improve quality of the products.	[28,37,73,82,91,108,122,126,140–143]
VII	**Organizational factors**		
30	Health and safety	Organizational health and safety should promote and maintain the good degree of physical, mental and social well- being of workers of the organization, in order to promote the sustainability.	[85,144]
31	Organizational capabilities and efforts	The evaluation of capabilities of organization is mandatory before going for the implementation of green practices and also evaluation should be done on the efforts required to maintain the sustainability in the organization.	[85,98]
32	Organizational management	Organizational commitment from top level managers and support from mid-level managers and other employees is very much necessary.	[72,77,87,98,108,109,120,124,144–147]

Table 3
The Structural Self Interaction Matrix (SSIM) of CSF's.

C.N	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2
1	A	A	V	A	A	A	A	A	V	V	V	A	A	V	X	A	A	A	A	A	A	V	V	V	X	X	X	A	X	O	V
2	A	A	A	A	A	A	A	A	V	V	V	A	A	V	X	A	A	A	A	A	A	V	V	V	X	X	X	A	X	A	
3	A	A	A	A	A	A	A	A	V	V	V	A	A	V	X	A	A	A	A	A	A	V	V	V	X	X	X	A	X		
4	A	A	V	A	A	A	A	A	V	V	V	A	A	V	A	A	A	A	A	A	A	V	V	V	X	X	X	A			
5	V	A	V	V	V	V	O	V	V	V	V	V	V	V	V	V	O	V	V	V	V	V	V	V	V	V	V				
6	A	A	V	V	A	A	A	A	V	V	V	A	A	V	A	A	A	A	A	A	A	V	V	V	V	V					
7	A	A	V	A	A	A	A	A	V	V	V	A	A	V	A	A	A	A	A	A	A	V	V	V	V						
8	A	A	V	A	A	A	A	A	V	V	V	A	A	V	V	A	A	A	A	A	A	V	V	V							
9	A	A	O	A	A	A	A	A	V	V	V	A	A	V	A	A	A	A	A	A	A	V	A								
10	A	A	A	A	A	A	A	A	V	V	V	A	A	V	A	A	O	A	A	A	A	V									
11	A	A	O	A	A	A	A	A	V	V	V	O	X	V	A	A	O	A	A	A	A										
12	V	V	V	V	V	V	V	O	V	V	V	V	V	V	V	O	O	V	V	V											
13	A	A	V	V	A	A	A	A	V	V	V	V	X	V	V	A	A	A	V												
14	A	A	V	V	A	A	A	A	V	V	V	X	X	V	V	A	A	A													
15	V	V	V	V	V	V	V	V	O	O	O	V	V	V	V	V	O														
16	V	V	V	V	V	V	V	V	O	O	O	O	V	V	V	A															
17	V	V	V	V	V	V	V	O	O	O	O	V	V	V	V																
18	A	A	A	A	A	A	A	A	V	V	V	O	O	V																	
19	A	A	O	A	A	A	A	A	V	V	V	O	O																		
20	A	A	V	A	A	A	A	A	V	V	V	A																			
21	A	A	V	X	A	A	A	A	O	O	O																				
22	A	A	A	A	A	A	A	A	V	V																					
23	A	A	V	A	A	A	A	A	V																						
24	A	A	A	A	A	A	A	A																							
25	V	V	V	V	V	V	V																								
26	V	V	V	V	O	A																									
27	V	V	V	V	V																										
28	V	O	V	V																											
29	A	A	V																												
30	A	A																													
31	A																														

4. Case study

The environmental effect of petroleum is frequently negative because it is toxic to almost all forms of life and its extraction has been implicated in climate change. Petroleum, commonly referred to as oil, is thoroughly linked to virtually all aspects of the present society, especially for transportation and heating for homes and for commercial and industrial activities.

The upstream activities in India comprise of land offshore and deep water E & P Coal Bed Methane (CBM) and a National Gas Hydrate (NGHP). Currently, 40 companies are contributing in the upstream E & P accomplishments in India, of which 23 are actually functioning. The combinations consist of Public Sector Undertakings (Government majority Companies-PSUs), private Indian companies and international oil companies. India has 26 sedimentary basins spanning 3.14 million sq. km of which 1.35 million sq. km. is in deep water (beyond 200 m isobaths).

Till the late 1980s, all the upstream activities were conducted by the Oil and Natural Gas Corporation (ONGC) and Oil India Limited (OIL), the two National Oil Companies (NOCs), and the land was given to them on a nomination basis. In the 1990s, some unexplored as well as discovered areas were opened for international competitive bidding. This led to the pronouncement of the New Exploration and Licensing Policy (NELP) in 1998. Since then, the practice of nomination has been stopped, and the entire land is given through competitive bidding under NELP rounds.

XYZ is a fully integrated oil and gas company of international scale with strong presence across the hydrocarbon value chain from explora-

Table 4
The initial reachability matrix for the sustainable CSF's.

C.N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1	1	1	0	1	0	1	1	1	1	1	1	0	0	0	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	1	0	0
2	0	1	1	1	0	1	1	1	1	1	1	0	0	0	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	0	0	0
3	0	0	1	1	0	1	1	1	1	1	1	0	0	0	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	0	0	0
4	1	1	1	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0	0	1	0	0
5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1
6	1	1	1	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0	1	1	0	0
7	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0	0	1	0	0
8	1	1	1	1	0	0	0	1	1	1	1	0	0	0	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	1	0	0
9	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	1	1	1	0	0	0	0	0	0	0	0
12	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1
13	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	0	0	1	1	1	1	1	1	1	0	0	0	0	1	1	0	0
14	1	1	1	1	0	1	1	1	1	1	1	0	0	1	0	0	0	1	1	1	1	1	1	1	0	0	0	0	1	1	0	0
15	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1
16	1	1	1	1	0	1	1	1	1	0	0	0	1	1	0	1	0	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1
17	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1
18	1	1	1	1	0	1	1	0	1	1	1	0	0	0	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0
20	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	0	0	0	0	1	0	1	1	1	0	0	0	0	0	1	0	0
21	1	1	1	1	0	1	1	1	1	1	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0
22	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0
23	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0
24	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
25	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
26	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	0	0	1	1	1	1	1	1	1	0	1	0	0	1	1	1	1
27	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	0	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1
28	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	0	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1
29	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	1	1	0	0
30	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	1	0	0
31	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	0	1	1	1	1	1	1	1	0	0	0	0	1	1	1	0
32	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	0	0	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1

Table 5
The final reachability matrix for the sustainable CSF's.

C.N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	Dr.P
1	1	1	0	1	0	1	1	1	1	1	1	0	0	0	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	1	0	0	**15**
2	0	1	1	1	0	1	1	1	1	1	1	0	0	0	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	1	0	0	**15**
3	0	0	1	1	0	1	1	1	1	1	1	0	0	0	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	0	0	0	**13**
4	1	1	1	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0	0	1	0	0	**15**
5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	**30**
6	1	1	1	1	0	1	1	1	1	1	1	0	0	0	0	0	0	1	1	0	0	1	1	1	0	0	0	0	1	1	0	0	**17**
7	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	1	0	0	**15**
8	1	1	1	1	0	0	0	1	1	1	1	0	0	0	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	1	0	0	**14**
9	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	**6**
10	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	**7**
11	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	1	0	1	1	1	0	0	0	0	0	0	0	0	**7**
12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	**29**
13	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	0	0	1	1	1	1	1	1	1	0	0	0	0	1	1	0	0	**21**
14	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	0	0	1	1	1	1	1	1	1	0	0	0	0	1	1	0	0	**21**
15	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	**26**
16	1	1	1	1	0	1	1	1	1	0	0	0	1	1	0	1	0	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	**22**
17	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	**25**
18	1	1	1	1	0	1	1	0	1	1	1	0	0	0	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	1	0	0	**15**
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	**4**
20	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	0	0	0	0	1	0	1	1	1	0	0	0	0	0	1	0	0	**17**
21	1	1	1	1	0	1	1	1	1	1	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	**15**
22	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	**4**
23	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	**5**
24	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	**2**
25	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**27**
26	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	0	0	1	1	1	1	1	1	1	0	1	0	0	1	1	1	1	**24**
27	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	0	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	**26**
28	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	0	0	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	**23**
29	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	0	0	1	1	1	1	1	1	1	0	0	0	0	1	1	0	0	**21**
30	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	1	1	0	0	0	0	0	1	0	0	**8**
31	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	0	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	**24**
32	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	0	0	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	**23**
De.P	**22**	**24**	**27**	**24**	**3**	**22**	**23**	**23**	**27**	**25**	**25**	**2**	**16**	**16**	**3**	**2**	**3**	**22**	**26**	**17**	**14**	**27**	**27**	**28**	**4**	**7**	**7**	**8**	**16**	**25**	**10**	**11**	

Table 6
Level partition of the reachability matrix.

C.N	Reachability set	Antecedent set	Intersection	Level
1	1,2,4,6,7,8,9,10,11,18,19,22,23,24,30	1,4,5,6,7,8,12,13,14,15,16,17,18,20, 21,25,26, 27,28,29,31,32	1,4,6,7,8,18	**VIII**
2	2,3,4,6,7,8,9,10,11,18,19,22,23,24,30	1,2,4,5,6,7,8,12,13,14,15,16,17,18, 20,21,25,26, 27,28,29,30,31,32	2,4,6,7,8, 18,30	**VIII**
3	3,4,6,7,8,9,10,11,18,19,22,23,24	2,3,4,5,6,7,8,12,13,14,15,16,17,18,20, 21,22,23, 24,25,26,27,28,29,30,31,32	3,4,6,7,8, 18,22,23,24	**VIII**
4	1,2,3,4,6,7,8,9,10,11,19,22,23,24,30	1,2,3,4,5,6,7,8,12,13,14,15,16,17,18, 20,21,25, 26,27,28,29,31,32	1,2,3,4, 6,7,8,	**VIII**
5	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15, 17,18,19,20,21,22,23,24,25,27,28, 29,30,31,32	5,12,31	5,12,31	**XVII**
6	1,2,3,4,6,7,8,9,10,11,18,19,22,23, 24,29,30	1,2,3,4,5,6,12,13,14,15,16,17,18,20, 21,25,26, 27,28,29,31,32	1,2,3,4,6, 18,29	**IX**
7	1,2,3,4,7,8,9,10,11,18,19,22,23,24,30	1,2,3,4,5,6,7,12,13,14,15,16,17,18, 20,21,25, 26,27,28,29,31,32	1,2,3,4,7,18	**VIII**
8	1,2,3,4,8,9,10,11,18,19,22,23,24,30	1,2,3,4,5,6,7,8,12,13,14,15,16,17, 20,21,25, 26,27,28,29,31,32	1,2,3,4,8	**VII**
9	9,11,19,22,23,24	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15, 16,17,18, 20,21,25,26,27,28,29,31,32	9,11	**IV**
10	9,10,11,19,22,23,24	1,2,3,4,5,6,7,8,10,12,13,14,15,17,18, 20,21,25, 26,27,28,29,30,31,32	10	**V**
11	11,19,20,22,23,24	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15, 17,18,20, 25,26,27,28,29,31,32	11,20	**V**
12	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15, 18,19, 20,21,22,23,24,26,27,28,29, 30,31,32	5,12	5,12	**XVII**
13	1,2,3,4,6,7,8,9,10,11,13,14,18,19, 20,21,22,23,24,29,30	5,12,13,14,15,16,17,20,21,25,26,27,28,29,31,32	13,14,20, 21,29	**IX**
14	1,2,3,4,6,7,8,9,10,11,13,14,18,19, 20,21,22,23,24,29,30	5,12,13,14,15,16,17,20,21,25,26,27, 28,29,31,32	13,14,20, 21,29	**IX**
15	1,2,3,4,6,7,8,9,10,11,13,14,15,17,18, 19,20,21,25,26,27,28,29,30,31,32	5,12,15	15	**XVI**
16	1,2,3,4,6,7,8,9,13,14,16,18,19,20, 25,26,27,28,29,30,31,32	16,17	16	**XIV**
17	1,2,3,4,6,7,8,9,10,11,13,14,16,17,18, 19,20,21,26,27,28,29,30,31,32	5,15,17	17	**XV**
18	1,2,3,4,6,7,9,10,11,18,19,22,23,24,30	1,2,3,5,6,7,8,12,13,14,15,16,17,18, 25,26,27,28, 29,30,31,32	1,2,3,6,7, 18,30	**VIII**
19	19,22,23,24	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15, 16,17,18,19, 25,26,27,28,29,31,32	19	**III**
20	1,2,3,4,6,7,8,9,10,11,13,14,20,22,23, 24,30	5,11,12,13,14,15,16,17,20,21,25, 26,27,28,29, 31,32	11,13,14, 20	**IX**
21	1,2,3,4,6,7,8,9,10,13,14,20,21,29,30	5,12,13,14,15,17,21,25,26,27,28,29, 31,32	13,14,21,29	**IX**
22	3,22,23,24	1,2,3,4,5,6,7,8,9,10,11,12,13,14,18, 19,20,22,23 25,26,27,28,29,30,31,32	3,22,23	**II**
23	3,23,24,30	1,2,3,4,5,6,7,8,9,10,11,12,13,14,18, 19,20,22, 23,25,26,27,28,29,31,32	3,23	**III**
24	3,24	1,2,3,4,5,6,7,8,9,10,11,12,13,14,18,19, 20,22,23,24,25,26,27,28,29,30,31,32	3,24	**I**
25	1,2,3,4,6,7,8,9,10,11,13,14,18,19,20, 21,22,23,24,25,26,27,28,29,30,31,32	5,15,16,25	25	**XIII**
26	1,2,3,4,6,7,8,9,10,11,13,14,18,19,20, 21,22,23,24,26,29,30,31,32	12,15,16,17,25,26,27	26	**XI**
27	1,2,3,4,6,7,8,9,10,11,13,14,18,19,20, 21,22,23,24,26,27,28,29,30,31,32	5,12,15,16,17,25,27	27	**XII**
28	1,2,3,4,6,7,8,9,10,11,13,14,18,19,20, 21,22,23,24,28,29,30,32	5,12,15,16,17,25,27,28	28	**XI**
29	1,2,3,4,6,7,8,9,10,11,13,14,18,19, 20,21,22,23,24,29,30	5,6,12,13,14,15,16,17,21,25,26,27, 28,29,31,32	6,13,14, 21,29	**IX**
30	2,3,10,18,22,23,24,30	1,2,4,5,6,7,8,12,13,14,15,16,17,18, 20,21,23,25, 26,27,28,29,30,31,32	2,18,23, 30	**VI**
31	1,2,3,4,5,6,7,8,9,10,11,13,14,18,19, 20,21,22,23,24,29,30,31,32	5,12,15,16,17,25,26,27,31,32	5,31,32	**X**
32	1,2,3,4,6,7,8,9,10,11,13,14,18,19, 20,21,22,23,24,29,30,31,32	5,12,15,16,17,25,26,27,28,31,32	31,32	**X**

Iteration I to Iteration XVII

tion and production to refining and oil retail. XYZ has a portfolio of onshore and offshore oil and gas blocks with about 1.7 billion barrels of oil equivalent in reserves and resources. XYZ oils owns India's fifth largest single site refinery at, xxx, Western India, having a capacity of 20 million metric tons per annum (MMTPA). The refinery is capable of processing some of the toughest crudes and produces high quality Euro IV and V grade products. Due to environmental regulations, XYZ Oil Company is committed to implementing sustainable practices. In this paper, the CSFs for the implementation of the same are identified. The procedure involved a literature survey and opinions of the expert team of the various oil and gas industries. The CSFs identified in this study are shown in Table 2.

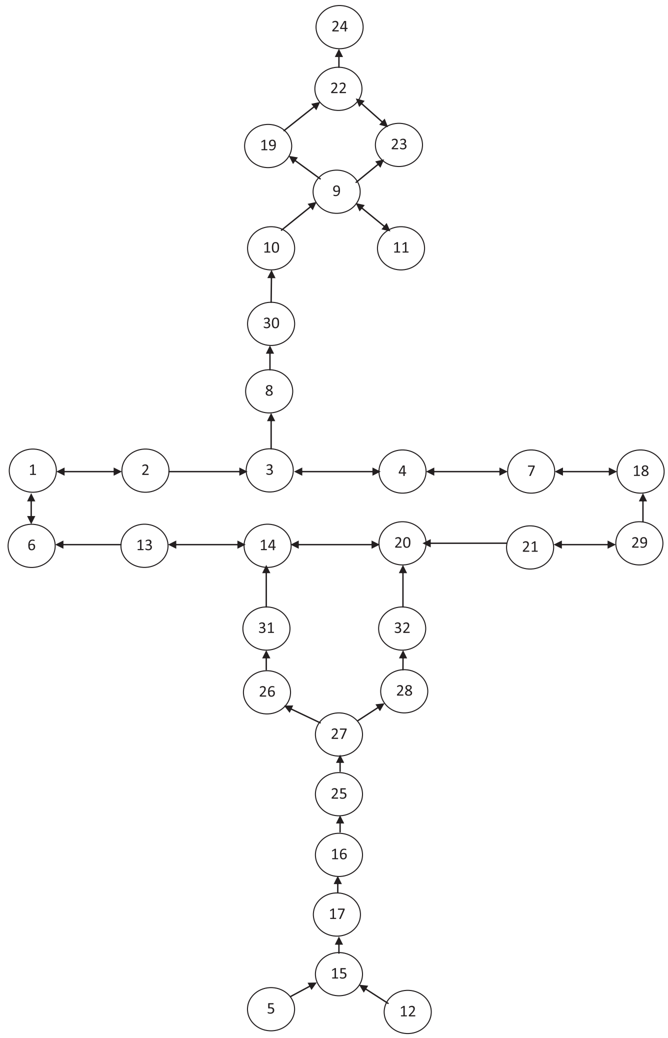

Fig. 2. Final digraph depicting relationship among the CSF's.

The ISM methodology was applied to the sector being studied. Various steps leading to the formulation of the ISM model are discussed below.

4.1. Identification of the sustainable CSFs in the oil and gas industries being studied

The important sustainable CSFs were identified through a literature review and expert's opinion from the oil and gas industries. The major drivers identified in this study are shown in Table 2.

4.2. Development of Structural Self-Interaction Matrix (SSIM)

The Structural Self-Interaction Matrix (SSIM) was formulated based on the contextual relationship between the 32 identified CSFs, which is shown in Table 3. For analyzing the CSFs in developing the SSIM, the following four symbols were used to denote the direction of the relationship among the CSFs (i and j).

V	CSF i will help to achieve CSF j,
A	CSF j will help to achieve CSF i,
X	CSFs i and j will help to achieve each other, and
O	CSFs i and j are not related

4.3. Reachability matrix

The initial reachability matrix (binary matrix) shown in Table 4 was developed from the SSIM using the following rules.

If the (i, j) entry in the SSIM is V, the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry becomes 0;

If the (i, j) entry in the SSIM is A, the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry becomes 1;

If the (i, j) entry in the SSIM is X, the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry also becomes 1; and

If the (i, j) entry in the SSIM is O, the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry also becomes 0.

The final reachability matrix was formulated by adding transitivity manually to the initial reachability matrix, which is shown in Table 5.

4.4. Level partitions

From the final reachability matrix (Table 5), the reachability and antecedent set for each sustainable CSF was obtained. The reachability set for an individual CSF consists of itself and the other CSFs, which it may help to achieve. The antecedent set consists of the CSFs themselves and the other CSFs, which may help in achieving it. The intersection of both these sets is derived for all CSFs. The sustainable CSFs, for which the reachability and the intersection sets are the same, secure the top level (level I) in the ISM hierarchy. This is a CSF that does not help achieve any other CSF above its own level [65]. After identifying the top-level CSF, it is separated from the remaining ones. The same procedure is repeated to find the CSFs of the next level, until the level of each CSF is evaluated. These levels help in building the diagraph and the final model [148]. In the present study, the 32 CSFs (initial to final iteration), along with their reachability set, antecedent set, intersection set and the initial and final level of all the CSFs is shown in Table 6. The level evaluation process of all the 32 CSFs was completed in 17 iterations. The identified levels help in constructing the digraph and the final ISM model.

4.5. Formation of the ISM model

A structural model was developed from the final reachability matrix (Table 5). If there is a relationship between the CSFs i and j, this is shown by an arrow that points from i to j and the generated graph is called an initial directed graph or initial digraph. After removing the transitivity from the initial diagraph, the final directed graph was formed, which is shown in Fig. 2. Later, this final digraph was transformed into an ISM model, as shown in Fig. 3...

4.6. MICMAC analysis

In the present study, Matrices' Impacts Croises Multiplication Applique´ and Classment (MICMAC) analysis was used to identify the sustainable CSFs in the field of oil and gas, based on their driving and dependence power. From the final reachability matrix, the driving and dependence power of each of the sustainable CSFs was calculated.

The identified CSFs were classified into four sectors/clusters, which are explained below-

Autonomous: These are the CSFs with a weak driving power as well as a weak dependence power.

Dependent: These are the CSFs with a weak driving power but a strong dependence power.

Linkage: These are the CSFs with strong driving as well as dependence power.

Driving or independent CSFs: These are the CSFs, which have a strong driving power but weak dependence power [65,149]. The driving and the dependence power diagram for CSFs has been shown in Fig. 4..

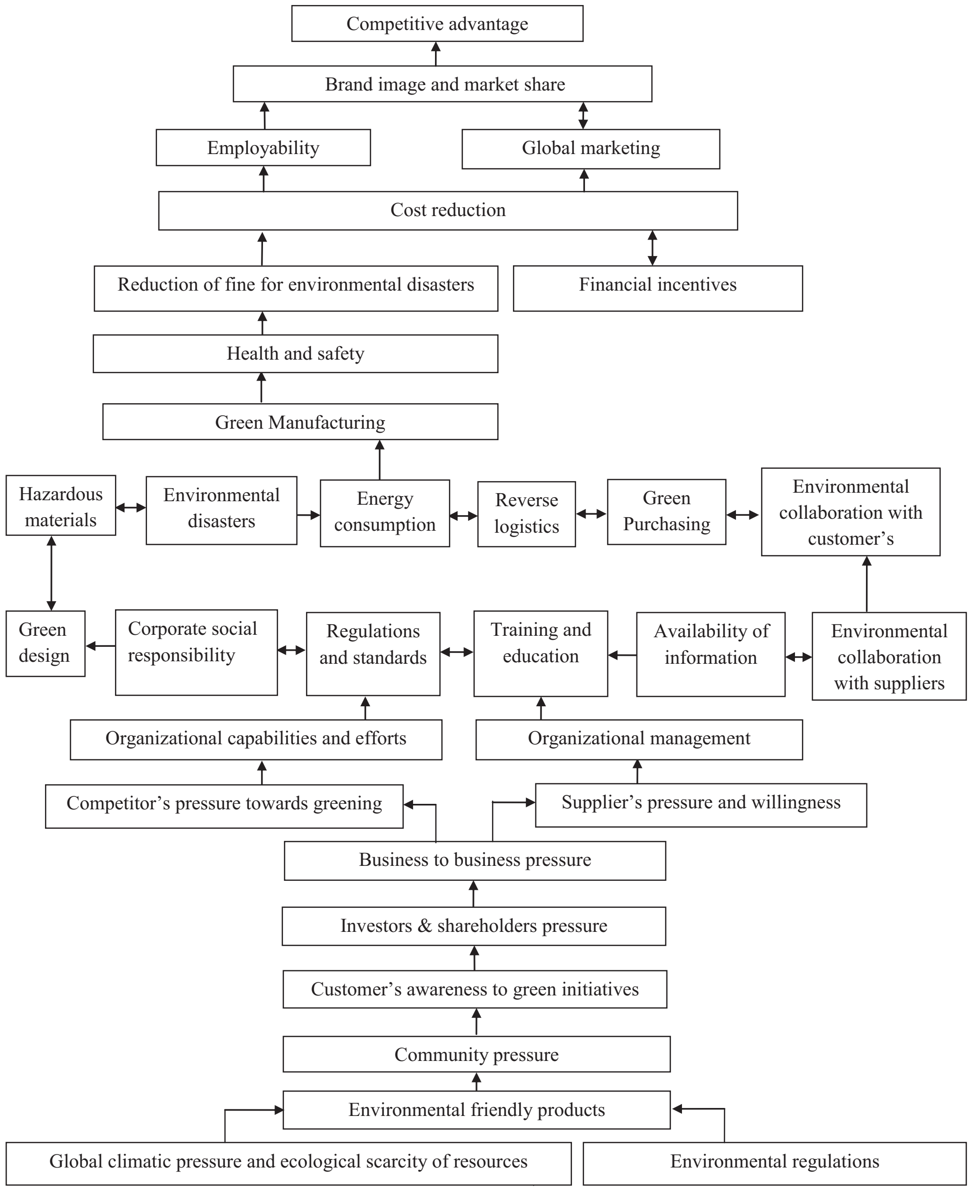

Fig. 3. ISM based model.

It may be noted that one CSF (C5), namely global climatic pressure and ecological scarcity of resources had the highest driving power while another CSF (C24), namely competitive advantage had the highest dependence power.

5. Results and discussions

The CSFs for sustainability show considerable challenges, because of the complex nature of green practices, customer, supplier, cost pressures and regulation uncertainty. In fact, implementing sustainability practices is considered as a thankless task that increases overall cost of the product [124]. The top management of the firm and decision-makers must have the knowledge of the importance of the various sustainable CSFs and the tools and techniques for implementing the same.

In the present study, an ISM model was developed considering the 32 important sustainable CSFs, based on a thorough literature review and experts' opinion. A Structural Self – Interaction Matrix (SSIM) was developed and the inter-relationship among all these drivers was analyzed using the ISM methodology and MICMAC analysis. Then, the 32 sustainable CSFs were iterated in 17 levels and a structure of ISM was developed, as shown in Fig. 2.

The top two CSFs of the structure of the model, namely, competitive advantage (C24) and brand image and market share (C22) were found to play the least influential role as compared to the other 30 CSFs. These CSFs encouraged less regarding the adoption of sustainability practices in Indian oil and gas industries and, hence, demand the least attention. From the third iteration to the seventh iteration, there were seven drivers, namely, employability (C19), global marketing (C23) (at the third level), cost reduction (C9) (at the fourth level), reduction of fine for environmental disasters (C10), financial incentives (C11) (at the fifth level), health and safety (C30) (at the sixth level), and green manufacturing (C8) (at the seventh level).

It may be noted that the CSFs that fall under this category (from iteration one to iteration seven) are less important as compared to the CSFs that are below this level, as they have relatively less influencing capability. From iteration eight to iteration eleven there were 17 CSFs that fell under the intermediate portion of the structural model hierarchy and had the power to influence the drivers of the top category. These were the CSFs that may be underscored as they provide

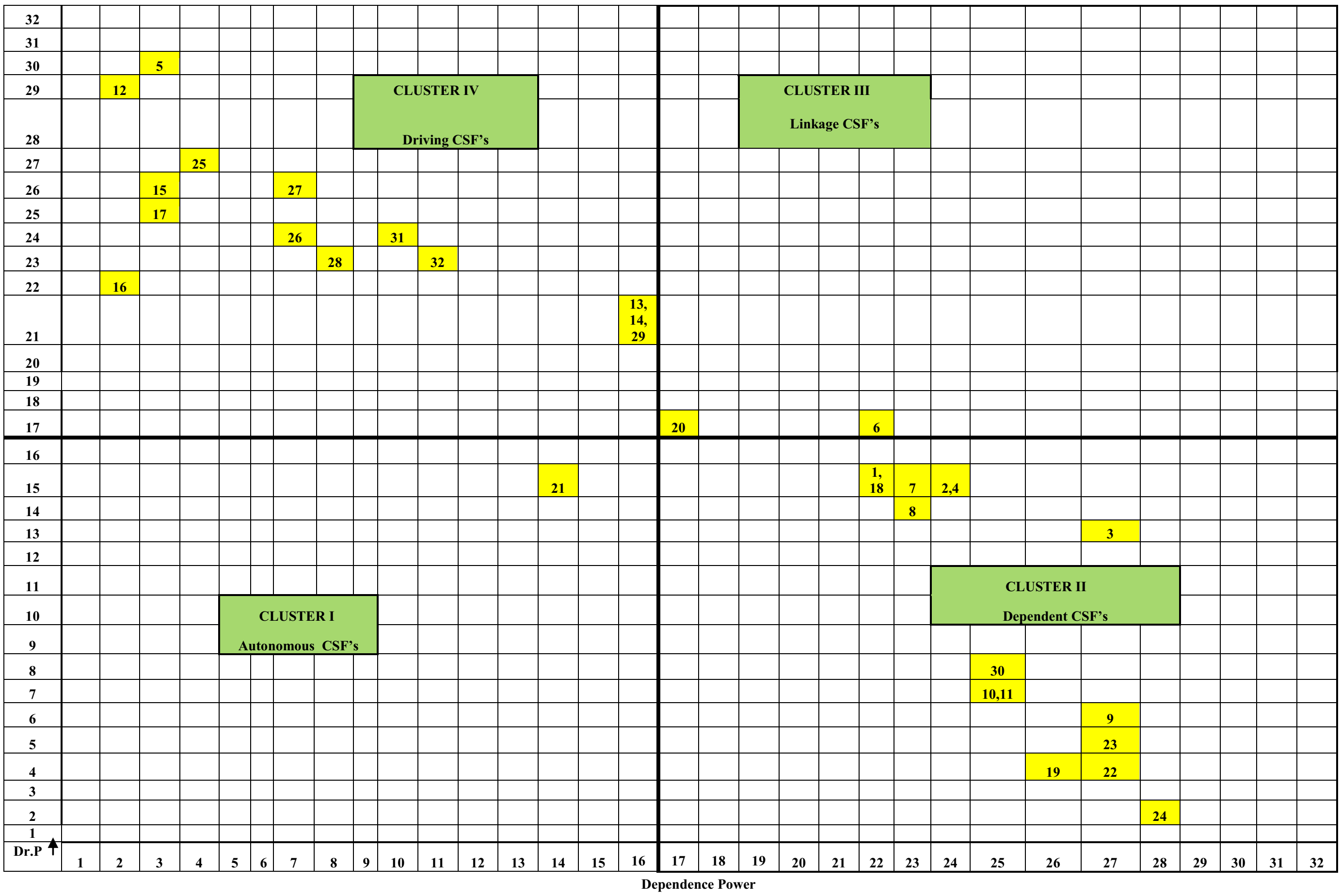

Fig. 4. The cluster of oil and gas sector sustainable CSF's.

some motivation and encouragement towards the adoption of sustainable practices in the industries being studied. The intermediate CSFs are hazardous materials (C1), environmental disasters (C2), energy consumption (C3), reverse logistics (C4), green purchasing (C7), environmental collaboration with customers (C18) (at the eighth level), green design (C6), corporate social responsibility (C13), regulations and standards (e.g. ISO 14000 and eco-labeling) (C14), training and education (C20), availability of information (C21), environmental collaboration with suppliers (C29) (at the ninth level), organizational capabilities and efforts (C31), organizational management (C32) (at the tenth level), competitors' pressure towards greening (C26), and suppliers' pressure and willingness (C28) (at the eleventh level).

From the iteration 12 to iteration 17, there were seven CSFs, which were found to have significant influencing power to affect the CSFs of the top level and intermediate level. These CSFs need the maximum attention and focus. These are: business to business pressure (C27) (at the twelfth level), investors and shareholders' pressure (C25) (at the thirteenth level), customers' awareness of green initiatives (C16) (at the fourteenth level), community pressure (C17) (at the fifteenth level), environment-friendly products (C15) (at the sixteenth level), global climatic pressure and ecological scarcity of resources (C5), and environmental regulations (C12) (at the seventeenth level). Fig. 2 also indicates that CSFs C5 and C12 are very significant for achieving a CSF (C15), which in turn will help achieve the CSF, C17 and so on.

The MICMAC analysis, shown in Fig. 4, indicates that there is only one CSF (C21) which has a weak dependence and driving power. Hence, cluster 1 comprises of one CSF. On the other hand, there are 15 CSFs (C1, C2, C3, C4, C7, C8, C9, C10, C11, C18, C19, C22, C23, C24, and C30) that have a strong dependence power but a weak driving power, which are shown in cluster II. The CSFs C6 and C20 have a strong driving and dependence power, and have been included in cluster III. Cluster IV reflects the CSFs with a strong driving power but weak dependence power; these CSFs are C5, C12, C13, C14, C15, C16, C17, C25, C26, C27, C28, C29, C31, and C32. These are the CSFs requiring the maximum attention.

6. Conclusion

The present case study was conducted taking only the oil and gas industries into consideration. In future, the same approach may be extended to other industries for the implementation of sustainability practices. An integrated ISM methodology along with the ISM approach (i) total Interpretive Structural Modeling (TISM), (ii) analytic network process (ANP), (iii) structural equation modeling (SEM), (iv) interpretive ranking process (IRP), (v) technique for order of preference by similarity to ideal solution (TOPSIS), (vi) path analysis, (vii) concept advanced ISM (CAISM), (Viii) analytic hierarchy process (AHP), and (ix) decision-making trial and evaluation laboratory (DEMATEL) may be used as these studies yield better results as compared to the ISM methodology alone. In this study, only 32 important CSFs were considered; however, there may be other CSFs that were omitted in this model but may affect the sustainable practices. Also, considering more CSFs in other studies is bound to yield better results. The present model was developed by considering the judgments of the expert panel from the oil and gas field, which may be biased, affecting accuracy of the final results. In future, authors would like to validate this model using a structural equation modeling (SEM) methodology also, which is commonly known as the linear structural relationship approach.

7. Managerial implications

Due to strict government and environmental regulations and the demands of environmental accountability, environmental issues have become an intrinsic part of strategic planning in organizations [150]. It is the need of the hour to think on the lines of sustainability, as these practices are going to play a key role in the oil and gas sector regarding the socio- economic and environmental segments.

The oil and gas industry has made commendable progress over the past few decades in the field of social responsibility, safety and environmental protection. However, there is plenty of scope for improvement. Oil companies should focus continuously on the aspects of pollution control, biodiversity and global climate change. Success for the social responsibility programs will depend on the level of corporate commitment and the effectiveness of the partnerships with other stakeholders or shareholders. The issues are extremely complicated and the abilities needed in future will be beyond technical solutions; it will assuredly include the process of listening to and negotiating with a wide range of partners including governments, community organizations and NGOs [4].

The roles of the oil and gas industry towards sustainable development are:- 1. To provide the required technology, finance, and trained manpower to meet the needs of the society for oil and gas safety and economy until alternate energy sources are available. 2. To reduce the impact of the operations performed on the environment. 3. To work constructively and positively with all parts of civil societies. 4. To support the social objectives of the communities. 5. To demonstrate a high ethical standard [20,151].

A sustainable supply chain may help the organizations gain competitive advantage and secure the loyalty of all the stakeholders, including shareholders and investors in the coming years [17]. In general, developing countries implement sustainability practices enforced by the relevant legislation [152] while in the developed countries, sustainability is used as a tool to reach out to socially and environmentally conscious customers and build a positive brand image [25]. The oil and gas industry's role in sustainable development should be to meet the needs of the global society for oil and gas at a reasonable cost and safety and with the least impact on the environment until suitable alternate energy sources are available [4].

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