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A New Framework for Evaluation Sustainable Green Service Supply Chain Management in Oil and Gas Industries

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Abstract: Oil and gas industries are among the industries involved in the international service supply chain, which include domestic and international transportation, import and export, and technology information. By creating utility and satisfaction from environmental perspective throughout the service supply chain, the supply chain managers of leading companies have recently tried to use green logistics and improve environmental performance in the entire of their service supply chain as a valuable resource for sustainable competitive advantage. Thus, the main reasons for investment in creating a sustainable green service supply chain includes management of unwanted environmental, social, and economic risks and creating sustainable services by increasing revenue and enhancing cooperation. Given the purpose of this article which is to provide a framework to assess sustainable green SSCM dimensions. Organizational factors, environmental factors were obtained. In this study, structural equation modelling (SEM) was used to test the hypotheses.

Keywords: green management; oil and gas; supply chain management; sustainability

1 INTRODUCTION

Due to intense competition in global markets, products with short life cycle, and increased customer expectations, businesses pay more attention to investment and supply chain. This combined with continuing improvements in communication and transportation technologies have created incentives for continuous development of supply chain and its management practices. Oil and gas industries are among the industries involved in the international supply chain which include domestic and international transportation, ordering and inventory control, storage of materials and equipment, import and export, and technology information. In a supply chain, a company is related with its upstream, middle and downstream sections through information exchange, liquidity and raw materials. Tendency to SCM in industries has markedly increased in recent years. Various factors have contributed to this. Many companies have lowered their production costs as far as possible. In addition, they found that they can achieve significant savings through effective planning and supply chain management. Finally, one can point to technological change in the transportation industry which led to various forms of transportation methods and its reduced cost. But the logistics systems have been significantly more complex. Thus, it is not surprising that many companies are analysing their supply chain. In most cases, this analysis is based on experience and intuition, and analytical models and design tools are less used in the process.

2 RESEARCH PROBLEM STATEMENT AND LITERATURE REVIEW

Changes in customers, technological requirements, international obligations, globalization, volatile markets and global sourcing have created new challenges in SCM [1]. In addition, today competition is not only between companies, but also between their supply chains. In the competition between different supply chains, the success of companies producing the final products more depends on their ability in the integration management of their business relations networks with suppliers, distributors, partners, etc. in the supply chain. The Integration of business processes, that will create value for customers, is seen as key to the success of companies [2].

In recent decades, the world has experienced an astonishing economic growth because of access to new technologies, globalization of economy and the financial and credit resources, open world markets, accelerated movement of production factors. Unfortunately, serious environmental problems threaten the quality of human life such as thinning of the ozone layer, rapid destruction of rainforests, water and air pollution, global warming, and acid rain. Therefore, ensuring and continuation of sustainable development in any country are subject to the conservation and efficient use of limited and often irreplaceable natural resources [3].

Supply chain which covers all activities related to the goods conversion flow from raw material delivery to end-users, as well as information flow throughout the supply chain [4] has a potentially important impact on the environment. Supply chain managers look for faster delivery of goods and services, reduced latency, lower costs and increased quality. [5]

By creating utility and satisfaction from environmental perspective throughout the supply chain especially among end-users, the supply chain managers of leading companies have recently tried to use green logistics and improve environmental performance in the entire of their supply chain as a valuable resource for sustainable competitive advantage. Organizations that are using the strategic weapon of customer value are trying to maximize customer satisfaction by recognition of the key dimensions of customer value and responding to them. Naturally, this customer satisfaction will be followed by customer loyalty and repurchase and ultimately, maintaining competitive advantage [6].

Since the demand for natural resources, especially fossil fuels, is increasing and the capacity of the world's resources does not meet the demand of consumers now and in the future, this difference leads to the early termination of natural resources, higher energy prices and lack of access to affordable energy sources [6].

2.1 Sustainable Green SCM

The term sustainable development was first formally proposed by Brantland in 1987 in the "Our Common Future" report. The word means "correct and efficient management and utilization of basic resources, natural resources, financial resources and human resources to achieve optimal consumption pattern with the use of technical facilities, and suitable organization and structure to meet the needs of present and future generations continually and satisfactorily." Supply chains are the key rings that connect the organizational input to output. In fact, a network is created which covers supplier(s) to consumer(s). Challenges this network faces are about lower costs, ensuring timely delivery and reduced shipping time in order to better respond to business environment. On the other hand, due to increased environmental costs in this network and growing consumer pressure for offering environmentally standard products, increased awareness of community and staff on social issues related to organizations and the creation of groups in support of community and individuals and increased social responsibilities of organizations and companies, many organizations move towards supply chain stability and consider new criteria (key factors) in their operations [7].

However, long-term trends imposed challenges on supply chain managers and created the need for expertise in the SCM areas in today's companies and factories. These trends include globalization, increased competitive intensity, more need for security, lack of resources, and finally a reliable, flexible and cost-effective business system in order to support different categories of customers. Moreover, the supply chain managers deal with more complex and dynamic supply chains than in the past, which will reduce their forecasting capability [8]. Clearly, SCM is extraordinary more complex than management of an organization. The supply chain managers need to understand more the sustainability issues in their business environment and this, especially on the global scale and fragmented supply chain, not only needs more efficient supply chain operations, but also networking skills, (and knowledge of key factors) so that they can permanently meet the sustainable development requirements to create a customer-centric supply chain [9].

Today, control of natural resources has increased in order to realize sustainable development, minimize environmental sustainability and negative impacts on the environment. Focusing more on the use of green technologies in materials supply, this belief has strengthened that all industrial activities affect the environment. These industrial activities include the development and use of products, equipment, systems and natural resources, which can reduce the negative effects of human [10, 11].

Finally, those organizations involved in the oil and gas industries are looking for sustainable development and with a deep understanding of all aspects of key factors in the deployment of sustainable green supply chain in their decisions, they consider a new dimension called "social costs" in addition to considering the common costs and benefits and measure the environmental dimensions of their decisions. This way, they obtain the benefits of sustainable green supply chain and take steps to protect the environment and minimize negative impacts on environment due to supply chain decisions. The main reasons for investment to create a sustainable green supply chain are as follows:

- Management of unwanted environmental, social and economic risk
- Reputation and shareholder expectations management
- Reducing costs and improving efficiency
- Development of sustainable products by increasing income and improving cooperation [12].
- In fact, the sustainable SCM can create value and success for business and society [13].

2.2 Components Identified in Connection with the Proposed Framework

Given the purpose of this article, which is to provide a framework to assess sustainable green SCM dimensions, the following components are identified and extracted after extensive review of research literature. After several refining, organizational factors, environmental factors, economic factors, social factors, and political factors were obtained.

3 RESEARCH METHOD

3.1 Descriptive Study of Demographic Characteristics

Descriptive statistics refer to a set of criteria that can provide an overview of collected data for the researcher. Note that in descriptive statistics, the results cannot be generalized to the general conditions but the criteria just provide an overview of the study. This study descriptively examines observations by providing related charts and tables. Tab. 1 shows the descriptive results of demographic characteristics of respondents.

Table 1 Descriptive results of the respondents' demographic characteristics

Description		Frequency	Percent
Gender	Female	72	28.6
	Male	180	71.4
	Total	252	100.0
Education	Associate	6	2.4
	License	66	26.2
	MA	180	71.4
	Total	252	100.0
Experience in the industry	1-10 years	72	28.6
	11-20 years	114	45.2
	Over 20 years	66	26.2
	Total	252	100.0
Education field	Humanities	42	16.7
	Basic sciences	36	14.3
	Engineering	144	57.1
	Other	30	11.9
	Total	**252**	**100.0**

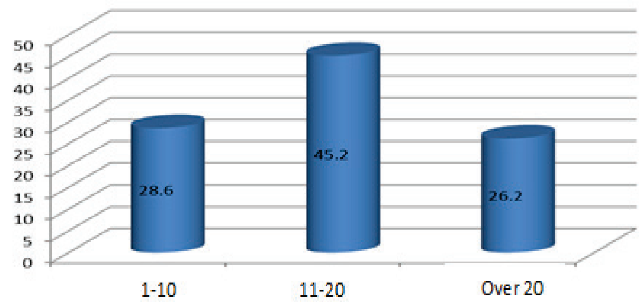

Figure 1 Experience of respondents

According to the above table and exhibit, 28.6% of respondents have less than 10 years of experience, 45.2% between 11 and 20 years and 26.2% over 20 years. Figs. 2 and 3 show the education and field of respondents, respectively.

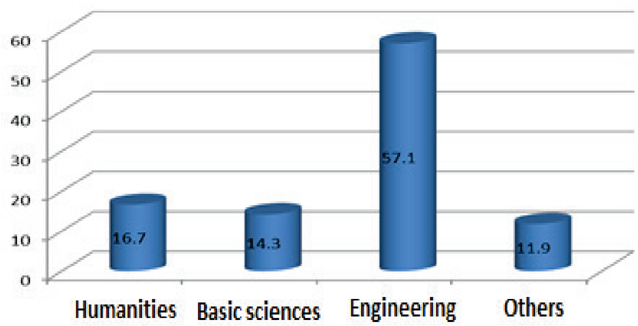

Figure 2 Education field of respondents

In terms of age, the highest percentage of participation (16.7%) are educated in the humanities, 14.3% basic sciences%, 57.1% engineering and 11.9% other disciplines.

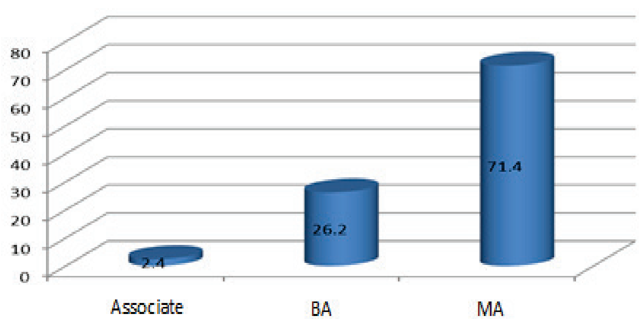

Figure 3 Education of respondents

In terms of education, 71.4% have MA, 26.2% BA and 2.4% associate degree.

3.2 Inferential Analysis of Results

In inferential statistics, the following tests were used:

- Confirmatory factor analysis (CFA)
- Structural equation modelling (SEM).

Since the simultaneous multivariate analysis, instead of bivariate analysis (each time one independent variable is examined with the dependent variable) needs specific methods, it is one of the strongest and most appropriate methods of analysis in behavioural and social science research. In this study, structural equation modelling (SEM) was used for hypothesis testing. One of the new concepts in structural equation topics is latent variables and manifest variables. Latent variables (LVs) refer to variables that cannot be directly measured and are qualitative. To resolve this problem in structural equation, variables called manifest variables (MVs) or indicators were defined that are easily measurable. Another point is that latent variables are divided into two types: endogenous and endogenous. In the first group, models are divided into two types: structural (inner) and measurement (outer). Structural or inner models are composed of relationships between latent variables. In fact, these relationships have been derived through literature and theoretical support. For each latent variable in structural model, an outer model should be defined. In fact, these models consist of the relationships between the latent variable and its measurement indicators, i.e. manifest variables. The interesting point is that each measurement model is drawn based on the theoretical framework and the existing theories, because scientists believe that if measurement models lack theoretical support, the structural model will be unclear and the empirical review of theories will be impossible [14].

This study used structural equation modelling with partial least squares (PLS) method using SMARTPLS for studying independent variables and multi collinearity to confirm the model and respond to hypotheses. The PLS estimation method determines coefficients in a way that the resulted model has the highest power to interpret and explain. This means that the model can predict the final dependent variable with highest accuracy. The partial least squares method (or PLS in regression modelling discussions) is a multivariate statistical methods. Despite some limitations such as the uncertainty of the response variable distribution, the low number of observations or the existence of a serious autocorrelation between independent variables, one or more response variables can be modelled simultaneously on several independent variables.

3.3 Validation of Measurement Models

Before getting into hypothesis testing and the conceptual model, we must confirm the validity of exogenous and endogenous measurement variables. This is done through confirmatory factor analysis. The confirmatory factor analysis is one of the oldest statistical methods to investigate the association between latent variables (main variables) and the observed variables (questionnaire statements) and represents the measurement model [15].

This technique which estimates parameters and tests hypotheses according to the basic factors of the markers, is based on a strong theoretical and empirical foundation that specifies which variable is correlated with which factor (dimensions of that factor) and which factor is correlated with which factor(s). The validation criteria of the measurement models are summarized in Tab. 2.

Table 2 Validation criteria of measurement models

Type of validation	Indicator	Interpretation of the indicator	Reference
Internal consistency reliability	Cronbach's alpha (CA)	This indicator measures the simultaneous loading of structure or latent variables when a manifest variable increases. The value of this indicator ranges from 0 to 1. The value of this indicator should not be less than 0.6.	[16]
Internal consistency reliability	Composite reliability (CR)	This indicator is the sum of factor loadings of latent variables divided by the sum of factor loadings plus error variance. Its value is between 0 and 1 and it is an alternative to Cronbach's alpha. The value of this indicator should not be less than 0.6. This indicator is also called Dillon-Goldstein's (or Jöreskog's) rho.	[17]
Indicator reliability	Factor loadings of indicators	This shows that what extent of the variances of indicators is explained by the latent variable. The value of this indicator should be greater than 0.6 and be significant at the 5% confidence interval. The significance of this indicator is derived by the bootstrapping or jack-knifing.	[18]
Convergent validity	Average variance extracted (AVE)	It measures the amount of variance a latent variable takes from its indicators. The value of this indicator should be greater than 0.5.	[19]
Separated validity	Fornell-Larcker Criterion	According to this indicator, the variance of each latent variable for its own indicators must be greater than any other indicator. To identify this, we first calculate the square root of the AVE of the latent variable and then compare the result with the correlation values this latent variable has with other latent variables. The AVE square root must be greater than correlation values. We repeat this for other latent variables.	[20]

3.4 The research Diagrams and the Results of Confirmatory Factor Analysis

Fig. 4 shows the model when estimating standard coefficients. The green sustainable SCM is endogenous (dependent) and the organizational factors, environmental factors, economic factors, social factors, political factors and cultural factors are exogenous (independent). In this diagram, numbers or coefficients are divided into two categories. The first category is called measurement equations, which explain the relationship between latent variables (oval) and manifest variables (rectangle). These equations are called factor loadings. The second category is called structural equations that explain the relationships between latent variables and are used for hypothesis testing. These coefficients are called path coefficients. All factor loadings less than 5.0 must be excluded from the model, and the model must be estimated and modified regardless of these indicators. All factor loadings in the model had the necessary validity because their factor loadings were greater than 0.5 [21].

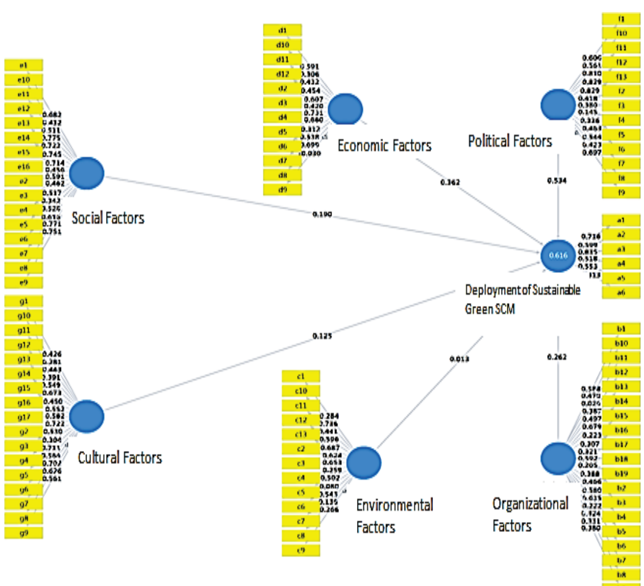

Figure 4 Initial model when estimating standard coefficients

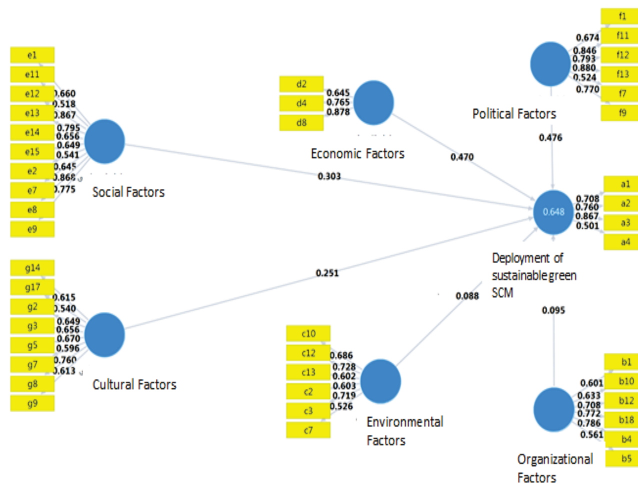

Figure 5 Modified models (removal of questions with factor loadings less than 0.5) in the estimation of standard coefficients

Fig. 5 shows the confirmatory factor analysis and structural equation model in the t-value mode. This model tests all measurement and structural equations using t-statistic. According to this model, path coefficient is significant at the 95% confidence level if the t-statistic value is greater than 1.96.

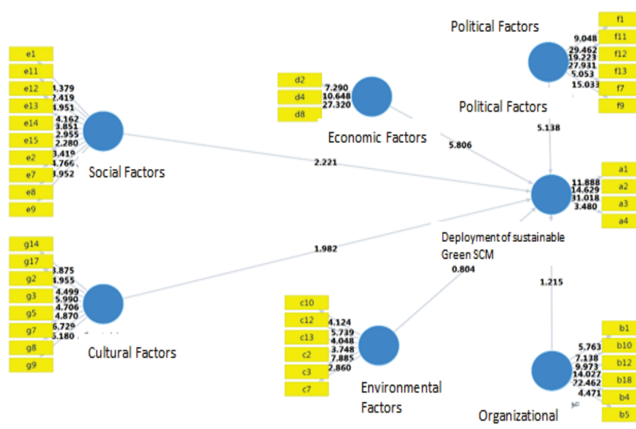

Figure 6 Model in the significance absolute value (|T-Value|)

Studies show that the highest factor loading value for each indicator is related to the structure of that indicator; for other structures, less factor loading reflects that each structure or latent variable accepts the highest factor loadings from its own indicators. As a result, we can say that the latent variables of the model are distinct enough from each other.

Table 3 Validity, reliability indicators

Latent variables	AVE	Composite reliability	Coefficient of determination	Cronbach's alpha	Average response	$\sqrt{AVE}$	$\sqrt{R^2}$	GOF
Deployment of sustainable Green SCM	0.561	0.808	0.648	0.676	4.025	0.751	0.805	0.605
Organizational Factors	0.565	0.837		0.776	3.975			
Environmental Factors	0.520	0.811		0.771	3.891			
Economic Factors	0.591	0.810		0.749	4.043			
Social Factors	0.600	0.907		0.899	3.761			
Political Factors	0.573	0.887		0.848	3.804			
Cultural Factors	0.540	0.846		0.810	3.900			

Tab. 3 shows the validity and reliability indicators for all the research variables. In addition to the structure validity, which is used to investigate the importance of selected markers for measuring structures, discriminant validity is used in this study. This means that the markers of each structure finally provide a good separation in terms of measurement for other structures of the model. To put it simply, each marker measures only its own structure and their combination is in such a way that all structures are well separated. With the help of the average variance extracted indicator, it was found that all the studied structures have an average variance extracted higher than 0.5. The composite reliability (CR) and Cronbach's alpha indicators are used to check the questionnaire reliability. This indicator must be higher than 0.7 to approve reliability. All of these factors are above 0.7, so the measurement tool is reliable. A column of Table 3 shows the average responses. Given that the 5-option Likert scale was selected for the questions composing the research variables, the values resulted from respondents' views should be examined to know that whether the average of their responses is different from 3 (the middle number of the Likert scale)? As you can see in this column, all the research variables were assessed above average (the response average was greater than 3) which the variable situation is satisfactory. Social factors have the weakest evaluation and economic factors have the most favourable assessment [22].

3.5 Goodness of Fit Indicator (GOF)

This indicator shows the compromise between the quality of the structural model and the measured model and is equal to:

$$GOF = \sqrt{\overline{AVE}} \times \sqrt{\overline{R^2}} \tag{1}$$

Where $\overline{AVE}$ and $\overline{R^2}$ are the averages of AVE and R. A GOF value higher than 5.0 shows the model goodness. The GOF value is 0.605 (> 0.5), so the model has a proper fit. In simpler words, the data of this study has a good fit with factor structure and the research theoretical basis, which indicates that the questions are consistent with theoretical structures [23, 24].

Table 4 Correlation coefficients and separated validity indicator

Latent variables	(1) SGS	(2) OF	(3) EF	(4) EF	(5) SF	(6) PF	(7) CF
(1) Deployment of sustainable green SCM	0.749						
(2) Organizational factors	0.524	0.752					
(3) Environmental factors	0.444	0.325	0.721				
(4) Economic factors	0.644	0.436	0.507	0.769			
(5) Social factors	0.340	0.531	0.494	0.340	0.775		
(6) Political factors	0.631	0.566	0.476	0.350	0.620	0.757	
(7) Cultural factors	0.549	0.576	0.741	0.452	0.727	0.664	0.735

** Main diagonal represents the square root of average variance explained (AVE).

Tab. 4 examines correlation coefficient and separated validity. The main diagonal of the matrix shows the square root of the average variance explained (AVE). Separated validity is confirmed if the square root of AVE is greater than all correlation coefficients of the related variable with other variables. For example, the square root of AVE for the sustainable green SCM deployment variable (74.9%) which is greater than the correlation value of this variable with other variables. As the table suggests, the square root of the AVE indicator for all variables is greater than the correlation of that variable with other variables. The lower part of diagonal represents Pearson correlation coefficients. A positive coefficient indicates a direct positive relationship between the two variables and a negative coefficient indicates a negative reverse relationship. All coefficients are significant at the error level less than 0.05.

3.6 Validation of Structural Model

After validation of measurement models, the structural or inner model must be studied. In this part, the validation criteria of structural models are given in Tab. 5.

Table 5 Validation criteria of structural model

Type of validation	Indicator	Indicator interpretation	Source
Model validity	Coefficient of determination (R^2)	It measures the explanation variance of an endogenous variable versus its total variance by exogenous variables. For this indicator, values greater than 0.670 are considered strong, greater than 0.333 intermediate, and less than 0.190 weak.	[25, 26]
Model validity	Path coefficients	Path coefficients between latent variables must show the relationship between two variables based on algebraic signs, value and significance. A negative coefficient shows a reverse relationship and a positive variable shows a direct relationship between the two variables.	[27]

Table 6 Results of structural equation to evaluate sub-hypotheses

Research hypothesis	*Beta*	*t*	R^2	Hypothesis result	Relationship direction
Organizational factors ≥ Deployment of sustainable green *SCM*	0.095	1.215	0.648	Rejected	Non-significant
Environmental factors ≥ Deployment of sustainable green *SCM*	0.088	2.804		Confirmed	Direct
Economic factors ≥ Deployment of sustainable green *SCM*	0.470	5.806		Confirmed	Direct
Social factors ≥ Deployment of sustainable green *SCM*	0.303	2.221		Confirmed	Direct
Political factors ≥ Deployment of sustainable green *SCM*	0.476	5.138		Confirmed	Direct
Cultural factors ≥ Deployment of sustainable green *SCM*	0.251	1.952		Confirmed	Direct

$|T| > 1.96$ Significant at $P < 0.05$, $|t| > 2.58$ Significant at $P < 0.01$

Table 7 Framework for the Deployment of Sustainable Green *SCM* in Oil and Gas Industries

Organizational factors	Expertise and loyalty of employees
	Attention to specialization, professional orientation, division of labor
	Senior management commitment, employee engagement and teamwork
	Continuous monitoring of how to shorten delivery times to customers
	Effective communication within and outside the organization
	Needs identification and customer focus (increasing flexibility)
Environmental factors	Owners of technology and the level of technological competence
	Political, economic, social and cultural conditions
	Environmental legislation
	Senior officials of the Ministry of Oil, partner organizations and companies
	Communication between stakeholders
	Environmental considerations and focus on the use of clean technology, environmental liabilities, energy consumption
Economic factors	Interest rate
	Inflation rate
	Exchange rate and a stable value of money
Social factors	Individual features of employees
	Social structure of employees
	Improving social infrastructure and cooperation in the shaping of social morality
	Development of working relationships in order to respect human rights
	Observance of the principle of equality and transparency in the relations between suppliers and contractors
	Supporting sports and healthy lifestyle and supporting charitable organizations
	Respect for civil rights and developing equal opportunities
	Respect for human dignity and socioeconomic rules and regulations
	Amount and distribution of income
	Individual culture, entrepreneurial spirit and creativity of employees
Political factors	Government tax policy-making
	Setting restrictions on the advertisement of companies, new business planning
	Laying down laws for protecting the environment, people's health, customer support, social equality and economic development
	Legal framework for contract enforcement
	Protection and support of intellectual capitals
	Business rules and regulations (business, environment, trade restrictions, freight)
	A basic model of assumptions, values and basic beliefs, practices and behaviors, and signs and symbols
	Power structures and control systems
	Tendency to loyalty, commitment to the organization and maintaining morale
	Willingness to learn, grow and strengthen the scientific character and respect for rules
	Working based on cooperation and innovation
	Stability
	Conflict between people based on struggle for survival
	Resonance and cooperation between people

4 CONCLUSIONS

According to the surveys made, Tab. 6 shows the results obtained in this study:

- The calculated effect of organizational factors on the deployment of sustainable green SCM is 0.095. Because the t-statistic value is within the critical range (between –1.96 and +1.96), the researcher's claim that "there is a significant relationship between organizational factors and the deployment of sustainable green *SCM*" is rejected with a probability of 0.95.
- The calculated effect of environmental factors on the deployment of sustainable green *SCM* is –0.088. Because the t-statistic value is not within the critical

range (between –1.96 and +1.96), the researcher's claim that "there is a significant relationship between environmental factors and the deployment of sustainable green *SCM*" is accepted with a probability of 0.95. Considering the positive beta coefficient, there is a direct and positive relationship between the two variables.

- The calculated effect of economic factors on the deployment of sustainable green *SCM* is 0.047. Because the t-statistic value is not within the critical range (between –1.96 and +1.96), the researcher's claim that "there is a significant relationship between economic factors and the deployment of sustainable green *SCM*" is accepted with a probability of 0.95. Considering the positive beta coefficient, there is a direct and positive relationship between the two variables.
- The calculated effect of social factors on the deployment of sustainable green *SCM* is 0.303. Because the t-statistic value is not within the critical range (between –1.96 and +1.96), the researcher's claim that "there is a significant relationship between social factors and the deployment of sustainable green *SCM*" is accepted with a probability of 0.95. Considering the positive beta coefficient, there is a direct and positive relationship between the two variables.
- The calculated effect of political factors on the deployment of sustainable green *SCM* is 0.476. Because the t-statistic value is not within the critical range (between –1.96 and +1.96), the researcher's claim that "there is a significant relationship between political factors and the deployment of sustainable green *SCM*" is accepted with a probability of 0.95. Considering the positive beta coefficient, there is a direct and positive relationship between the two variables.
- The calculated effect of cultural factors on the deployment of sustainable green *SCM* is 0.251. Because the t-statistic value is not within the critical range (between –1.96 and +1.96), the researcher's claim that "there is a significant relationship between cultural factors and the deployment of sustainable green *SCM*" is accepted with a probability of 0.95. Considering the positive beta coefficient, there is a direct and positive relationship between the two variables.
- The coefficient of determination is 0.648. Thus, all the variables (organizational factors, environmental factors, economic factors, social factors, political factors, cultural factors) together explained 64.8% of the changes of the deployment of sustainable green *SCM* variable. Considering the beta value, it can be said that political factors have the greatest impact (highest beta value) and cultural factors have the least impact (lowest beta value).

Given the study results, Tab. 7 shows the proposed evaluation framework for the deployment of green sustainable SCM in oil and gas industries.

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