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Investigating Impact of Environmental Tax Policy on Behavior of Investors in Renewable Energies Using a Dynamic Panel Data Approach

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ABSTRACT

Expanding use of renewable energies (RE) around the world is a critical mission to achieve global environmental policies. The largest share of global energy mix relates to deployable and carbon-intensive fossil fuels, so it is necessary to create proper incentives for investors to invest in RE in order to move toward a low carbon economy. In this regard, one of the implemented policies is imposing tax on using deployable energies, which includes tax on both energy consumption and motor vehicle transportation. This paper investigates the impact of environmental tax policy on investors' behavior in 13 leading selected developed and developing countries during 2004 to 2016. Based on economic theory, investment, particularly in capital-intensive energy industries, has a long gestation period. To capture this feature and evaluate the dynamic relations of investments in RE, a partial adjustment dynamic model is applied and estimated using generalized method of moments (GMM). The results show that imposing tax on fossil fuel energy consumption and transportation systems, in particular those which use fossil fuels, has a significant negative and positive impact on investing in RE, respectively. Moreover, empirical results demonstrate that there is a significant negative relation between the interest rate (IR) and investments in renewable energies (IRE).

1. Introduction

In order for the world's governments to limit the rise of global temperatures to less than 2 °C, to stem the climate damage that is already starting to occur, to shift to a low-carbon economy, and to seize the economic opportunities of clean energy and other climate-related activities, trillions of dollars of investment are required over the coming decades (UNEP FI, 2010). Environmental challenges are increasing the pressure on governments to find ways to reduce environmental damage while minimizing harm to economic growth. Governments have a range of tools at their disposal, including regulations, information programs, innovation policies, environmental subsidies, and taxes. Taxes in particular are a key part of this toolkit. Environmental taxes have many important advantages such as environmental effectiveness, economic efficiency, the ability to raise public revenue, and transparency. Furthermore, environmental taxes have been successfully used to address a wide range of issues, including waste disposal, water pollution, and air emissions. Regardless of the policy area, the design of environmental taxes and political economy considerations in their implementation are crucial

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determinants of their overall success. Thus, not only can taxes directly address the failure of markets to take environmental impacts into account by incorporating these impacts into prices, but also environmental pricing through taxation leaves consumers and businesses to flexibly determine how best to reduce their environmental "footprint" (Braathen et al., 2010). Without government intervention, there is no market incentive for firms and households to take into account environmental damage since its impact is spread across many people, and it has little or no direct cost to the polluter. Therefore, the protection of the environment generally requires collective action, usually led by the government.

More than 80% of global energy supply relies on delectable fossil fuels, which create significant energy security challenges with resources being unevenly distributed across world regions. Wüstenhagen, et al., (2012) mention that increased investment in renewable energy technologies, in combination with energy efficiency, can help to meet future energy demand. To reach the proposed framework of renewable energies (RE), cooperation between public and private investors needs to be strengthened. The trend of investments in renewable energies (IRE) sector in 13 selected developed and developing coungtries[1] during 2004-2016 is depicted in Figure 1.

As shown in Figure 1, investing in RE is volatile in the most of the selected countries, and it is reasonable to pay more attention to the behavior of investors in RE market. Bloomberg publishes yearly report on clean energy investment trends and releases the IRE of some world countries. This study selects 13 developing and developed countries which are leader in IRE, where, based on Louw (2017), the selected countries would have the most volume of investments in RE across the world. In other words, the countries are leading nations in expanding their renewable energy sector in the world. More importantly, data on IRE are more easily available for the chosen countries than others. The financial crisis reversed the upward trend in economic aggregates observed during 2002-2008. Energy and transport tax revenue together with total environmental tax revenue had already fallen in 2008, while GDP, total revenue from taxes and contributions, and pollution and resource taxes still grew, albeit very slightly in that year, and only fell sharply in 2009. Looking closer at the three types of environmental taxes, namely energy taxes, transport taxes, and pollution/resource taxes, there are slight differences in their pattern. Transport tax revenue increased at a faster pace than the other types of taxes, recording an overall rise of 43.4% between 2002 and 2017. Over the same period, energy taxes rose by 38.7% and pollution and resource taxes by 34.5%. While in 2016, the growth of all economic aggregates slowed down slightly, they regained speed in 2017. The only exception observed was revenue from pollution and resource taxes, which remained rather stable in 2015 and 2016 and then started to fall in 2017 (Environmental tax statistics, 2017).

The main focus of this paper is to investigate the effectiveness and efficiency of implementing tax policies, as one of the main influential factors, on investors' behavior in RE energy market considering a partial adjustment dynamic panel data model

In fact, the main question is that whether imposing

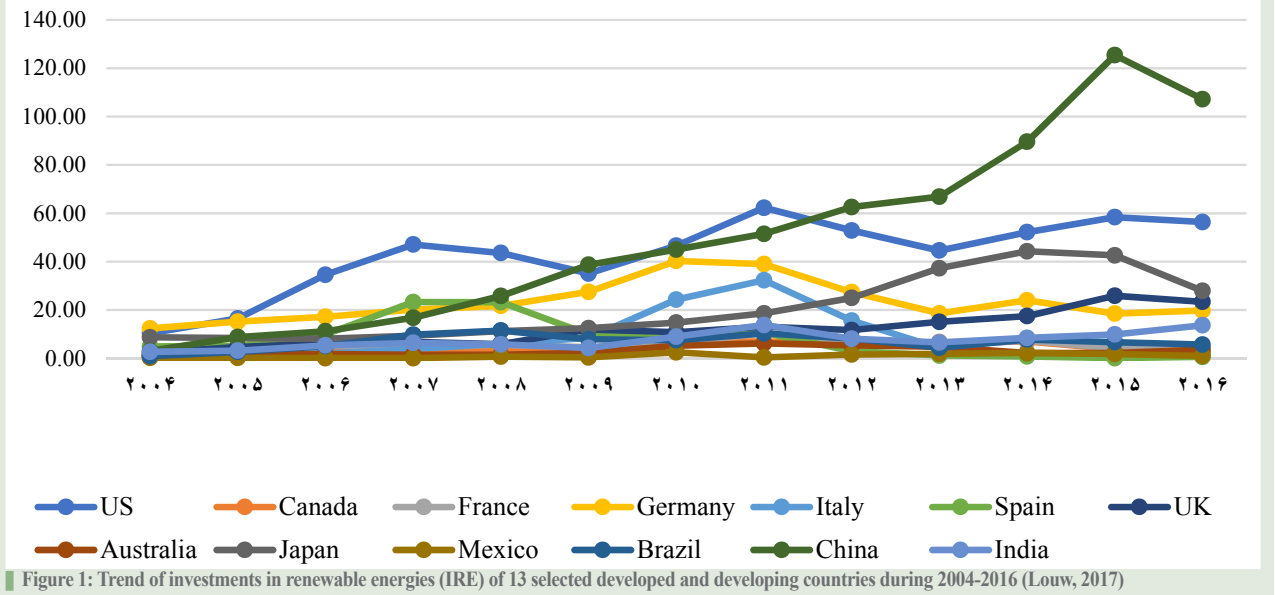

Figure 1: Trend of investments in renewable energies (IRE) of 13 selected developed and developing countries during 2004-2016 (Louw, 2017)

[1]The selected Countries including United States, Mexico, Canada, Brazil, France, Germany, Italy, Spain, United Kingdom, Australia, china, India, and Japan.

tax on fossil fuels encourages investors to move forwards and invest in RE sector. Is imposing tax policy effective? It is assumed that imposing tax on fossil fuel consumption induces investor to perform more activities in RE sector in accordance with climate change policies. Other than this factor, this research work also analyzes the influence of other factors impacting on investors' behavior in RE market, including interest rate, fossil fuel price, and population growth. In other words, the most behavioral factors influencing investments decision in the renewable energy market of the selected countries are considered in this paper.

The remainder of the paper is structured as follows. The next section reviews the relevant literature and the theoretical foundations of the research. Section 3 describes the data and the research model variables, and section 4 presents the research methodology used for the study. Section 5 illustrates the empirical results and discussions. Finally, section 6 highlights the main conclusions and policy recommendations especially for energy policy makers.

2. Literature Review and Theoretical Background

In 1920, British economist Arthur C. Pigou wrote the textbook titled "the economics of welfare." In this book, Pigou argues that industrialists seek their own marginal private interest (Pigou, 1920). Quite often the marginal social interest diverges from the marginal private interest, but the industrialist has no incentive to internalize the cost of the marginal social cost. To tackle over-production, Pigou recommends taxing offending market participants to cover the social cost. The producer would then have to pay for the externality created by his/her production. This problem can impact on the quantity of the produced goods and services and lead the economy back to equilibrium (Pigou, 1920). In this context, a growing number of literatures have analyzed the effect of taxation incentives on spurring renewable energy extension (Barradale, 2010; Bird et al., 2005). In addition, Barradale mentioned the missing commitment of policy as a main deficiency of taxes in order to direct dependency on the public budget (Barradale, 2010). Therefore, scholars tried to illustrate the effects of a number of various policy instruments on the contribution of renewables to the total energy supply (Bird et al., 2005). They showed that aggregated measures such as fiscal and financial incentives as well as measures that seek to define strategies and outline specific programs to promote these RE sources have a positive significant impact. Policies on RE growth had no significant positive influence on controlling a range of political elements such as energy security, Kyoto protocol ratification, and socio-economic factors (e.g. prices of fossil fuels, welfare, etc.) (Marques et al., 2012); however, fiscal and financial incentives (i.e. taxes) had a negative contribution to these factors (Aguirre et al., 2014).

The idea of political internalization of externalities brings together the elements (Coasian, 2015; Pigouvian, 2012) approaches to environmental policy. The issue of environmental policy arises due to production externality. It is assumed that firms in each industry use an input (raw materials, clean water, etc.) that has an external effect on the well-being of consumers (smoke, toxic wastewater, etc.). Furthermore, it is assumed that the government has access to two environmental policy instruments. Production tax-cum-subsidies can be used to affect activity in various sectors, and through that presumably the use of the externality generating inputs. Input tax-cum-subsidies, which in our specification are equivalent to pollution tax-cum-subsidies, can be aimed directly at the source of the externality, thereby presumably giving firms an incentive to use a cleaner production technology (Baumol et al., 1989).

Renewable energy investment is a type of environmentally/socially responsible investment specifically relating to investments in companies focusing on renewable energy resources like wind, solar, biofuels, hydropower, and tidal power as well as on the technology and systems relating to these sources. Renewable energy investment is a sub-category of environmental investment, which in turn is a sub-category of socially responsible investment (SRI). Growing concern for the environment and the well-evidenced existence of climate change and its devastating consequences combined with advancements in technology has seen the demand for a rise in alternative energy resources. As such, renewable energy investment is no longer considered a purely philanthropic endeavor but is now considered a profitable avenue for renewable energy investors looking for strong financial returns on capital invested as well as for supporting environmentally conscious companies. These companies and community organizations would seek seed enterprise investment scheme (SEIS), enterprise investment scheme (EIS), or venture capital trust scheme (VCT) investment (tax-advantaged venture capital schemes); community

organizations would also pursue social investment tax relief (SITR) investment, where a substantial part of the activities of the company or community organization is, or will be, eligible for a government subsidy for the energy generation from renewable sources. Individuals and some fund managers who invest in the companies or community organizations may also be affected (Wilson, 2015).

Herein, we refer to some studies related to the aim of this paper among a number of available empirical studies. Polzin et al., 2015 examined the impact of public policy measures on RE investments in electricity-generating capacity made by institutional investors across organization for economic co-operation and development (OECD) countries. Using a panel regression over a time period from 2000 to 2011, they investigated the effect of different policy measures in the selected OECD countries to recommend an effective policy mix which could resist failures in the market for clean energy. The results of this study call for technology-specific policies which consider actual market conditions and technology maturity.

Zhang et al. 2016 proposed a real options model for evaluating RE investment considering uncertain factors such as CO2 price, non-renewable energy cost, investment cost, and the market price of electricity. Their results showed that the current investment environment in China may not be able to attract immediate investment, while the development of carbon market helps to advance the optimal investment time. Tietjen et al., 2016 compared the investment risks of different technologies in markets with increasing shares of RE. The results confirmed that capital intensive REs face the highest stand-alone risks since their profits are most affected by the power price risk. However, the results further indicated that the stand-alone risks of variable REs decrease with their share in the market because of a negative correlation between output and price risk. Some researchers also analyzed the impact of clean-development mechanism and carbon emission on energy investment (Strand et al.. 2014; Hieronymi et al., 2015; Mo et al., 2015; Jones et al., 2016; Cadarso et al., 2014; Cucchiella et al., 2016).

In one of the most recent studies, Aflaki and Netessine, 2017 analyzed incentives to invest in the capacity to generate renewable electricity, and they modeled the trade-off between renewable (e.g. wind) and nonrenewable (e.g. natural gas) technologies. They proved that the intermittency of renewable technologies drives the effectiveness of carbon pricing mechanisms, which suggests that charging more for emissions could unexpectedly discourage investment in renewables. In short, they showed that, compared to carbon taxes alone, actions to reduce the intermittency of renewable sources may further affect promoting investment in renewable generation capacity (Aflaki and Netessine, 2017).

This paper covers the recent developments of RE deployment and investments (until 2016). In this study, we intend to contribute to the existing academic literature by exploring and investigating the effectiveness of environmental tax policies on investors' investment behavior in RE sector, including all kinds of renewable energies (wind, solar, biomass, geothermal, etc.). In contrast to the previous studies, this study separates tax policies in two parts, namely tax on energy (fossil fuels) consumption (TEC) and tax on motor vehicles in transportation systems, and aims to investigate the effects of these tax policies on investors' behavior in RE sector. In other words, the effectiveness of tax policies on expanding renewable energy is examined in two dimensions in the leading developing and developed countries.

3. Data and Research Variables

This paper constructs an empirical model of investments in renewable energies using a panel data set of 13 selected developed and developing countries during 2004 to 2016. The selected countries are a combination of developing and developed nations, including the United States, Mexico, Canada, Brazil, France, Germany, Italy, Spain, the United Kingdom, Australia, China, India, and Japan. Table 1 summarizes research variables used in this study. As shown, investment in renewable energy (IRE) is the dependent variable and the others are independent variables. All the monetary variables are used in real values.

Also, Table 2 tabulates the summary statistics of the described variables.

4. Methodology

Dynamic panel data models contain one or more lagged dependent variables, allowing for the modeling of a partial adjustment mechanism (Baum, 2013). Similar to any longitudinal analysis, this paper assumes that the dependent variable (IRE) is affected by its own past values immediately and with a time delay. This approach is applied to the model of this paper through a lagged dependent variable structure named dynamic

panel data. This approach helps to account for the time-dependent influence of policy measures on investors' behavior in the RE sector (Angrist et al., 2008; Wooldridge, 2009). Hence, this paper investigates the impacts of environmental policies on investment in RE considering the dynamic and lagged nature of investment decision in the RE sector. Accordingly, based on the work of (Polzin et al., 2015), the research model can be expressed by Equation 1:

$$IRE_{i.t}=\beta_0+\beta_1 IREi.t\text{-}1+\beta_2 IRE_{i.t\text{-}2}+\beta_3 IRE_{i.t\text{-}3}+\beta_4 TEC_{i.t}+\beta LTM_{i.t}+\beta_6 FFC_{i.t}+\beta_7 POP_{i.t}+\beta_8 FFP_{i.t}+\beta_9 IR_{i.t}+\varepsilon_{i.t} \quad (1)$$

where, IRE refers to the amount of investment in the RE sector, and TEC represents tax on energy consumption; LTM indicates logarithm of tax on motor vehicles transportation, and FFC is an aggregated amount of fossil fuel (oil, natural gas, and coal) consumption measured in ton per day; POP also stands for the population growth, and FFP is the weighted average of fossil fuel (oil, natural gas, and coal) prices calculated in US dollars per ton; IR is interest rate; it subscript stands for country i in year t, and s_{it} denotes the error term.

There are many ways in the literature to estimate dynamic panel data models. The first way is instrumental variables (IV) method to correct the bias of an estimator and the second method is generalized method of moments (GMM) estimation technique. This research work uses balanced panel data to estimate the research model. To this end, we have examined a number of estimators, including fixed effects (FE), random effects (RE), and GMM estimators. After evaluating several estimation methods, we used GMM to estimate a partial-

Table 1- Description of research model variables[2]

Variable	Description	Measurement Unit	Source of Data
IRE	Investment in renewable energy (dependent variable)	Billion dollars (constant 2004 US$)	(Louw ,2018) -Bloomberg New Energy Finance
TEC	Tax on energy consumption	Million dollars (constant 2004 US$)	(Eurostat, 2018)
LTM	Logarithm of tax on motor vehicles transportation	Million dollars (constant 2004 US$)	(Eurostat, 2018)
POP	Population growth	%	World Bank
FFP	Weighted average of fossil fuel prices	US dollar per ton (constant 2004 US$)	Authors calculation based on BP Statistical Review of World Energy 2017 (BP Statistical Review, 2018)
FFC	Aggregate amount of fossil fuels consumption	Million ton per day (constant 2004 US$)	Authors calculation based on BP Statistical Review of World Energy (BP Statistical Review, 2018)
IR	Interest rate of each country	%	(Federal Reserve Bank of St. Louis, 1914)

Table 2 - Descriptive statistic of the estimated variables

Variable	Observations	Mean	Standard Deviation	Min	Max
IRE	169	14.85325	19.65211	0.1	125.4
TEC	169	32642.03	25185.41	-19660.54	78690.53
TM[3]	169	9.198462	0.8767765	7.33	11.04
FFP	169	321.4219	139.2549	69.44	685.32
FFC	169	734.1957	1132.196	105.9	4606.49
IR	169	4.32142	5.157661	0.1	26.27
POP	169	$2.84\times10^{+8}$	$4.35\times10^{+8}$	$2.01\times10^{+7}$	$1.38\times10^{+9}$

[2] We have examined logarithmic and non-logarithmic form of all the variables in Table 1. After estimating and testing several combinations of the variables, the coefficient estimated for tax on motor vehicles would give a significant result in the logarithmic form, while all the other variables would have the most significant estimated coefficients in the non-logarithmic form.

[3] Tax on motor vehicles (TM)

adjustment dynamic panel data model and examine the factors impacting on renewable energy investment, including energy and environmental taxes. The GMM estimation method helps to explore a dynamic relation of investment function in the RE sector.

5. Empirical Results and Discussion

Before estimating the main model and discussing the empirical results, first, we perform Pesaran's cross section dependence (CD) test (Pesaran, 2004) to determine the type of appropriate panel unit root (stationary) test for the research variables (Omri, 2015). Second, the study carries out panel unit root test to find the order of the integration of the model variables. Then, we utilize the two-step Arellano-Bond (differenced GMM) method to estimate the research model and discuss the given results.

5.1. Cross Section Dependence Test

In panel data model analysis, it is required to test error terms for cross-section dependence when N is relatively large with respect to T. Thus, this paper applies Pesaran's CD test (2004). The result of Pesaran's CD test of the estimated model is presented in Table 3.

According to the results listed in Table 3, we fail to reject the null hypothesis, and the error terms of the estimated model have cross-section independency. This means that we can use Levin, Lin, and Chu (LLC) and Im, Pesaran, and Shin (IPS) tests for performing panel unit root tests on the model variables.

Table 3- Pesaran's cross section dependence (CD) test of

Test	Test statistics	Probability	Result
Pesaran's CD	0.431	0.6663	Cross section independence

Source: Authors' findings

5.2. Panel Unit Root and Cointegration Test Results

Since there is no cross-section dependence in the panel data model, for improving reliability and validity of the results, this paper utilizes Levin, Lin, and Chu (LLC, 2002) t* and Im, Pesaran, and Shin (IPS, 2003) W-test methods for stationary tests (Levin et al., 2002; Im et al., 2003). The results of LLC and IPS unit root tests for the model variables are tabulated in Table 4.

As presented in Table 4, the null hypothesis of unit root is almost rejected for all the variables at the 5% or 10% significance levels. This means that all the series are stationary, revealing that all the variables, except for IRE and IR which are stationary in the first difference using IPS unit root test, are integrated of zero order, I (0). Based on the given results of the panel unit root tests, since variables are stationary in both LLC and IPS unit

Table 4 - The results of panel unit root tests for the variables of estimated model.

Unit Root Test	Variable	Test Statistics	Prob (P-value)	Result
LLC	IRE	-5.1297	0.0000***	Stationary, I (0), Level
	TEC	-3.2331	0.0006***	Stationary, I (0), Level
	LTM	-3.9285	0.0000***	Stationary, I (0), Level
	FFC	-2.7180	0.0033***	Stationary, I (0), Level
	POP	-3.4407	0.0003***	Stationary, I (0), Level
	FFP	-1.8591	0.0315**	Stationary, I (0), Level
	IR	-5.0473	0.0000***	Stationary, I (0), Level
IPS	IRE	-1.3093	0.0952*	Stationary, I (0), First difference
	TEC	-2.7668	0.0028***	Stationary, I (0), with trend
	LTM	-2.1962	0.0140**	Stationary, I (0), with trend
	FFC	-1.3358	0.0908*	Stationary, I (0), with trend
	POP	-1.5750	0.0576*	Stationary, I (0), Level
	FFP	-1.6974	0.0448**	Stationary, I (0), Level
	IR	-1.3815	0.0836*	Stationary, I (0), First difference

***, **, and* denote the rejection of the null hypothesis at the 1%, 5%, 10% levels of significance respectively.

Source: Authors' findings

root tests, there is no need to implement panel cointegration test.

5.3. Estimation Results and Discussion

This study estimates the dynamic panel data model (1) using two-step Arellano-bond estimator based on GMM proposed by (Arellano and Bond, 1991). Equation 1 includes the lagged dependent variables of investment in the RE sector, which are endogenous considering country fixed effects, so we can take into account endogeneity using GMM-type instruments for the lagged dependent variable of investment in RE sector. The estimation results of Equation 1 are listed in Table 5. Also, the test statistics and the P-values of serial correlation tests, AR (1), AR (2), and Sargan test are reported in Table 5 (Sargan et al., 1958; Sargan et al., 1983).

The estimations include three lags of the dependent variable, and the test statistics of autocorrelation and the validity of the instruments are satisfactory. The estimation coefficients of all the variables except tax on energy consumption (TEC) in the estimated model have the expected signs. The null hypothesis about the test for first-order autocorrelation, AR (1), is autocorrelation, but the null hypothesis about the test for second-order autocorrelation, AR (2), is no autocorrelation. The test statistics of AR (1) and AR (2) are satisfactory, which is crucial for the validity of the instruments. The null hypothesis about the AR (1) test is rejected, but the null hypothesis about AR (2) test is not rejected. Moreover, the test statistic of the Hansen test for over identifying restrictions (the validity of the instruments) is satisfactory; the null hypothesis is not rejected, so the Hansen test is robust.

As can be seen in Table 5, the amount of investment in the RE sector (IRE) has a positive relation with its first and third order lagged value but a negative relation

Table 5 - Estimation results of dynamic panel data model of investment in renewable energy sector in selected developed and developing countries during 2004-2016

Difference in Dynamic Panel Data Estimation: Two-Step Results					
IRE	Coefficient	Standard Error	Z	P > |Z|	95% Confidence Interval
IRE (-1)	0.56923***	0.21917	2.60	0.009	0.139659 0.998820
IRE (-2)	-1.48453***	0.47970	-3.09	0.002	-2.424736 -0.544337
IRE (-3)	0.04795	0.23346	0.21	0.837	-0.409634 0.505550
FFC	0.03977*	0.02194	1.81	0.070	-0.003239 0.082798
TEC	-0.00067**	0.00030	-2.22	0.026	-0.001269 -0.000080
LTM	83.41202**	38.39504	2.17	0.030	8.159127 158.6649
POP	5.49032	4.70527	1.17	0.243	-3.731853 14.7125
FFP	-0.00681	0.00629	-1.08	0.279	-0.019148 0.005524
IR	-17.6061*	9.51862	-1.85	0.064	-36.26228 1.050042
Cons	-685.3912**	316.2118	-2.17	0.030	-1305.155 -65.62747
Number of observations	117				
Number of groups	13				
Number of instruments	70				
Arellano-bond test for AR (1)	1.7972 (Z)		0.0722 (Prob)		
Arellano-bond test for AR (2)	0.7995 (Z)		0.4239 (Prob)		
Sargan test of overi-dentifying restrictions	0.7874 chi2(60)		1.0000 (Prob)		

a*,**,and*** indicate statistical significance at 10%, 5%, and 1% levels respectively.
Source: Authors' findings

with its second order lagged value for the selected countries during 2004-2016. In other words, decision to invest in the RE sector deals with delays from one to three years because of specific characteristics of energy sector such as reliance on non-renewable energies, capital intensiveness of investments in the RE sector, long gestation period, and other economic and technical factors affecting investment decisions in energy market. Furthermore, the estimated coefficients of the first and second order lagged value of IRE are significant at the 1% significance level, but IRE does not have a significant relation with its third order lagged value. Accordingly, we have estimated that, other things being equal, a 1 billion $ increase in IRE in the current year would on average lead to 0.56 billion $ rise in investment in RE in next year; consequently, IRE decreases significantly more than 1 billion $ two years from now in the selected nations. In other words, the fluctuations of fossil fuel prices, the limitation of resources, and increasing concerns on climate change have made investors have variable behaviors in the RE sector in the selected countries over time.

As depicted in Figure 1, this estimated result also complies with real investment behavior of investors in the selected countries during 2004 to 2016. Another effective variable is the aggregate amount of fossil fuels (oil, natural gas, and coal) consumption (FFC), where the estimated coefficient of FFC shows an important positive impact on IRE at the 10% significance level. Actually, it is estimated that, on average, a 1 million ton rise in FFC per day increases IRE by about 40 million $ in the selected countries from 2004 to 2016. This result is accompanied by empirical facts in sample data because consuming more fossil fuels increases greenhouse gas (GHG) emissions and causes environmental problems. To deal with this issue, policy makers align policies for transition towards a low carbon economy, which makes investment in RE more desirable for investors. Hence, increasing FFC leads to rising IRE in the selected countries.

Imposing tax on energy consumption (TEC) has a significant and negative effect on IRE at the 5% significance level. This unexpected outcome rejects the research hypothesis that tax on energy consumption would increase incentives to raise investments in the RE sector. This impact establishes some implications that some environmental policies like carbon tax or tax on fossil energies consumption do not lead to predetermined results. In other words, some researches have reported that actions to reduce the intermittency of renewable sources may be more effective than carbon taxes alone on promoting investment in renewable generation capacity (Aflaki et al., 2017). The results show that TEC, simultaneously, increases the cost structure of the RE generation and reduces the profitability of investments. In addition, this result may prove that market liberalization, expanding RE, and giving subsidies to investors (or consumers) are more effective than tax on energy consumption policy. The intermittency of renewable technologies drives the effectiveness of carbon pricing mechanisms, which suggests that charging more for emissions could unexpectedly discourage investment in renewables as stated by (Aflaki and Netessine, 2017). Thus, the result indicates that although tax on fossil energy consumption may lead to reducing GHG emissions, this policy might not be an appropriate approach to encouraging and promoting investment in RE.

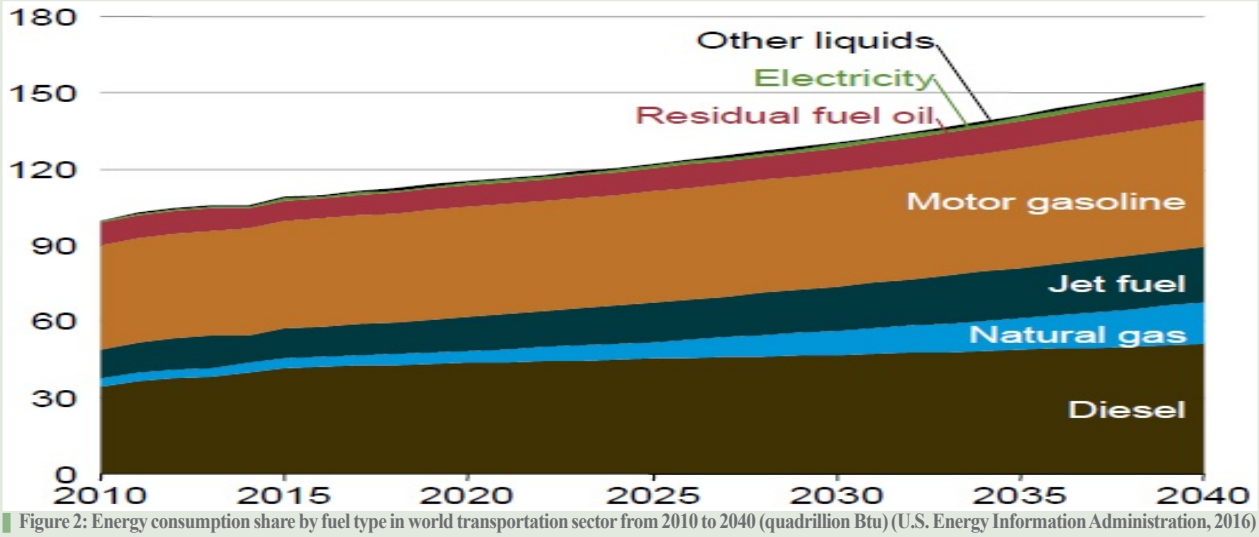

Figure 2: Energy consumption share by fuel type in world transportation sector from 2010 to 2040 (quadrillion Btu) (U.S. Energy Information Administration, 2016)

Furthermore, the estimation results show that tax on motor vehicle transportation (LTM) has a significant positive impact on IRE at the 5% significance level; it is also estimated that, on average, a 1% rise in tax on motor vehicle transportation approximately results in an 834 million $ increase in investment in the renewable energy sector in the selected countries over the studied period, indicating a large share of fossil fuel consumption in transportation sector in the given sample data. In fact, petroleum and other liquid fuels are the dominant energy source in the transportation sector worldwide, including the selected countries although their share in total transportation energy use is expected to decline from 96% in 2012 to 88% in 2040 (Energy Information Administration (EIA)'s Energy Outlook 2016). Figure 2 illustrates the share of different fuel consumption in transportation sector all over the world from 2010 to 2040.

According to Energy Information Administration (EIA) Energy Outlook 2016, transportation sector generates a substantial share of the GHG emission in the world and off course in the selected countries. Therefore, in contrast to TEC, tax on motor vehicle transportation, which uses fossil (liquid) fuels, should expect desirable implications due to its considerable impacts on the environment. Thus, those countries that use fossil fuels in their transportation systems could apply this policy to reducing GHG emission from motor vehicles.

In addition, population growth (POP) has a positive, but statistically insignificant, impact on IRE. This result indicates that after several meetings on climate change such as Kyoto protocol (1997) and Paris agreement (2015) and the increasing concerns about climate change, most of countries, including the selected 13 countries, have enhanced their endeavors and designed educational programs to encourage people to use and invest in RE. In other words, it shows that the new born population is being encouraged to use and invest in RE more than fossil fuels, but the success rate has been low due to economic growth and environmental conflicts, lack of resources, barriers to renewable energy technologies, low price of fossil fuels, political issues, etc. Moreover, the weighted average of fossil fuel prices (FFP) has a negative and statistically insignificant effect on IRE, stating that increasing fossil fuel prices has led to a decrease in investments in the RE sector over time in the studied nations . This relation, mostly, is due to the increasing marginal profit of fossil fuel energies with a price rise compared to renewable energies. In other words, this result shows that high price fossil fuel energies would make investment in the fossil fuel sector more profitable than the RE sector, in the selected countries with abundant oil over the study period, at least in short term

Finally, the last effective variable is interest rate (IR) which has a negative important effect on IRE variable at the 10% significance level. As given in Table 5, it is estimated that, on average, a 1% increase in interest rate results in a 176 million $ drop in investment in the renewable energy sector in the selected countries over the study period. The result is supported by economic theory.

In response to the main research question, the empirical results show that imposing tax on fossil fuels and energy has two separate and diverse impacts on the RE sector. First, tax on energy consumption (TEC) has, unexpectedly, a significant negative but negligible impact on IRE. The results demonstrate that tax on energy consumption may increase the production cost of the renewable energy generation leading to a decline in the investment profitability. Additionally, this result may prove that market liberalization, expanding RE, and giving subsidies to investors (or consumers) could be more effective than tax on energy consumption policy. Secondly, tax on motor vehicle transportation has a positive and substantial significant effect on IRE. This considerable impact is due to the large share of fossil fuel consumption and GHG emissions in transportation systems, across the world, including the selected countries. Moreover, the results indicate that imposing tax on motor vehicles is a more viable and effective policy tool than imposing tax on energy consumption (fossil fuels) to influence investors' behavior in the RE sector. In other words, imposing tax on energy consumption merely discourages investment in RE (IRE), but tax on motor vehicles encourages IRE. These conclusions are consistent with renewable energy policy realities in the selected countries.

Based on KPMG international 2017 report (KPMG International, 2014), the most leading countries have focused on investments and operating subsidy[4] schemes (called investment subsidies) instead of merely concentrating on tax penalties for energy consumers. Investment subsidies are unique to operating subsidies, which encourage the production of renewable energy. Investment subsidies provide financial assistance through grants, low-interest loans, education, or tax incentives such as R&D tax concession in the RE sectors

[4]These subsidy schemes include feed-in-tariffs (FIT), premiums, quota obligations, renewable portfolio standard (RPS), tradable renewable energy certificates (RECs), etc.

to encourage the investment in a particular renewable energy industry (KPMG International, 2014).

6. Conclusion and Policy Implications

This paper contributes to the stream of academic and institutional literature by investigating and exploring, merely, the efficiency of two types of tax policies on doing business or investments in renewable energy sector. Climate change and sustainability issues continue to gain headlines, and the likelihood of costs being imposed on carbon dioxide emissions in the developed countries has profoundly changed the economic outlook of RE sources. Making the shift from fossil fuels to renewable energy is leading global governments, businesses, and consumers alike to examining all the aspects of their environmental footprint and creating strategies to become environmentally responsible and thrive in today's economic climate (KPMG International, 2014).

Many agreements and protocols like Kyoto protocol in 1997 and COP 21 and Paris agreement in 2015 have been signed by most of the world countries to lower the implications of fossil fuel consumption based on United Nations Framework Convention on Climate Change (UNFCCC) policies. To reach global agreements' goals and keep the global temperature rise to less than 2 °C, developing RE is essential and policies should be implemented in this regard. Imposing tax on carbon-intensive tools or fossil fuel consumption is one of the proposed solutions to reduce environmental pollutions in the world. To this end, this paper investigates the effectiveness of imposing taxes on energy consumption and motor vehicle transportation to encourage investments in the RE sector during 2004-2016 for 13 developing and developed countries. Other factors like the price of fossil energies and interest rate are included in the research model to evaluate the investors' behavior in the RE sector. Based on the empirical results, we conclude that tax on fossil fuel consumption do not enforce investors to do businesses in the RE sector; however, imposing tax on transportation systems, which use fossil fuels, is effective and encourage investors to move their capital towards technologies producing lower carbon or greenhouse gas (GHG) emissions.

In accordance with economic theories, investing in the RE sector deals with some time delays, one and two years. Investment volume in RE is volatile, and many organizations in the world, like UNFCC, try to make doing business in RE attractive for global investors. Investors evaluate different risks, factors, business indicators, and policies to make decision about investing in the RE sector. Based on the empirical results in Table 6, investing in RE usually increases in the first year in the sample countries, but investors move their profits and capital to other businesses in next year and may then decide to invest their profits from other sectors in the RE sector. Hence, investing in the RE sector grows in a nonlinear path, and investors reduce their portfolio risks by diversifying assets value. The main purpose of the current paper is investigating the effectiveness of tax policies in encouraging investors to take part in the RE sector. Imposing tax on fossil fuel energies is implemented to protect the world environment from the negative outcomes of consuming fossil fuels. As mentioned, tax on fossil fuel energies is separated in two parts: tax on energy consumption and tax on transportation systems. Despite the research assumption, tax on the consumption of fossil fuel energies does not encourage investors to move their capital towards the RE sector of the selected countries. Therefore, it is proposed that giving subsidies to investors or consumers in the RE sector can be more effective than imposing tax on fossil fuel consumption and/or production. Based on the results, unlike tax on energy consumption, tax on motor vehicle transportation is effective in inducing investors to make investment in the RE sector. Tax policies cause innovations, investments, and agreements to apply modern, cost-effective, and efficient technologies to transportation systems. Due to the considerable share of transportation system in polluting the environment, rigorous regulations are employed in this sector to encourage people to use modern transportation systems and persuade investors to do business in this sector for accessing more air quality. Consequently, tax policies in the developed and developing countries can be efficient and effective along with the subsidy payments.

Considering substitutability of RE and fossil fuel energies and a negative relation of fossil fuel prices (FFP) with expanding RE, policy makers in global energy market should try to keep FFP in a reasonable range to attract investors to RE sustainable development plans. The interest rate of banking system is the other behavioral effective risk factor for global investors which is analyzed in the behavioral economic of investments in RE market. We recommend that an optimal interest rate should be pursued by all the countries in the sample to encourage moving accumulated capital towards the RE sector projects.

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Declaration of Conflicting Interest

The author(s) declare that there is no conflict of interest.

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Identification and Prioritization of Dimensions and Components Effective on Human Resources Valuation: A Case Study on National Iranian Oil Company and its Subsidiaries

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ABSTRACT

The purpose of the current work, conducted in 2017 and 2018, is to identify and prioritize the qualitative and quantitative factors affecting human resources (HR) valuation at National Iranian Oil Company and its subsidiaries. Using a snowball sampling method, 28 experts were selected from the head of human resources, the head of finance, and some staff members of National Iranian Oil Company and its subsidiaries. In order to identify the dimensions and components affecting human resources valuation, a comprehensive literature review at international and national levels, interviews with experts, and three stages of distribution and collection of questionnaires using the Fuzzy Delphi method were performed. Then, two phases of the paired comparison questionnaire were developed and provided for the experts to explain and evaluate the cause-and-effect relationships between the dimensions and the components together. The specified components and dimensions were prioritized using the Fuzzy DEMATEL method. Using the Fuzzy Delphi method, 15 dimensions and 101 components influencing HR valuation were identified at National Iranian Oil Company and its affiliated companies. According to Pareto 20-80, 20 components were identified as the factors influencing human resources valuation at National Iranian Oil Company and its subsidiaries, and using the Fuzzy DEMATEL method, 15 dimensions and 20 specified components were prioritized. According to the results obtained, the most important dimension and component affecting human resources valuation at National Iranian Oil Company and its subsidiaries are job satisfaction, motivation, and perseverance in employees' assignments.

1. Introduction

In today's competitive world, human resources are one of the factors that can provide competitive advantage to organizations. The success or failure of any organization depends to a large extent on the people of that organization, and the organizations can survive, which can play a decisive role in adapting to the changes of the current world. In this context, it should be noted that the reason for the distinction between human resources and other organizational resources is that the human resources of an organization have capabilities such as learning, changeability, innovation, and creativity, which can guarantee the long-term survival of organizations, if properly managed. The importance of creating a new accounting system, followed by the effective management of human resources, is due to the fact that an annual large share of the cost of each organization is composed of its operational costs, a significant part of which goes to manpower.

Contrary to the industrial age when organizations took into

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account their physical assets, today, based on the requirements of the environment and the emergence of a knowledge-based economy, human capital forms a significant part of the value of the organization; accordingly, human resources should be presented as an asset in the balance sheet so that appropriate decisions should be made and necessary measures should be taken by the management based on quantitative analyses. Human resources accounting has been focusing on human resources analysis since the middle of the last century and is still on the rise.

Accounting as one of the branches of social sciences seeks to report on the financial status and economic performance of individuals, both real and legal. As long as human beings are not considered as an element in reporting the financial situation and the outcome of the operation, human values are not at the right place (Talaneh et al., 1994). Promoting human capital and its impact on different aspects of an organization performance and, more broadly, on the economic and social development of a society is not overlooked by anyone. Using human resources accounting, people can be considered as a long-term capital, not as short-term expenditures which must be minimized (Wadi Zadeh et al., 2009).

In fact, human resources accounting is the transformation of the qualitative and subjective meaning of human resources value in a quantitative and objective way using accounting knowledge and deals with three major components of human resources, including their quantity identification and quality analysis, the evaluation and measurement of their economic value, and their appropriate financial reporting (Tabarsa et al., 2007).

Over the past 100 years, the oil industry has been a major player in Iran's economy and has actually been at the heart of the country's progress and development in all areas. Hence, the growth and development of the country depends on the growth and development of this industry. Since human resources are considered as one of the important factors in the development of the oil industry, the significance of human resources in this industry is also increasing. In recent decades, due to insufficient attention to the training of expert human resources, the abnormal withdrawal of qualitative forces, and the quantitative and qualitative inadequacy of successors, the pyramid of the human resources of Iran oil industry is disrupted, so in the near future, Iran oil industry will face a serious shortage of experts and top managers at top levels of organizations. It is worth mentioning that the average age of the managers of Iranian oil industry highlights the lack of appropriate training of human resources in various management categories (Gol-Shirazi, 2014).

Today, the managers of the oil industry have a wide range of material, physical, and equipment resources, but managers' information is limited in the evaluation of human resources. Also, if managers want more efficiency and effectiveness in their tasks and missions, it is imperative to acquire the ability to evaluate and measure the importance of the human resources needed to manage their capabilities. With the help of human resources accounting, information about the value of an organization's human resources which should be used in the supervision and decision-making of managers is recorded and reported (Hassan Ghorban, 2000).

At present, oil and gas companies are facing serious shortages of trained and skilled personnel due to the increasing growth of oil projects around the world. Consequently, competitive conditions have been created to attract skilled and experienced manpower among active companies in these industries globally, especially in the Middle East. The losers of this competition are the companies offering the least attractiveness of maintaining human resources. In this regard, the migration of experts from these companies to competing companies is the evidence of this claim.

The weakness of the oil industry services compensation system in the international competitive environment and in comparison with the leading domestic companies has reduced the attractiveness of the oil industry for attracting and retaining specialized forces and changing the pattern of human resources competency (Gol-Shirazi, 2014).

The main purpose of human resources accounting is to attract the attention of managers who are indifferent about keeping the manpower and the managers who do not pay attention to job satisfaction and positive motivation of their employees and do not create job security, hope, and sense of loyalty; in fact, they do not think of creating opportunities for improving and/or eliminating human resources problems, and they result in the expulsion or resignation of employees (Abtahi, 1996).

In fact, this research, by examining the literature of research and the opinion of certified experts, seeks to identify all the aspects and components of human resources valuation at National Iranian Oil Company and its subsidiaries.

2. Theoretical Foundations and Research Background

The process of accounting developments involves four stages of "invoicing accounting," "financial accounting," "management accounting," and "socio-economic accounting,"; the accounting has more or less gone through the first three stages; the future challenge of accountants is the implementation of the fourth stage of accounting, which is the "human resources accounting" of this category.

The development of human resources accounting can be described in six periods as follows:

First period: the derivation of the basic concepts of human resources accounting from the corpus of relevant theories (1960-1967);
Second period: academic fundamental research into the development of measuring models (1971-1967);
Third period: the rapid growth of inclinations to human resources accounting in the academic society (1976-1971);
Fourth period: the recession of the academic society's desire to human resources accounting (1976-1980);
Fifth period: reviving universal inclination to human resources accounting in theory and practice (1980-99);
Sixth period: the origins of intellectual capital (1995- present) (Karami and Hasani Azar, 2006).

Today, the lack of measurement, evaluation, and reporting of human resources value is the main reason for the adoption of non-optimal decisions by the managers of organizations. Due to the lack of the measurement of the economic value of human resources, the effects of directors' decisions on the value of human resources are not investigated. In their decisions, directors pay attention only to quantitative variables but do not take into account qualitative variables. Therefore, managers' decisions may seem to be useful, but it can be detrimental to the organization in practice and can unknowingly lead to the destruction and weakening of its human resources. For example, decisions made by managers in order to reduce costs and the effects of such decisions on employees' orientations, motivation, and satisfaction are not taken into account, which may lead to the loss of employees' motivation and satisfaction and may weaken human resources. Therefore, it can be emphasized that HR valuation is one of the most crucial issues of any organization (Pazhoohi, 2016). The advantages of human resources accounting can be noted as follows:
* Human resources accounting shows the impact of human resources on company performance.
* Human resources accounting should assist managers in evaluating different strategies of the company.
* Human resources accounting can develop a capital budgeting system and correct the quality of the investment return.
* Human resources accounting enables managers to better use human resources scarcity (Mutmani et al., 2012).
* Human resources accounting information can be viewed through two methods:
1. Human Resources Costing: a human resources accounting system first requires identifying costs related to human resources which must be separated from other business unit costs. The methods and practices used should distinguish between the capital and current sectors. Human resources costing consists of two parts:
1.1 Primary Costs: all the funds required for supplying human resources, including selection and recruitment of manpower, placement and in-service training, retraining and practical training for the acquisition of skills.
1.2 Replacement Costs: the cost of replacing employees who are currently in the organization, including:
(a) post or occupational replacement costs, including maintenance, education, or retirement expenses.
(b) Other personnel costs, including rewards (cash and non-cash), facilities (tools, furniture, and equipment necessary for the welfare of employees), health and hygiene, consultancy and negotiation expenses, payroll, and other payments such as insurance.
2. Human Resources Valuation: human resources accounting needs more value than costing. The concept of the value of human resources is based on the theory of value in the general economy. Given that human beings are able to create potential future benefits, one can value human like other resources as the current value of a set of services that a person is expected to create during the period of his service in an organization. A group has rejected this theory and believes that human resources are beyond evaluation, and in fact, irrecoverable. According to the theory of researchers, there are two basic steps to measure human resources. This means that one must first define the concept of human resources in non-monetary or qualitative terms and then describe it in monetary terms so as to be represented in the organization's balance sheet. Some HR practices are economic value (current), replacement value, value coefficient, Flamholtz model, Marco model, auction theory, and historical cost (Tabarsa et al., 2008).

Some researchers believe that a person is not owned and therefore should not be considered as an asset and should not be depreciated; by contrast, the advocates of human resources accounting believe that what is considered in the human resources accounting system for asset management is the imaginary, expected, and future prosperity service source of human resources. Some believe that there is a lot of uncertainty about identifying people's services, so identifying people as assets is not correct according to the conservatism principles; however, supporters believe that the fundamental objective of reporting (matching revenue with period expenses) should not be sacrificed for conservatism. Some other also admit that there is ambiguity about the timing of determining the future benefits of investing in manpower, so taking into account the cost of manpower costs could create the possibility of distorting profit; nevertheless, the proponents support that there is potential for the distortion of profit and loss through the absence of investment in human resources (Hassan Qorban, 1996).

Soraya et al. (2006) addressed "prioritizing the indicators of human resources assessment under a fuzzy environment" in a study and developed a methodology based on the fuzzy hierarchy process analysis to weight the indicators of human resources assessment. Their model includes five main criteria

of intelligence and talent; leadership; perseverance and seriousness in work; initiative; and creativity, flexibility, and relevant sub-criteria and 20 indicators. Their results showed that the level of the application of individual knowledge to creating optimal results, staff skill level, the transfer of information, and the success rate in educational programs are the most significant indicators of human resources assessment.

In another study entitled "prioritizing human resources performance evaluation indicators using hierarchical analyses under fuzzy environment," Bozbura et al. (2007) described a methodology for prioritizing the indicators of human resources assessment in fuzzy environments in Turkey. Their results confirmed that the rate of knowledge utilization in obtaining outcomes, staff skills, information reporting, and the success rate of educational programs are the most significant indicators of human capital estimation in Turkey.

Abeysekera (2008) examined the issue of "determinant factors in the disclosure of human capital information on the financial statements of companies accepted by the Colombo Stock Exchange (Sri Lanka Stock Exchange)." Therein, senior HR managers of 30 companies were interviewed, and the results showed that the disclosure of HR information in financial reports was solely to reduce the concern of the company stakeholders about the company capital growth. According to the results of this work, companies have provided information on human resources only to add qualitative information to the financial statement appendixes and reported information such as staff assessment, personnel training, and staff welfare; on the other hand, the health indicators of personnel, personnel skills, and the creativity of personnel are less considered in these reports.

Michael Oyewo Babajide (2013) addressed "the comparative analysis of human resources accounting disclosure practices in Nigeria's financial and production services companies." 30 variables disclosing human resources accounting including total human resources value, number of employees, added value of employees in the form of value-added, composition of the board, manager's rights, retirement benefits, performance identification, employment of disabled people, health, safety, and environment at work, the range of salaries received by employees without a pension, the scope of salaries received by managers, the disclosure of diverse and non-discriminatory practices in employment, the number of employees employed by each department, the disclosure of the method for determining the salary of individuals, etc. were identified and placed on the checklist. The study stated that although HR disclosure index of banks is higher than that of manufacturing firms, the difference is not statistically significant. There is also a strong positive correlation between the disclosure of human resources accounting and firm size. Companies may consider valuation and combination of human assets in their financial statements to increase the credibility of financial statements. The relevant authorities should set up specific financial reporting standards for human resources activities to resolve the issues of arbitrary disclosure of human resources accounting.

Soltani et al. (2014) investigated "prioritization of human resources accounting indicators based on the valuation approaches in the industrial machinery and equipment industry." The purpose of this study was to identify the value of human capital assets and prioritize them based on the human resources accounting approach and using Flam Holtz model. Their findings indicated that managers approved the following as the criteria for determining the value of human assets in an organization:

* Ability index: the dimensions of creativity, innovation, adaptive ability, and teamwork capabilities;
* Performance index: the dimensions of duty, participation, obedience, and work conscience
* Potential index: the dimensions of age, health, talent, and experience;
* Attitude index: dimensions of succession, optimism, honesty, kindness, and sacrifice .

The dimensions of skill, duty, talent, and success are of the highest priority in the four indicators.

Abdi et al. (2016) conducted a research entitled "determining the role of factors affecting the valuation of players (human capital) of the Iranian football league". Based on the results of the coefficients of the regression model, the findings indicated that factors such as age, number of national matches, player goals, previous player level, and constant participation in the previous season have a significant effect on player prices as the human capital of the club; however, other factors such as game post, individual and team prizes and honors, leg position, height, goal ratio, and the minutes of the game did not remarkably influence determining the price of players.

Omole et al. (2017) examined "the impact of human capital accounting on the market value of oil and gas companies in Nigeria." They collected second-hand information from 2005 to 2014 from annual reports, accounts of oil and gas companies, as well as books published by the stock exchanges of Nigeria. Their results indicate that human capital has a positive and significant relationship with stock prices. The findings suggest that capitalizing corporate investment in human resources should increase the market value of oil and gas companies and should also be able to create a favorable image of Nigeria's oil and gas companies. Therefore, this study recommends that a standard for the disclosure and measurement of human resources information be developed to enhance human capital valuation and insure uniformity in the disclosure, interpretation, and more reliable comparison of

financial statements.

Fazel et al. (2017) studied "identify the dimensions and components that affect the utilization of university human resources with an emphasis on third and fourth generation universities using the fuzzy Delphi approach: providing a conceptual model." The survey was carried out in four stages in 2016, and the results of each stage were refined using the formulas of the fuzzy Delphi method. A model of empowering human resources in Iran universities, emphasizing entrepreneurship and value creation universities in three dimensions and including 22 components for faculty members and 23 components for higher education system staff was proposed.

Naghshbandi et al. (2017) investigated "measuring factors adoption of HR valuation: manager's perception." They highlighted the factors affecting the adoption of human resources accounting and predicted organization performance. For this purpose, the data on 100 managers were gathered from 15 companies operated in India and abroad. The companies were selected for the purpose of this study on the basis of the invested capital. The data analysis methods were Chi-square tests and multiple regression method for identifying that weather respondents have a positive perception about the use of HRA. Since the perception of managers was treated as evidence for wealth creation, it was proposed that managers of Indian and global companies should adopt human resources accounting.

Khodabandeh et al. (2018) worked on "designing a human resources agility model based on grounded theory approach (case study: social security organization), and indicated that the agility of human resources as an axial phenomenon is due to a set of individual-organizational, individual-personal, organizational, and occupational characteristics. The effects of this phenomenon were categorized into two groups: individual and organizational. Moreover, in this model, the underlying factors (power sharing practices, human resources management practices, organizational coordination, communication and information technology, and organizational process) and interventional conditions (organizational culture, leadership style, self-development, and environmental factors) impact on the ruling relations.

Khorshidi et al. (2018) addressed "identification and explanation of dimensions, components, and indices of human resources development in Sama organization." The data obtained from the qualitative part were examined through content analysis, and the collected data in the quantitative part, according to the research questions, were analyzed through descriptive (mean, standard deviation, tables, etc.) and inferential statistics (structural equation modeling, exploratory factor analysis, and one-sample T-test) using SPSS and Lisrel software. The results proved that empowerment, job performance, and improvement are the elements of human resources development in Sama organization. Furthermore, given the proposed mechanisms, facilitators, and barriers, a well-fitted model was designed.

Patrick Olajide et al. (2018) conducted an "empirical study of human resources accounting disclosure on financial performance of selected listed firms in Nigeria." The collected data were analyzed using descriptive statistics, correlation, and regression. The study revealed that there is a positive co-efficient value of 0.565 between the independent and dependent variables. Based on these findings, the study therefore recommends that the listed firms should imbibe the culture of capitalizing on their reports and disclose all the expenditure on human resources so as to improve the productivity of the firms. Moreover, the regulatory body should set a minimum standard of reporting human resources accounting in the financial statement of the listed firms in other to enhance stakeholders' valuation in the statement of financial position and note to the accounts.

3. Research Methodology

The purpose of this study is to apply applied research and to collect data from an analytical-type survey conducted in 2017 and 2018. The statistical population consisted of all the experts in the field of human resources valuation who have been involved in determining the importance of dimensions and components, including human resources, finance chiefs, and some experts of National Iranian Oil Company and its subsidiaries. In the present work, 28 experts were selected using snowball sampling method.

First, with a comprehensive literature review on human resources assessment and interviews with experts, with the three stages of the distribution of the questionnaire, and with the use of the fuzzy Delphi method, the dimensions and components that affect the human resources valuation at National Iranian Oil Company and its subsidiaries were identified. Then, two phases of the fuzzy DEMATEL comparison questionnaire were developed for the purpose of explaining and evaluating the cause-and-effect relationships between the dimensions and the components together and were presented to the experts. The specified components and dimensions were prioritized using the fuzzy DEMATEL method. Microsoft Excel software was utilized to analyze the fuzzy Delphi and the fuzzy DEMATEL questionnaires.

4. Data Analysis Method

In this study, in order to identify and determine the dimensions and components that affect the human resources

valuation using the fuzzy Delphi method and then the fuzzy DEMATEL method and to achieve a more accurate analysis, we used effective and influential relationships between the dimensions and the components determined.

After the initial design of the questionnaire, some of the experts were asked to do the initial test on the questionnaire. The results showed that the experts had a common understanding of the subject and of the questions of the questionnaire, which indicates the validity of the questionnaire structure. Moreover, when designing the questionnaire, we tried to study the research literature and related articles to identify effective and relevant dimensions in the field of human resources valuation. Then, according to the experts' opinions, their initial screening was dealt with, and then the questions were designed based on the dimensions and components approved by the experts (supervisors, consultants, and a number of the heads of the organization). Therefore, the questions were approved by the experts, which affirms the validity of the content of the questionnaire. To assess the reliability of the questionnaire, both the Cronbach's alpha and the test-retest were used between the first, the second, and the third rounds. According to the amount of elongation and sloping data, the data were analyzed to separate the normal or non-normal data.

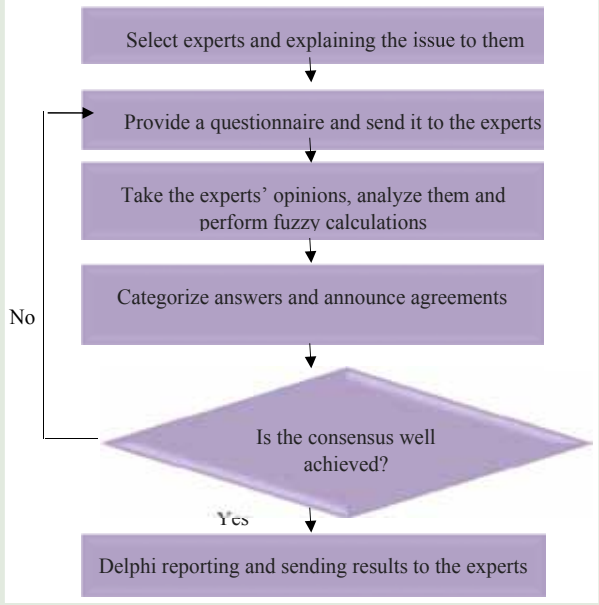

Figure 1: Fuzzy Delphi algorithm

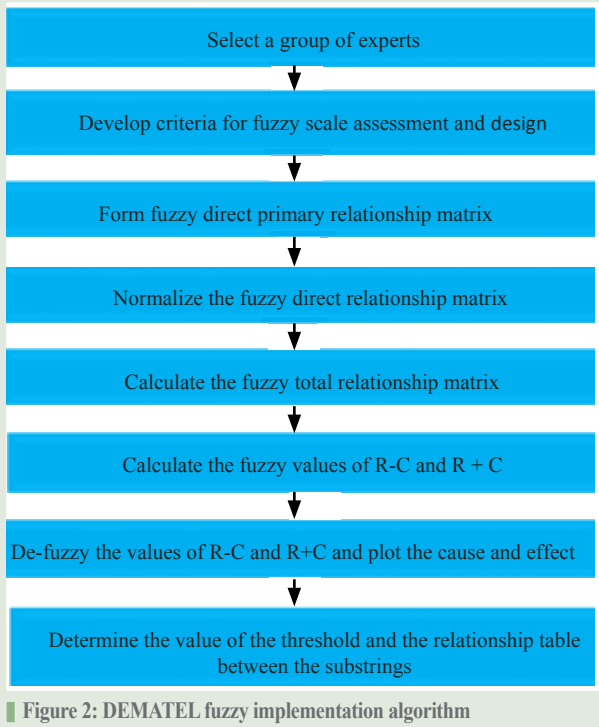

Figure 2: DEMATEL fuzzy implementation algorithm

The implementation phases of the fuzzy Delphi method are in fact a combination of the implementation of the Delphi method and the analyses of information using the definitions of the fuzzy sets theory. The algorithm for implementing the fuzzy Delphi method is shown in Figure 1 (Habibzadeh et al., 2016).

In the fuzzy DEMATEL method, the experts were asked about the relative importance of each component with respect to the other components and each dimension compared to the other dimensions. In other words, all the components and dimensions were compared two by two. After collecting experts' opinions, the components and dimensions were prioritized using the relationships specified in the fuzzy method. The advantages of the fuzzy DEMATEL method are the acceptance of relationships compared to other decision-making methods based on paired comparisons. That is, in the hierarchical structure of each element, it can affect all the elements at a higher or lower level, and elements can interact with each other individually; also, structuring complex factors in the form of causal groups is one of the advantages of the fuzzy DEMATEL method, and given the complexity of human resources valuation at National Iranian Oil Company and its subsidiaries, this method can be of great help to us. The algorithm of implementing the fuzzy DEMATEL method is displayed in Figure 2 (Habibzadeh et al., 2016).

5. Research Findings

In the fuzzy Delphi method, the questionnaires were distributed among the experts, and their views were examined. After identifying the components of the research based on the literature review and the background of the research and interviewing the experts, the first-round questionnaire was designed with 98 questions and one open question. After collecting questionnaires in the first-round and reviewing them, it became clear that five new components, including avoiding political gambling and paying attention to expertise

and commitment, complying with HSE, managing skills of the staff, updating the knowledge of doing work, identifying the opportunities of the organization, were added to the previous components. In order to evaluate the questionnaire, the first step should be to determine a de-fuzzy of the responses given to each question and then compare them with the average of the range or threshold indicator (which is always equal to 3 for the 5-point Likert scale). The amount of the de-fuzzy response of all the questionnaire questions was higher than the target threshold, so all the questions were confirmed at this stage. The Cronbach's alpha of the first-round of the questionnaire was 0.801 (which is more than 0.7), confirming the reliability of the first-round questionnaire. The amount of the statistics of the index of sloping and elongation ranges from -2 to +2. In general, if elongation and skidding are in the range of -2 to +2, we can consider that the distribution is normal (Habibpour Gatabi, 2016). Therefore, according to the results, the normalization of the data related to each question can be accepted.

Table 1- Main dimensions which are effective on human resources valuation

Main Dimensions	
C1: Tacit knowledge	C9: Job satisfaction
C2: Joining	C10: Individual loyalty to the organization
C3: Talent	C11: Obedience and conscience
C4: Creativity	C12: Coaching
C5: Skill	C13: Succession
C6: Kindness and dedication	C14: Teamwork ability
C7: Duty	C15: Quantitative variables
C8: Leader	

Table 2- Components which are effective on human resources valuation

Components	Rating	Components	Rating
C1: Employee experience	18	C11: The spirit of readiness to help around people	10
C2: Staff technical information	16	C12: Belief in doing the right thing	1
C3: Participation of staff in providing suggestions	14	C13: Honesty and truthfulness	3
C4: Individual staffing abilities and talents	8	C14: Having an accountability feature for employees	15
C5: The mental health of the staff	2	C15: Create added value on the job	6
C6: Energetic staff	19	C16: Having a bias feature and defending the organization	7
C7: Thinking before action	11	C17: Staff performance	4
C8: Having a location feature	9	C18: The reliability of the staff	13
C9: A quick understanding of employees' work issues	5	C19: Flexibility of staff	12
C10: Having the spirit of helping people with high workload	17	C20: Motivation and persistence in staffing assignments	20

Table 3- The fuzzy spectrum of the verbal expression

Verbal phrase	Fuzzy value
No impact	(0,0,0.25)
Small impact	(0,0.25,0.5)
Medium impact	(0.25,0.5,0.75)
Great impact	(0.5,0.75,1)
Enormous impact	(0.75,1,1)

Then, in the second-round, by distributing the new questionnaire, the general results obtained from the first questionnaire were provided to the experts, and their opinions were evaluated. In the second questionnaire, considering that all the questions of the questionnaire were important in the first-round of the questionnaire and that five new questions were developed for five components introduced by the experts and added to the previous questionnaire, 103 questions were designed generally. At least 70% of the experts should have the same answers to each question to check the condition of consensus or the agreement of the experts (Hsu and Stanford, 2007). Since there was still no accumulation of experts' opinions, and there were insignificant questions in the questionnaire, the stop level was not achieved. The answers to the two questions have a de-fuzzy value less than the average value of the spectrum, i.e. 3 that is the basis of the evaluation, so these questions (components) were considered to be negligible questions and were eliminated.

According to the results of the second-round questionnaire, a third-round questionnaire was designed and distributed. After collecting the third-party questionnaires, most of the questions reached a consensus level. Therefore, the condition of the research agreement was provided. Due to the condition for stopping, 15 points and 101 components were identified.

In accordance with Pareto 20-80,[1] (Pareto's Principle or Law 20-80 states that 20% of factors create 80% of the issues), 20 qualitative components were determined as the factors affecting human resources valuation at National Iranian Oil Company and its subsidiaries. None of the following components, including quantitative variables such as age, physical health, organizational occupation level, educational level, experience, the rights and benefits of the individual, etc. was among the first 20 factors affecting human resources valuation in National Iranian Oil Company and its subsidiaries.

Using the fuzzy DEMATEL method, 20 components and 15 specified dimensions were prioritized. The first step of the

[1] The history of the 80/20 rule goes back to 1906 when Pareto proved through mathematics that the distribution of wealth in his country was completely unequal. Indeed, he once came to the mathematical formula proving that 20% of the Italians had more than 80% of the country's wealth; interestingly, after discovering his idea, many other scholars and experts also discovered similar phenomena in their field of activity and in other countries, and it turned out that such a hypothesis became a universal law.

fuzzy DEMATEL method is to compare the components and dimensions separately using the experts based on the degree of priority on the 5-point Likert scale. The verbal comments of the individual respondents (the experts) on the components and dimensions affecting human resources valuation at National Iranian Oil Company and its subsidiary companies were collected. Then, using the Chang fuzzy method, the verbal expressions became fuzzy numbers (Table 3).

In the second step, the matrix of the aggregation of experts' opinions was extracted. Using the arithmetic mean, the collected comments were aggregated into a matrix. This matrix is calculated based the average of the experts' opinions and triangular fuzzy numbers.

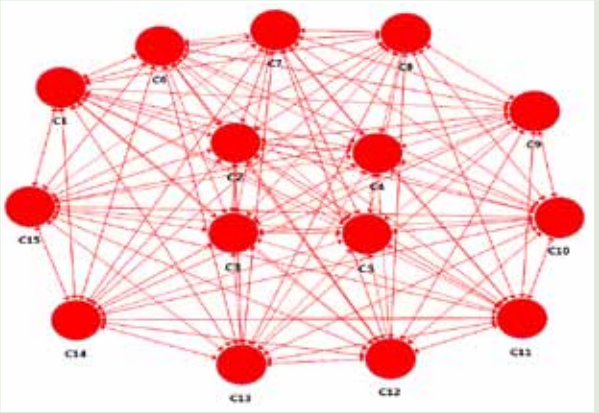

Figure 3: Dimensional cause-and-effect relationships

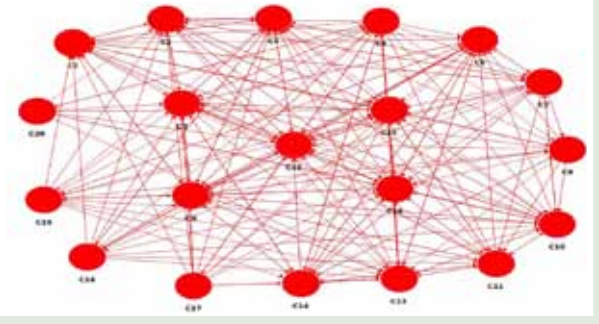

Figure 4: The causal relationships between the components

The third step involves normalizing the extracted matrix. To this end, we first calculated all the lowe bound of the experts' opinions; then, the maximum was selected from the sum of the bottom boundary numbers, and all the numbers were divided by the maximum number.

In the fourth step, the lower bound (HL) of the normalized matrix was calculated using the experts' opinion. To do so, the lower bound of the normalized matrix just entered the matrix.

Then, in the fifth step, the matrix I-HL was calculated. The unique matrix (I) is a matrix in which all the matrix elements on the original diameter are equal to one, and the rest of the elements are zero; in this step; all the lower boundary elements (HL) are subtracted from all the unique matrix elements.

The sixth step involves calculating the inverse of the I-HL matrix.

In the seventh step, the matrix of (HL×(I-HL))-1 was calculated. The bottom bound matrix was multiplied by the matrix obtained from the previous step.

The eighth step involves calculating the median boundary (HM) of the normalized matrix of experts' opinions. To this end, only the middle bound of the normalized matrix was inserted into the matrix.

The ninth step involves calculating the matrix of I-HM. The unique matrix (I) is a matrix in which all the matrix elements on the original diameter are equal to one and the rest of the elements are zero; in this step, all the median boundary elements (HM) are subtracted from all the unique matrix elements.

The tenth step involves calculating the inverse of I-HM matrix.

The eleventh step calculates the matrix of (HM×(I-HM))-1. The matrix of the intermediate boundary was multiplied by the matrix obtained from the previous step.

In the twelfth step, the upper bound (HU) was the normalized matrix of the experts' opinions, so only the upper bound of the normalized matrix entered the matrix.

The thirteenth step calculates the matrix of I-HU. The unique matrix (I) is a matrix in which all the matrix elements

Table 4- Calculate the importance of the dimensions and their relationships

Relations Matrix	C8	C7	C6	C5	C4	C3	C2	C1
R+C	4.033	2.333	5.692	7.170	3.287	6.257	7.970	2.931
R-C	2.106	1.899	-15.332	-0.539	1.337	2.823	-3.525	2.082

Relations Matrix	C9	C10	C11	C12	C13	C14	C15
R+C	6.743	5.834	6.981	7.449	7.091	10.138	3.014
R-C	4.012	2.473	0.526	-1.751	0.189	1.066	1.053

on the original diameter are equal to one and the rest of the matrix elements are zero; in this step, all the upper boundary elements (HU) are subtracted from all the unique matrix elements.

In the fourteenth step, the inverse of I-HU matrix was calculated.

In the fifteenth step, the matrix (HU×(I-HU))-1 was calculated. The upper bound matrix was multiplied by the matrix obtained from the previous step.

The sixteenth step involves the construction of a matrix of the total fuzzy relations (T). To construct this matrix, all the elements of the matrix (HL×(I-HL))-1, (HM×(I-HM))-1, and (HU×(I-HU))-1 entered the matrix.

The seventeenth step calculates the de-fuzzy matrix. To calculate the elements of the de-fuzzy matrix, the boundary of the bottom with a high bound and the double of the middle boundary of the matrix were summed up and then divided into four. The sum of each of the rows (R) and each of the columns (C) of the de-fuzzy matrix was calculated, and the threshold value was then determined using the mean total of the de-fuzzy matrix elements.

In the eighteenth step, the cause-and-effect matrix was created. To construct this matrix, all the elements with threshold values were compared one by one. If the value of each of elements is greater than or equal to the value of the threshold, 1 was placed in the cause and effect matrix, otherwise it was set to zero.

In the nineteenth step, the causal relationships and the relationship between the variables were plotted as depicted in Figure 3 and 4.

In the 20th step, the significance of the dimensions and relationships between them and the importance of the components and their corresponding relationships were calculated (Tables 4 and 5). To obtain the importance of the dimensions and components, the rows and the columns were added, and the columns were subtracted from the de-fuzzy matrix rows.

Based on the results obtained from the dimensions, the dimension of teamwork capability is the highest (R); therefore, it is considered to be the most influential factor. Also, the dimension of altruism and sacrifice is the highest (C), so it is the most impressive factor. Then, job satisfaction with the highest (R-C) value is considered to be the most influential factor affecting human resources valuation at National Iranian Oil Company and its subsidiaries. Moreover, teamwork capability has the highest (R+C) value, which means it is strongly related to the other factors.

According to the data on the components, the thinking component before the action has the highest (R) value; thus, it is the most influential factor. Furthermore, the component of creating value-added work has the highest (C) value and is the most impressive factor. It should be noted that the sum of row elements (R) of each factor indicates the extent of its influence on other system factors; in other words, the effect of the variables is illustrated. On the other hand, the sum of column elements (C) of each factor indicates the extent of its impact on other system factors; in other words, the degree of impact variables is demonstrated. Therefore, the horizontal vector (R+C) shows the amount of impact and effect of a desired agent in the system. In other words, a higher (R+C) factor means a stronger interaction with other system factors. The vertical vector (R-C) shows the impress of each factor. In general, if (R-C) is positive, the variable is a causal variable, but if it is negative, it is considered to be an effect. Hence, on the basis of the above discussion, it can be stated that the component of motivation and perseverance of staffing assignments with the highest (R-C) is the most influential factor in human resources valuation at National Iranian Oil Company and its subsidiaries. In addition, the component of bias and defense of the organization has the highest (R+C) value, which means that this factor has the strongest relationship with other factors.

Dimensions and components affecting human resources valuation at National Iranian Oil Company and its subsidiaries are listed in the order of priority in Tables 6 and 7.

Table 5- Compute the importance of the components and their relationships

Relations Matrix	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
R+C	-3.975	-6.310	-5.023	-3.415	-5.217	-4.387	-3.424	-6.344	-2.688	-4.130
R-C	-1.521	-1.300	-3.439	-1.572	1.442	1.600	0.777	1.560	-1.302	-1.883

Relations Matrix	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20
R+C	-5.512	-3.091	-4.114	-3.712	-3.008	-2.196	-12.311	-6.760	-6.783	-13.771
R-C	-.084	-2.986	-1.443	-0.089	-4.259	-1.732	4.905	4.014	3.992	6.334

6. Discussion and Conclusion

The promotion of human capital and its impact on various aspects of the organization's performance and, more broadly, on the economic and social development of the early society is not a secret. The promotion of this capital involves a set of competencies for using knowledge and skills in order to achieve the results of the programs. Competencies include features such as creativity, flexibility, leadership ability, problem-solving ability, constructive communication with others, entrepreneurship, and complex skills such as how to learn. An effort to measure activities related to the formation of human capital requires the use of relevant and reliable tools and equipment. Reducing investment in human resources may increase short-term profits, but it threatens the long-term profitability of the organization. At least the advantage of using human resources accounting is the availability of such information to investors.

By specializing in occupations, the role of powerful manpower as an asset is undeniable. But, so far, accounting has not been able to properly assess this primary and costly asset and reflect it in the financial statements to help stakeholders decide, and it has always been a challenge. On the other hand, human resources accounting can be beneficial for investors, because human resources accounting can show if the human resources of an organization are preserved, degraded, or developed. Therefore, it can affect the investors' decision.

The main purpose of human resources accounting is to attract the attention of managers who are indifferent to the maintenance of human resources, who fail to create job satisfaction and positive incentives for employees and do not think about job security, creating hope and loyalty, creating opportunities for improvement, and solving human resources problems, and who lead to the expulsion or resignation of employees (Wadi Zadeh et al., 2009).

In most developed countries, especially in countries lacking rich natural resources such as fossil fuels etc., the economy has been based on the preservation and development of human resources, and human resources productivity is the most significant issue. However, in countries rich in natural resources, especially those with vast oil and gas resources, the main source of funding depends on the sale of fossil fuels, and less attention is paid to manpower; thus, the phenomenon of elite migration and the escape of efficient human resources is a serious challenge in these countries. Unfortunately, Iran is also among these countries.

From the viewpoint of human capital management, due to the lack of attention to the principle of competence and professionalism in recruitment, promotion, and appointment of manpower, the oil industry faces the challenge of the inconsistency of the combination of manpower to match expertise and skills needed by businesses. This topic, rather than coherence, led to the disruption of the integrated integrity of the intellectual, behavioral, and functional manpower in individual, group, and organizational dimensions. There are several barriers to the synergy of human resources activities in the oil industry.

Planning weakness in creating the necessary structures to motivate and reinforce the employees' interest and increase the possibility of influencing them through the creation of a workplace environment coupled with role-playing and the effective and proper evaluation of the performance of individuals, which prevents the disturbance and disengagement of the workforce from an organizational system, is one of the challenges of human resources in the oil industry (Gol-Shirazi, 2014).

Table 6- Main dimensions effective on human resources valuation

Components	Rating	Components	Rating
Job satisfaction	1	Quantitative variables	9
Individual loyalty to the organization	2	Obedience and conscience	10
Talent	3	Succession	11
Leader	4	Skill	12
Tacit knowledge	5	Coaching	13
Duty	6	Joining	14
Creativity	7	Kindness and dedication	15
Teamwork ability	8		

Table 7- Components effective on human resources valuation

Components	Rating	Components	Rating
Motivation and persistence in staffing assignments	1	Staff technical information	11
Staff performance	2	A quick understanding of employee work issues	12
The reliability of the staff	3	Honesty and truthfulness	13
Flexibility of staff	4	Employee's experience	14
Energetic staff	5	Individual staffing abilities and talents	15
Having a location feature	6	Having a bias feature and defending the organization	16
The mental health of the staff	7	Having the spirit of helping people with high workload	17
Thinking before action	8	Belief in doing the right thing	18
The spirit of readiness to help around people	9	Participation of staff in providing suggestions	19
Having an accountability feature for employees	10	Create added value in the job	20

This study was conducted to identify and prioritize all the dimensions and components which affect the valuation of the human resources of National Iranian Oil Company and its subsidiaries by reviewing the literature and experienced experts' opinions.

Of the 15 dimensions, job satisfaction is the most important influential dimension factor in human resources valuation at National Iranian Oil Company and its subsidiaries. Job satisfaction is a continuation of the individual and organization's cooperation, which increases individual productivity, insures the physical and mental health of the individuals, improves individual's mood, and helps them learn new skills quickly. Prioritizing dimensions and components to attract the attention of the managers and the heads of National Iranian Oil Company and its subsidiaries will help invest in human resources based on their importance and work harder to improve and enhance more important dimensions and components.

Dimensions in the order of importance included job satisfaction, individual loyalty to organization, talent, leader, tacit knowledge, conscientiousness, creativity, teamwork ability, quantitative variables, obedience and conscientiousness, success, skill, coaching, participation, and type friendship and sacrifice.

According to the results, motivation and perseverance of staffing assignments are the most significant influential components of human resources valuation at National Iranian Oil Company and its subsidiaries. These components reflect the extent of staffing efforts in carrying out affairs. If employees are highly motivated in each organization and hope to meet expectations, both the organization and the staff will achieve their goals in this regard.

The components in the order of importance are motivation for and perseverance in the performance of staff assignments, employees' performance, staff reliability, employee flexibility, energetic staff, having a positioning feature, employees' mental health, pre-action thinking, moral readiness to help around, having a staff accountability feature, employees' technical information, quick understanding of staffing issues, honesty and truthfulness, employees' experience, individual capabilities and talent, organization bias and defense, having the spirit of helping people with high workload, belief in doing the right thing, participation of staff in providing suggestions, and creating added value in the work.

With regard to the priority given to the components and dimensions, National Iranian Oil Company and its subsidiaries can plan and invest in high-priority cases, which will lead to the promotion and improvement of human resources and promotion of industry.

Determining and prioritizing the dimensions and components is a part of the research conducted in my doctoral dissertation titled "human resources valuation model and its reporting at National Iranian Oil Company and its subsidiaries", which designs a human resources valuation model and reports it to National Iranian Oil Company and its subsidiaries.

This study identified the dimensions and components of human resources evaluation in line with the work of Fazel et al. (2017) and prioritized the components of human resources valuation in accordance with the researches of Bozbura et al. (2007) and Soltani et al. (2014).

7. Suggestions for Future Research

1. According to the data obtained on components using the method of fuzzy DEMATEL, motivation for and persistence in performing the assignments of employees is the most significant factor affecting human resources valuation at National Iranian Oil Company and its subsidiaries. Managers and corporate executives can motivate employees to carry out assignments by methods such as informing the individuals about the status of an organization, paying rewards for timely assignments, and training and justification classes should be designed to familiarize the staff with the organization's policies and compliance requirements.

2. It is suggested that in researches similar to the present study methods other than Pareto principle should be used to select the components for a paired comparison.

3. In future research, we can examine the interaction between the components and dimensions.

4. This research should be carried out at subsidiary staff and operating companies of National Iranian Oil Company and the results should be compared with this work.

5. It is suggested that similar research be carried out in relation to other business units, and their results should be compared with the results of this study.

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A Hybrid Swing-xTOPSIS: An Application of Ranking the Vendors at Iranian Offshore Engineering and Construction Company (IOEC)

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ABSTRACT

Abstract: Since a large number of the oil and gas projects are related to the supply chain, the selection of contractors and suppliers is very important. In projects, a contractor is obliged to supply the goods from suppliers and manufacturers approved by the clients, while most companies in Iran, including the company surveyed in this research, i.e. Iranian Offshore Engineering and Construction Company (IOEC, do not have a scientific approach to this issue. The main objective of this research is providing a scientific and practical approach to ranking suppliers and contractors at IOEC and selecting the best ones. In order to achieve such an objective, an integrated model of Swing and TOPSIS methods with fuzzy approach has been designed and applied to a real case. The actual data used are obtained from the post-lay survey of the exports and infield pipelines of South Pars development phases 13, 14, and 22.

1. Introduction

In the past decade, managers have realized the important role of supply chain in value creation in companies. Rapid variations happening throughout all markets have fundamentally changed the managers' look to their environment. One of the areas the company leaders have paid more attention to is managing the purchasing and sourcing. In the past decade, purchasing management has become a competitive worldwide issue. In most industries, the cost of raw materials is the original cost of the final product, and this amount reaches approximately 19% of the final product price in production industries (Razmi et al., 2009). Therefore, the purchasing department can play a key role in the effectiveness and efficiency of a company because it can directly affect the cost reduction, flexibility, and profitability of the company. Doubtlessly, the most critical stage in the purchase process of any company is the evaluation, assessment, and selection of suppliers or vendors. Over the years, many approaches have been presented for evaluating and selecting contractors/vendors. Experts believe that, in reality, there is no unique optimal method for the evaluation and selection of contractors/vendors. Therefore, companies, based on their specific conditions, have different methods for solving this problem. The importance of the evaluation and selection of vendors/suppliers comes from the reality that materials and resources impact on activities such as production planning and control, inventory management, and production quality simultaneously. Purchase decisions are more important as companies increasingly become more dependent on their suppliers, and direct and indirect consequences of poor decision-making in this area becomes clearer (De Boer et al., 2001). An effective and efficient purchase is one of the

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activities which is important for the success in the supply chain of an engineering and construction company such as IOEC Company. The important activity of practice of buying is selecting an appropriate vendor/supplier since the selection of vendors/suppliers brings significant savings to the organization (Boran et al., 2009). IOEC, which is surveyed in this study, works in the field of offshore platform construction and oil and gas production jackets in their yards located in Khorramshahr, province of Khuzestan. Moreover, the company's major projects are related to the Iranian South Pars phases. IOEC Company should choose the ideal vendor because the vendor list provided by the employer includes many retailers having a wide range of activities; as a result, a specific model or procedure is required to evaluate and select an ideal supplier. In the current work, owing to the lack of a guide direction in this context, a scientific and applicable model and procedure for ranking vendors will be proposed.

This research aims at developing a framework for the contractor/vendor selection with the use of a multi attribute decision making (MADM) method. A case is considered to implement the framework, to choose the most suitable criteria, and to rank contractor/vendor indicators in the offshore platform construction of oil and gas industry.

2. Literature Review

In the case of decision-making evaluation models, research has been carried out to select the best contractor, and various parameters and decision-making methods have been employed. A number of previous studies in MADM and weighting methods are presented in Table 1 (Razmi et al., 2008).

In the work of Razmi et al. (2008), a basic multi-criteria model was developed which can select the best contractor for the implementation of a project by taking into account all the qualitative and quantitative factors affecting the contractor's assessment. In this model, six general criteria, some of which include their own specific sub-criteria, are presented as the effective measure to choose a contractor in a tender (Razmi et al., 2008). In this study, a hybrid multi-criteria method by the fuzzy approach is used to express variables for ranking and selecting the best contractor in the tender. Nieto-Morote and Ruz-Vila (2012) provided systematic qualification based on the fuzzy set theory. Compared to other models, the use of an algorithm for managing contradictions in relation to fuzzy preferences when using pairwise comparison judgments and the use of linguistic and accurate evaluation of the performance of contractors by quantitative and qualitative criteria are the main advantages of this model. In a study by Plebankiewicz (2012), a plan for qualifying contractors is introduced, which includes two steps: 1) in the rank and 2) in each project. Fuzzy set theory has been used to evaluate "per project" in the qualification model. Then, using a numerical example, the model performance and qualification procedures are described. Dickson's (1996) work can be considered as the pioneer of supplier assessment. In a review, he considered 23 different criteria for assessing supplier performance. Quality, delivery time, and performance history were introduced as three important criteria for this assessment. In another paper presented by Khorshid and his colleagues (2004), the evaluation and selection of suppliers in the supply chain were studied in the case of single sourcing and fuzzy approach. In the current work, linguistic terminology has been used to evaluate the performance of each supplier with respect to each criterion and to determine the weight of the criteria; the technique employed herein is ranking by fuzzy TOPSIS. Due to exploiting fuzzy TOPSIS technique, it is possible to apply quantitative and qualitative criteria simultaneously. To illustrate the validity and effectiveness of the proposed method, a numerical example, in which three decision makers (DM) pay five suppliers through the five criteria of the supplier's profitability, facilities, technological capabilities, quality, and delivery time, is also presented, and the suppliers' ratings are ultimately based on their scores.

With respect to the theoretical weakness of past researches, it should be noted that there are a variety of MADM techniques to assign weights to the criteria, but the application of several techniques to vendor selection problem has not been reported in the literature yet; Some of these technique, among others, are step-wise weight assessment ratio analysis (SWARA) (Kersuliene et al., 2010), best worst method (BWM) (Rezaei, 2015), generalized rank sum (GRS) (Wang and Zionts, 2015), correlation coefficient and standard deviation (CCSD) (Wang and Lou, 2010), and indifference threshold-based attribute ratio analysis (ITART) (Hatefi, 2019). Moreover, considering the practical vacuum of previous studies in Iran, the literature review (Safarani et al., 2017; Toosi and Samani, 2012; Afshar et al., 2011) states that there are a few organizations which have really employed the scientific models to resolve their problems of supplier selection.

3. Proposed Model

The contractor selection method proposed herein consists of three phases:

A. Determining the criteria;

B. Assigning the weights to the criteria by Swing method;

C. Contractor selection process by performing a fuzzy TOPSIS (called xTOPSIS).

Both phases B and C are performed by MADM models,

Table 1- Previous studies (Ref.: Razmi et al., 2008, completed by this work)

Reference	MADM Method	Weighting Method	Area of Research	Country
Assellaou et al. (2018)	DEMATEL (Decision Making Trial and Evaluation) (Fontela and Gabus, 1976)TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) (Hwang and Yoon, 1981)	ANP (Analytic Network Process) (Saaty and Takizawa, 1986)	Refining company	Morocco
Safarani, el. al. (2017)	TOPSIS ELECTRE (Elimination and Choice Translating Reality) (Roy, 1968),VIKOR (Vlse Kriterijumsk Optimizacija Kompromisno Resenje)- (Opricović et al., 1979)	Pairwise comparison (Thurstone, 1927)	Medical equipment	Iran
Wang Chen et al. (2016)	Fuzzy TOPSIS (Chen, 2000)	Fuzzy AHP (Analytic Hierarchy Process) (Van Laarhoven and Pedrycz, 1983)	Green supplier selection	Vietnam Taiwan
Kaur et al. (2016)	Linear programming model (Schrijver, 1998) Fuzzy AHP (Chen, 2000), Fuzzy TOPSIS	Weighted IRP (Interpretive Ranking Process) (Kumar and Singh, 2015)	Industry	Switzerland India
Karsak and Dursun (2014)	QFD (Quality Function Deployment) (Akao et al., 1996), DEA (Data Envelopment Analysis) (Kretter, 1957)	Fuzzy weighted average	Private hospital	Turkey
Toosi and Samani (2012)	ANP (Saaty and Takizawa, 1986)	Pairwise comparison, SAW	Water pollution control	Iran
Eskandari et al. (2012)	SAW (Simple Additive Weighting) (Churchman and Ackoff, 1954)	Pairwise comparison (Thurstone, 1927), ROC (Rank Order Centroid) (Barron, 1992)	Landfill siting	Iran
Edwards, W. and Barron, F. H., (1994)	SMARTER (Simple Multi-attribute Rating Technique Exploiting Ranks) (Edwards and Barron, 1994)	Revised SIMOS procedure (Figueira and Roy, 2002)	Urban water conservation	Brazil
Machiwal et al. (2011)	AHP (Saaty, 1980)	Pairwise comparison (Thurstone, 1927), Eigenvector (Saaty, 1977)	Ground water potential zones	India
Ozcan et al. (2011)	TOPSIS (Hwang and Yoon ,1981), ELECTRE,Grey Theory (Deng, 1982)	SIMOS procedure (Simos, 1990)	Ware house selection	Turkey
Afshar et al. (2011)	FMCDM based on TOPSIS (Hwang and Yoon, 1981)	Fuzzy UNEP (The United Nation En Pairwise comparison (Thurstone, 1927) vironmental Program) (UNEP, 1987)	River basin	Iran
Aalianvari et al. (2012)	AHP (Saaty, 1980), Fuzzy Delphi method (Linstone, 1975)	Delphi method. pairwise comparison (Thurstone, 1927), Fuzzy weights	Potential of ground water flow	Iran
(Alipour et al. (2010)	FMCDM	Fuzzy weights	Water diversion	Iran
Chen et al. (2010)	TOPSIS (Hwang and Yoon, 1981)	Pairwise comparison (Thurstone, 1927)	Performance evaluation	China
Calizaya et al. (2010)	AHP (Saaty, 1980)	Pairwise comparison (Thurstone, 1927)	Integrated water resources management	Bolivia
Kodikara et al. (2010)	PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluations) (Brans, 1982)	SIMOS procedure (Simos, 1990)	Urban water supply	Australia
Vincent and Hu (2010)	Fuzzy TOPSIS	Voting method (Williams, 1780), Rating method	Evaluation of manufacturing plants	Taiwan
Garcia et al. (2010)	GP (Goal Programming) (Charnes and Cooper, 1977), TOPSIS (Hwang and Yoon, 1981)	CRITIC (Criteria Importance Through Inter-criteria Correlation) (Diakoulaki et al., 1995)	Ranking of firms	Spain
Tervonen et al. (2009)	ELECTRE Tri (Yu 1992) SMART (Edwards, 1977)	SIMOS procedure (Simos, 1990)	Sorting problems	Portugal, Finland
Shanian et al. (2008)	ELECTRE Tri (Yu, 1992)	Pairwise comparison, Eigenvector (Saaty, 1977)	Material selection	Canada, USA
Yang et al. (2008)	ANP (Saaty and Takizawa, 1986), TOPSIS (Hwang and Yoon, 1981)	Pairwise comparison (Thurstone, 1927)	Vendor selection	India
Balasubramaniam et al. (2007)	ELECTRE III (Roy, 1968) Weighted Summation	Swing (Von-Winterfeldt and Edwards, 1986)	Selection of remediation techniques for petroleum contaminated land	UK

which are widely utilized in complex decision-making, especially when there are many, and sometimes conflicting, criteria. Additionally, this research includes a real-world case study which uses interview and questionnaire techniques for collecting the required data. To present the research methodology more clearly, first of all, the literature and background of the research should be studied in order to determine the criteria, indicators, and methods of decision making. Then, for finding the useful criteria, a survey of the opinion of the IOEC experts should be carried out. After identifying the criteria and methods that can conform to the particular company circumstances in the field of offshore oil and gas industry, the questionnaires should be prepared regarding the initial investigations revealing that the combination of multi criteria decision methods is better. Also, the viewpoints of the related experts about the ranking should be asked and taken into account for ratings. Finally, the practical procedure should be submitted to the company. The above descriptions are schematically displayed in Figure 1 as the proposed process of contractors' selection.

3.1. Phase A: Determining the criteria

This phase was conducted in two stages. Stage (I): reviewing the respected state-of-the-art to create a list of any criteria reported in the literature. Stage (II): eliciting the experts' judgments to select the final criteria. With regard to stage (I), many researchers have reviewed criteria used in contractor/vendor selection and have collected them at various time intervals. The most mentioned criteria surveys are tabulated in Table 2.

Owing to stage (II), using the combination of both literature and company knowledge works in multiple ways, the company's experts and DM's can indicate which criteria should be used in the industry. For this purpose, 12 experts are selected from experienced staffers with a combination of managerial and executive positions, including project management office (PMO) manager, project managers, and operational personnel. They have about 14 to 20 years of experience in the oil and gas industry, and they are from 34 to 55 years old. The experts of IOEC are asked to select the criteria they find important in the contractor selection process with the use of a questionnaire prior to presenting the criteria from the literature in order to insure that the respondents' replies are not influenced by this information. The selected criteria are listed in Table 3. The number of times the criteria are indicated by the respondents is displayed in the right column. The criteria which are referred more than 6 time (by more than 50% of the experts) will be selected to evaluate the contractors. Interestingly, a top-ten list is obtained.

To determine the screening criteria, same as the above rule, the criteria which are selected by more than half of the experts, are selected as the screening filters of the contractors. In this case, "Price" and "Quality" were chosen as the screening criteria with being referred eight and seven times respectively.

3.2. Phase B: Criteria weight assignment

In this phase, the Swing method is used, including three stages. Stage (I): Ranking the criteria from the most important (i.e. the

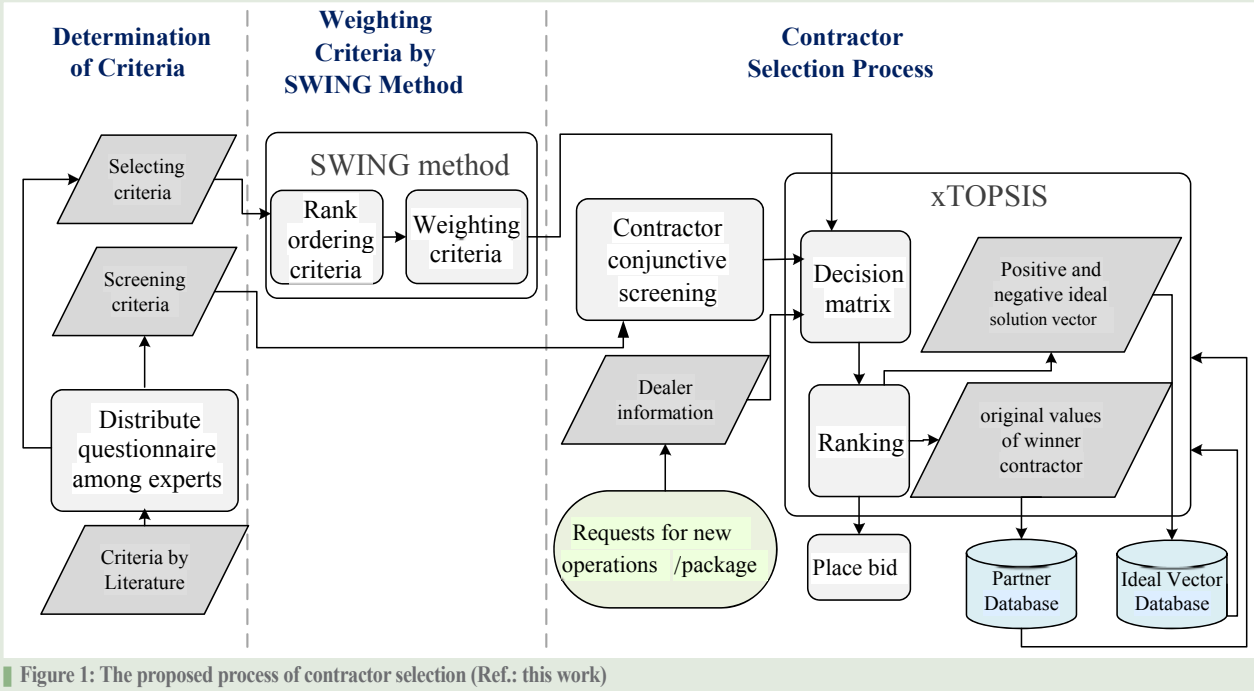

Figure 1: The proposed process of contractor selection (Ref.: this work)

highest level) to the least important one (i.e. the lowest level). Stage (II): Assigning the numerical rates to the criteria. Stage (III): Normalizing the assigned rates to get the final weights.

At stage (I), the DM is asked to consider a given option with the lowest levels of criteria. Assuming that all the criteria are at their lowest level, the DM is asked to promote one of the criteria to the highest level. This is done one after another and is repeated each time for one of the criteria. DM's preference for the sequence of the criteria is shown in the upper box of Figure 2. At stage (II), a rate of 100 is assigned to the criterion at the highest level, and

Table 2- The criteria for the supplier selection reported in the respected literature (Ref.: this work)

Criteria Name	References
Quality	Erdem and Gocen (2012), Ku et al. (2010), Doloi et al. (2011), Kibria et al. (2010), Zavadskas et al. (2008), Bendana et al. (2008), Abdel-Tawwab et al. (2008), Phillips and Dudik (2008), Singh and Tiong (2006), Gary Teng and Jaramillo (2005), Birgün Barla (2003), Palaneeswaran and Kumaraswamy (2001), Min (1994).
Price (unit cost)	Watt et al. (2009), Abdel-Tawwab et al. (2008), El-Sayegh (2009), Birgün Barla (2003), Aung et al. (2000), Masterman and Duff (1994), Singh and Murphy (1990), Skitmore and Marsden (1988).
Technical Capability	Erdem and Gocen (2012), Doloi et al. (2011), El-Sayegh (2009), Watt et al. (2009), Phillips and Dudik (2008), Abdel-Tawwab et al. (2008), Singh and Tiong (2006).
Service	Doloi et al. (2011), Ku et al. (2010), Zavadskas et al. (2008), Bendana et al. (2008), Singh and Tiong (2006), Birgün Barla (2003), Min (1994).
Production Facilities and Capacity	Watt et al. (2009), Bendana et al. (2008), Zavadskas et al. (2008), Singh and Tiong (2006), Birgün Barla (2003), Aung et al. (2000).
Delivery	Aung et al. (2000).
Financial Position	El-Sayegh (2009), Watt et al. (2009), Abdel-Tawwab et al. (2008), Bendana et al. (2008), Birgün Barla (2003), Aung et al. (2000), Min (1994).
Flexibility	Doloi et al. (2011), El-Sayegh (2009), Zavadskas et al. (2008), Abdel-Tawwab et al. (2008), Singh and Tiong (2006), Gary Teng and Jaramillo (2005), Singh and Murphy (1990), Skitmore and Marsden (1988).
Costs (ordering, transportation, etc.)	Erdem and Gocen (2012), Ku et al. (2010), Doloi et al. (2011), Abdel-Tawwab et al. (2008), Bendana et al. (2008), Phillips and Dudik (2008), Gary Teng and Jaramillo (2005), Aung et al. (2000), Min (1994).
Performance History	Doloi et al. (2011), Watt et al. (2009), El-Sayegh (2009), Phillips and Dudik (2008), Abdel-Tawwab et al. (2008), Bendana et al. (2008), Singh and Tiong (2006), Almossawi (2001), Aung et al. (2000).
Desire for Business	Palaneeswaran and Kumaraswamy (2001), Min (1994).
Trade Restrictions	Min (1994).
Labor Relation Record	Aung et al. (2000).
Geographical Location	Watt et al. (2009).
Political Situation	Bendana et al. (2008), Singh and Tiong (2006), Aung et al. (2000).
Reliability	Gary Teng and Jaramillo (2005), Birgün Barla (2003).
Reputation and Position in Industry	Watt et al. (2009), El-Sayegh (2009), Singh and Tiong (2006), Doloi et al. (2011).
Communication System	Aung et al. (2000).
Relationship	Watt et al. (2009), Bendana et al. (2008), Singh and Tiong (2006), Singh and Tiong (2006), Aung et al. (2000).
Warranty and Claim Policies	Doloi et al. (2011), Zavadskas et al. (2008), Bendana et al. (2008), Singh and Tiong (2006).
Capabilities and Standards	Erdem and Gocen (2012), Ku et al. (2010).

the DM is then asked to assign a number which matches the rest proportional to 100. The rates allocated to the criteria are shown in the middle box of Figure 2. Finally, at stage (III), the rates will be normalized to obtain the normalized weights, as the sum of the weights is equal to one. In the bottom box of Figure 2, the normalized weights are drawn.

3.3. Phase C: Contractor selection process

This phase includes two stages. Stage (I) screening the contractors/vendors with the use of conjunctive screening. Stage (II) applying an extended fuzzy-TOPSIS (called xTOPSIS) to rank the contractors.

3.3.1. Stage one: Screening vendors

The questionnaire asks the respondents (in question number 4) to state their opinion on the criterion/criteria that should be used as a minimum requirement. These are used for the conjunctive screening of the vendors (see Table 4). A screening criterion needs to be indicated by at least more than half of the experts (i.e. more than six times) in order to be incorporated in this research. The screening criteria are presented in Table 4.

According to Table 4, the fourth contractor (Dana Niroo Company) is eliminated at this stage because this vendor does not have the minimum requirement of the screening criteria.

3.3.2. Stage two: Performing xTOPSIS

In this subsection, the data gained by questionnaire is processed by xTOPSIS, and, at the end of each round, a contractor is selected and presented to the relevant units of the company. Let us, first, have some explanations of the classical TOPSIS method. TOPSIS is one of the important methods in dealing with MADM problems. It considers both the smallest distance from the positive-ideal solution and the largest distance from the negative-ideal solution. According to Kim et al. (1997), four TOPSIS advantages are as follows: (I) a sound logic that represents the rationale of human choice, (II) a scalar value that accounts for both the best and the

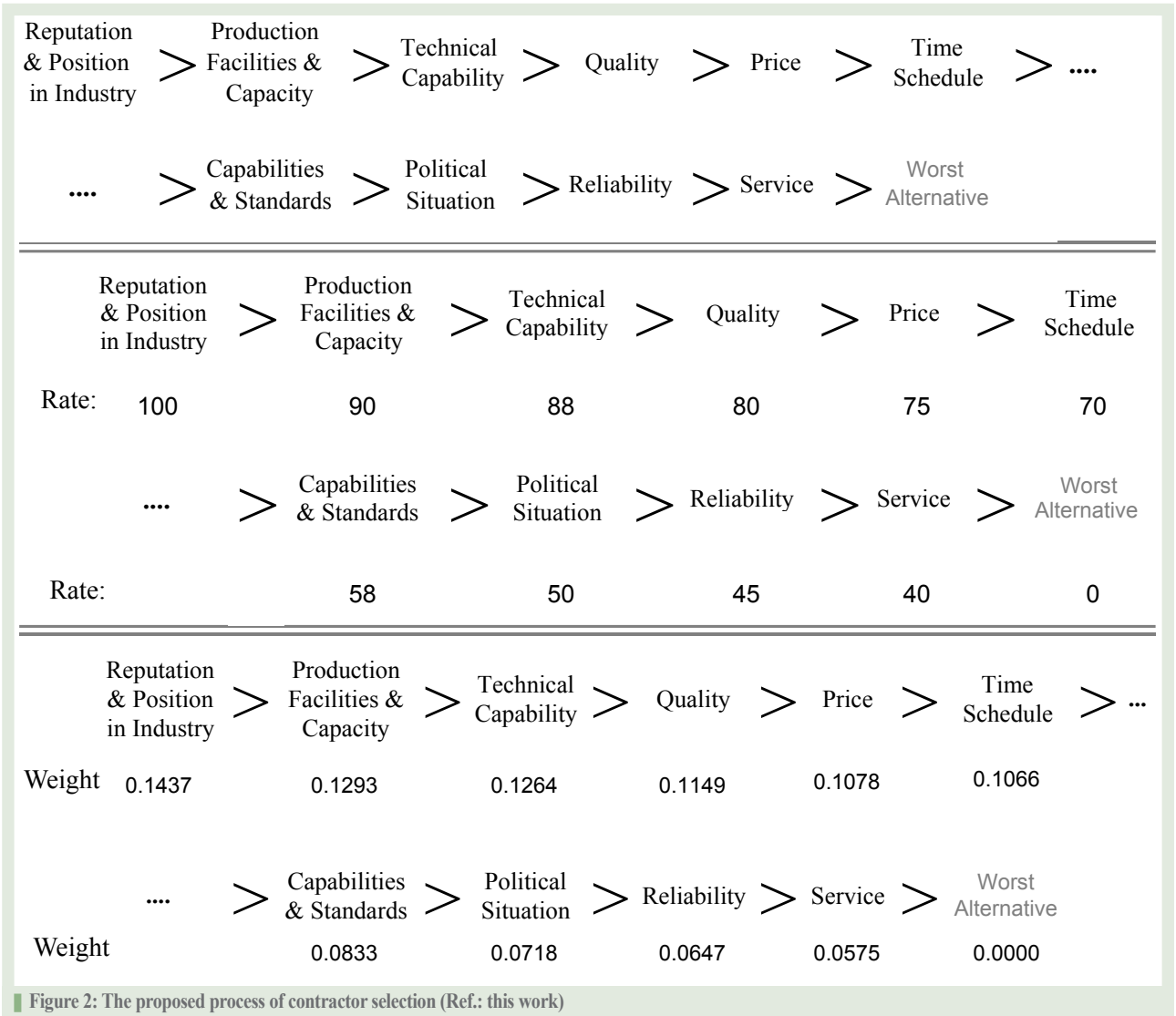

Figure 2: The proposed process of contractor selection (Ref.: this work)

Table 3- The summary result of questionnaire (Ref.: this work)

No.	Criteria	Indication
1	Reputation and Position in Industry	12
2	Quality	11
3	Production Facilities and Capacity	11
4	Technical Capability	9
5	Capabilities and Standards	9
6	Price	9
7	Time Schedule	8
8	Service	7
9	Reliability	7
10	Political Situation	6

Table 4- The screening contractors/vendors by screening criteria (Ref.: this work)

Code	Contractor Names of First Round	Screening Criteria	
		Price	Quality
C1	Akam Industry	✓	✓
C2	DANIEL Survey	✓	✓
C3	Deep Sea Offshore International	✓	✓
C4	Dana Niroo	×	✓
C5	Horizon Survey Company	✓	✓
C6	FUGRO	✓	✓

worst alternatives simultaneously, (III) a simple computation process which can be easily programmed into a spreadsheet, and (IV) the performance measures of all the alternatives of the attributes, which can be visualized on a polyhedron, at least for any two dimensions.

Human judgment and preference are often ambiguous and cannot be estimated with exact numeric values; thus, a set of crisp values is not suitable to model real-world situations (Rashid and Husnine, 2014). Probability theory, fuzzy theory, utility theory, and the models with interval or incomplete data are disciplines which aim at coping with such uncertainties. In the current paper, fuzzy theory is used to handle any imprecision in decision-making problems and the ambiguities in information (Bellman and Zadeh, 1970). Frank Schneider (2008) deduced an approach called xTOPSIS from the prerequisites of the tested and elaborated foundations and presented a numerical example to illustrate the process (Schneider, 2008). To start the first round of setting up xTOPSIS, considering the elimination of the fourth contractor in the screening step, a decision fuzzy matrix will be formed by the representative of the respective pipe-laying project. This matrix is given in Table 5.

The linguistic variables used in the decision fuzzy matrix were adjusted and equivalent to triangular fuzzy numbers. These equivalent triangular fuzzy numbers are listed in Table 6.

By using triangular fuzzy numbers equivalent to linguistic variables in Table 9, Table 5 (decision fuzzy matrix with linguistic variables) should be converted from triangular numbers to fuzzy numbers as it is presented in Table 7.

Table 5- Decision fuzzy matrix with linguistic variables (Ref.: this work)

	Criteria	Reputation & Position in Industry	Quality	Production Facilities & Capacity	Technical Capability	Capabilities & Standards	Price	Time Schedule	Service	Reliability	Political Situation
	Weight	0.143	0.114	0.129	0.126	0.083	0.107	0.106	0.057	0.064	0.071
	aspect	(+)	(+)	(+)	(+)	(+)	(-)	(+)	(+)	(+)	(+)
	C1	Medium	Low	Extremely Low	Low	Low	Extremely High	High	High	Low	Extremely High
Contractors	C2	Medium	Medium	Extremely High	High	Medium	Medium	High	Medium	Low	Medium
	C3	High	Medium	High	Medium	Extremely High	Medium	Low	Low	Medium	Low
	C5	Low	Extremely Low	Low	High	High	Low	Medium	Medium	High	Medium
	C6	Medium	High	Medium	Medium	Extremely High	Extremely High	Low	Low	Extremely High	Extremely Low

Table 6- Triangular fuzzy numbers equivalent to linguistic variables (Ref.: this work)

Number	Linguistic	Triangular fuzzy number		
		l	m	u
1	Extremely Low	0.25	0.33	0.5
2	Low	0.33	0.5	1
3	Medium	0.5	1	2
4	High	1	2	3
5	Extremely High	2	3	4

In the second step, the decision fuzzy matrix should be normalized by employing Equations 1-4.

$$r_{ij} = \left[\frac{a_{ij}}{C_j^+} \quad \frac{b_{ij}}{C_j^+} \quad \frac{c_{ij}}{C_j^+} \right] \tag{1}$$

$$C_j^+ = \max_i C_{ij}$$

$$r_{ij} = \left[\frac{a_j^-}{c_{ij}} \quad \frac{a_j^-}{b_{ij}} \quad \frac{a_j^-}{a_{ij}} \right] \tag{2}$$

$$a_j^- = \min_i a_{ij}$$

According to Equations 3 and 4 and the weight of criteria, the normalized balanced matrix (normalized weighted decision matrix) is formed, and FPIS and FNIS are specified

Table 7- Decision fuzzy matrix with fuzzy numbers (Ref.: this work)

	Criteria	Reputation & Position in Industry	Quality	Production Facilities & Capacity	Technical Capability	Capabilities & Standards	Price	Time Schedule	Service	Reliability	Political Situation
	Weight	0.143	0.114	0.129	0.126	0.083	0.107	0.106	0.057	0.064	0.071
	aspect	(+)	(+)	(+)	(+)	(+)	(-)	(+)	(+)	(+)	(+)
Contractors	C1	(0.5,1,2)	(0.33,0.5,1)	(0.25,0.33,0.5)	(0.33,0.5,1)	(0.33,0.5,1)	(0.25,0.33,0.5)	(1,2,3)	(1,2,3)	(0.33,0.5,1)	(2,3,4)
	C2	(0.5,1,2)	(0.5,1,2)	(2,3,4)	(1,2,3)	(0.5,1,2)	(0.5,1,2)	(1,2,3)	(0.5,1,2)	(0.33,0.5,1)	(0.5,1,2)
	C3	(1,2,3)	(0.5,1,2)	(1,2,3)	(0.5,1,2)	(2,3,4)	(0.5,1,2)	(0.33,0.5,1)	(0.33,0.5,1)	(0.5,1,2)	(0.33,0.5,1)
	C5	(0.33,0.5,1)	(0.25,0.33,0.5)	(0.33,0.5,1)	(1,2,3)	(1,2,3)	(1,2,3)	(0.5,1,2)	(0.5,1,2)	(1,2,3)	(0.5,1,2)
	C6	(0.5,1,2)	(1,2,3)	(0.5,1,2)	(0.5,1,2)	(2,3,4)	(0.25,0.33,0.5)	(0.33,0.5,1)	(0.33,0.5,1)	(2,3,4)	(0.25,0.33,0.5)
	$FPIS(A_1+)$	(1,2,3)	(1,2,3)	(2,3,4)	(1,2,3)	(2,3,4)	(0.25,0.33,0.5)	(1,2,3)	(1,2,3)	(2,3,4)	(2,3,4)
	$FNIS(A_1-)$	(0.33,0.5,1)	(0.25,0.33,0.5)	(0.25,0.33,0.5)	(0.33,0.5,1)	(0.33,0.5,1)	(1,2,3)	(0.33,0.5,1)	(0.33,0.5,1)	(0.33,0.5,1)	(0.25,0.33,0.5)

Table 8- The normalized balanced matrix (Ref.: this work)

	Criteria	Reputation & Position in Industry	Quality	Production Facilities & Capacity	Technical Capability	Capabilities & Standards	Price	Time Schedule	Service	Reliability	Political Situation
	Weight	0.143	0.114	0.129	0.126	0.083	0.107	0.106	0.057	0.064	0.071
	aspect	(+)	(+)	(+)	(+)	(+)	(-)	(+)	(+)	(+)	(+)
Contractors	C1	(0.02,0.04,0.09)	(0.01,0.01,0.03)	(0.00,0.01,0.01)	(0.01,0.02,0.04)	(0.00,0.01,0.02)	(0.05,0.08,0.10)	(0.03,0.06,0.10)	(0.01,0.03,0.05)	(0.00,0.00,0.01)	(0.03,0.05,0.07)
	C2	(0.02,0.04,0.09)	(0.01,0.03,0.07)	(0.06,0.09,0.12)	(0.04,0.08,0.12)	(0.01,0.02,0.04)	(0.01,0.02,0.05)	(0.03,0.06,0.10)	(0.00,0.01,0.03)	(0.00,0.00,0.01)	(0.00,0.01,0.03)
	C3	(0.04,0.09,0.14)	(0.01,0.03,0.07)	(0.03,0.06,0.09)	(0.02,0.04,0.08)	(0.04,0.06,0.08)	(0.01,0.02,0.05)	(0.01,0.01,0.03)	(0.00,0.00,0.01)	(0.00,0.01,0.03)	(0.00,0.00,0.01)
	C5	(0.01,0.02,0.04)	(0.00,0.01,0.01)	(0.01,0.01,0.03)	(0.04,0.08,0.12)	(0.02,0.04,0.06)	(0.00,0.01,0.02)	(0.01,0.03,0.06)	(0.00,0.01,0.03)	(0.01,0.03,0.04)	(0.00,0.01,0.03)
	C6	(0.02,0.04,0.09)	(0.03,0.07,0.11)	(0.01,0.03,0.06)	(0.02,0.04,0.08)	(0.04,0.06,0.08)	(0.05,0.08,0.10)	(0.01,0.01,0.03)	(0.00,0.00,0.01)	(0.03,0.04,0.06)	(0.00,0.00,0.00)
	$FPIS(A_1+)$	(0.04,0.09,0.14)	(0.03,0.07,0.11)	(0.06,0.09,0.12)	(0.04,0.08,0.12)	(0.04,0.06,0.08)	(0.00,0.01,0.02)	(0.03,0.06,0.10)	(0.01,0.03,0.05)	(0.03,0.04,0.06)	(0.03,0.05,0.07)
	$FNIS(A_1-)$	(0.01,0.02,0.04)	(0.00,0.01,0.01)	(0.00,0.01,0.01)	(0.01,0.02,0.04)	(0.00,0.01,0.02)	(0.05,0.08,0.10)	(0.01,0.01,0.03)	(0.00,0.00,0.01)	(0.00,0.00,0.01)	(0.00,0.00,0.00)

by Equations 5 and 6. The normalized balanced matrix is displayed in Table 8.

$$v_{ij} = r_{ij} \times w_{ij} = \left[\frac{a_{ij}}{c_j^+} \quad \frac{b_{ij}}{c_j^+} \quad \frac{c_{ij}}{c_j^+}\right] \times \left(\alpha_j \quad \beta_j \quad \gamma_j\right) = \left[\frac{a_{ij}}{c_j^+} \times \alpha_j \quad \frac{b_{ij}}{c_j^+} \times \beta_j \quad \frac{c_{ij}}{c_j^+} \times \gamma_j\right] \tag{3}$$

$$v_{ij} = r_{ij} \times w_{ij} = \left[\frac{a_j^-}{c_{ij}} \quad \frac{a_j^-}{b_{ij}} \quad \frac{a_j^-}{a_{ij}}\right] \times \left(\alpha_j \quad \beta_j \quad \gamma_j\right) = \left[\frac{a_j^-}{c_{ij}} \times \alpha_j \quad \frac{a_j^-}{b_{ij}} \times \beta_j \quad \frac{a_j^-}{b_{ij}} \times \gamma_j\right] \tag{4}$$

where, wij are the assigned weights.

Table 9- The similarity and closeness to ideal solution and the ranking of alternatives (Ref.: this work)

Code	Alternative	$S^+_{1\,x,y}$	$S^-_{1\,x,y}$	$R_{1,x,y}$	Rank
C1	Akam Industry	0.40717	0.17093	0.29568	5
C2	DANIEL	0.22017	0.36295	0.62243	1
C3	Deep Sea Offshore	0.27223	0.31095	0.53319	2
C5	Horizon Survey Company	0.33520	0.24618	0.42344	4
C6	FUGRO	0.33189	0.24907	0.42872	3

$$V_j^+ = \begin{cases} \max\limits_{i=1,\ldots,m} v_{ij}; j \in B \\ \min\limits_{i=1,\ldots,m} v_{ij}; j \in C \end{cases} \tag{5}$$

$$FPIS = \left\{v_j^+ \mid j = 1,\ldots,n\right\}$$

$$V_j^- = \begin{cases} \min\limits_{i=1,\ldots,m} v_{ij}; j \in B \\ \max\limits_{i=1,\ldots,m} v_{ij}; j \in C \end{cases} \tag{6}$$

$$FNIS = \left\{v_j^- \mid j = 1,\ldots,n\right\}$$

Now the similarity to the ideal solution of an alternative and then the closeness to A1+ and A1- should be computed, and ranking is done based on R1x,y. The results are listed in Table 9.

Contractor number two (i.e. DANIEL Company) ranked first in the first round, and it is assumed that the contractor won the tender. Now the original values of contractor number two (the winner of tender) are stored in the partner database (PD), and the ideal vectors are saved in the ideal vector database (IVD). Table 10 and Table 11 tabulate PD and IVD. The first round of xTOPSIS procedure is finished here.

Table 10- Partner database (PD) in the first round (Ref.: this work)

Partner Database (PD)	Round Number	Selected Contractor in Round	Criteria									
			Reputation & Position in Industry	Quality	Production Facilities & Capacity	Technical Capability	Capabilities & Standards	Price	Time Schedule	Service	Reliability	Political Situation
	1	DANIEL	(0.5,1,2)	(0.5,1,2)	(2,3,4)	(1,2,3)	(0.5,1,2)	(0.5,1,2)	(1,2,3)	(0.5,1,2)	(0.33,0.5,1)	(0.5,1,2)
	2	—	—	—	—	—	—	—	—	—	—	—

Table 11- Ideal vector database (IVD) in the first round (Ref.: this work)

Ideal Vector Database (IVD)	Round Number	FPIS & FNIS	Criteria									
			Reputation & Position in Industry	Quality	Production Facilities & Capacity	Technical Capability	Capabilities & Standards	Price	Time Schedule	Service	Reliability	Political Situation
	1	A_1^+	(1,2,3)	(1,2,3)	(2,3,4)	(1,2,3)	(2,3,4)	(0.25,0.33,0.5)	(1,2,3)	(1,2,3)	(2,3,4)	(2,3,4)
		A_1^-	(0.33,0.5,1)	(0.25,0.33,0.5)	(0.25,0.33,0.5)	(0.33,0.5,1)	(0.33,0.5,1)	(1,2,3)	(0.33,0.5,1)	(0.33,0.5,1)	(0.33,0.5,1)	(0.25,0.33,0.5)
	2	A_2^+	—	—	—	—	—	—	—	—	—	—
		A_2^-	—	—	—	—	—	—	—	—	—	—

To start the next round, the research was held for about a month for "post-lay survey" bidding. Finally, the projects of South Pars development phase 13 requested bidding for similar operation for 13A and 13B export pipeline, and six contractors, which are listed and screened by the screening criteria in Table 12, submitted their proposal to IOEC Company.

Table 12- Post-lay surveying contractors in the second round (Ref.: this work)

Code	Contractor Names of First Round	Screening Criteria	
		Price	Quality
C1	Akam Industry	✓	✓
C2	RAL	✓	✓
C3	FUGRO	✓	✓
C4	Horizon Survey Company	✓	✓
C5	DANIEL Survey	✓	✓
C6	Deep Sea Offshore International	✓	✓

According to Table 12, none of the contractors is eliminated in this step because they all meet the minimum requirement of the screening criteria.

The decision fuzzy matrix will be formed by the representative of the respective pipe-laying project. By using triangular fuzzy numbers equivalent to linguistic variables, "decision fuzzy matrix with fuzzy numbers" will be formed, and two ideal vectors are added to the set of alternatives forwarded from IVD (see Table 14). The built-in matrix will be normalized, and by multiplying the weight of the criteria by the vectors of the normalized decision matrix, the normalized balanced matrix (normalized weighted decision matrix) is created; FPIS and FNIS of the second round are specified by counting A1+ and A1-.

Now the similarity to the ideal solution of an alternative and then the closeness to A2+ and A2- should be computed, and ranking is done based on R2,x,y. The results are listed in Table 13.

Table 13- The similarity and closeness to ideal solution and the ranking of alternatives in the second round (Ref.: this work)

Code	Alternative	$S^{+}_{1\,x,y}$	$S^{-}_{1\,x,y}$	$R_{1,x,y}$	Rank
C1	Akam Industry	0.34952	0.24006	0.40717	6
C2	RAL	0.13976	0.45053	0.76324	1
C3	FUGRO	0.23865	0.34983	0.59447	3
C5	Horizon Survey Company	0.33514	0.25593	0.43299	5
C6	DANIEL Survey	0.27064	0.32178	0.54316	4
	Deep Sea Offshore International	0.20462	0.38814	0.65480	2

Contractor number two, i.e. RAL Company, ranked first in the second round and it is assumed that the contractor won the tender. After closing the deal, the original values of contractor number two are again saved in the PD. We also update the ideal vectors and copy the values to our IVD (see Tables 15 and 16).

In the later round, the set of alternatives is completed

Table 14- Decision fuzzy matrix with fuzzy numbers in the second round (Ref.: this work)

	Criteria	Reputation & Position in Industry	Quality	Production Facilities & Capacity	Technical Capability	Capabilities & Standards	Price	Time Schedule	Service	Reliability	Political Situation
	Weight	0.143	0.114	0.129	0.126	0.083	0.107	0.106	0.057	0.064	0.071
	aspect	(+)	(+)	(+)	(+)	(+)	(-)	(+)	(+)	(+)	(+)
Contractors	C1	(0.5,1,2)	(0.33,0.5,1)	(0.5,1,2)	(0.33,0.5,1)	(0.33,0.5,1)	(1,2,3)	(0.5,1,2)	(1,2,3)	(0.33,0.5,1)	(2,3,4)
	C2	(1,2,3)	(0.5,1,2)	(1,2,3)	(1,2,3)	(2,3,4)	(1,2,3)	(1,2,3)	(0.5,1,2)	(1,2,3)	(0.5,1,2)
	C3	(0.5,1,2)	(1,2,3)	(1,2,3)	(1,2,3)	(1,2,3)	(2,3,4)	(0.33,0.5,1)	(0.33,0.5,1)	(1,2,3)	(0.25,0.33,0.5)
	C4	(0.33,0.5,1)	(0.25,0.33,0.5)	(1,2,3)	(1,2,3)	(1,2,3)	(0.5,1,2)	(0.33,0.5,1)	(0.5,1,2)	(1,2,3)	(0.5,1,2)
	C5	(0.5,1,2)	(0.5,1,2)	(0.5,1,2)	(1,2,3)	(0.5,1,2)	(1,2,3)	(1,2,3)	(0.5,1,2)	(0.33,0.5,1)	(0.5,1,2)
	C6	(1,2,3)	(0.5,1,2)	(0.5,1,2)	(0.5,1,2)	(2,3,4)	(0.5,1,2)	(1,2,3)	(1,2,3)	(1,2,3)	(0.5,1,2)
	A_1^+	(1,2,3)	(1,2,3)	(2,3,4)	(1,2,3)	(2,3,4)	(0.25,0.33,0.5)	(1,2,3)	(1,2,3)	(2,3,4)	(2,3,4)
	A_1^-	(0.33,0.5,1)	(0.25,0.33,0.5)	(0.25,0.33,0.5)	(0.33,0.5,1)	(0.33,0.5,1)	(1,2,3)	(0.33,0.5,1)	(0.33,0.5,1)	(0.33,0.5,1)	(0.25,0.33,0.5)
	A_2^+	(1,2,3)	(1,2,3)	(2,3,4)	(1,2,3)	(2,3,4)	(2,3,4)	(1,2,3)	(1,2,3)	(2,3,4)	(2,3,4)
	A_2^-	(0.33,0.5,1)	(0.25,0.33,0.5)	(0.25,0.33,0.5)	(0.33,0.5,1)	(0.33,0.5,1)	(0.25,0.33,0.5)	(0.33,0.5,1)	(0.33,0.5,1)	(0.33,0.5,1)	(0.25,0.33,0.5)

Table 15- Partner database (PD) of the second round (Ref.: this work)

Partner Database (PD)	Round Number	Selected Contractor in Round	Criteria									
			Reputation & Position in Industry	Quality	Production Facilities & Capacity	Technical Capability	Capabilities & Standards	Price	Time Schedule	Service	Reliability	Political Situation
	1	DANIEL	(0.5,1,2)	(0.5,1,2)	(2,3,4)	(1,2,3)	(0.5,1,2)	(0.5,1,2)	(1,2,3)	(0.5,1,2)	(0.33,0.5,1)	(0.5,1,2)
	2	RAL	(1,2,3)	(0.5,1,2)	(1,2,3)	(1,2,3)	(2,3,4)	(1,2,3)	(1,2,3)	(0.5,1,2)	(1,2,3)	(0.5,1,2)

Table 16- Ideal vector database (IVD) of the second round (Ref.: this work)

Ideal Vector Database (IVD)	Round Number	FPIS & FNIS	Criteria									
			Reputation & Position in Industry	Quality	Production Facilities & Capacity	Technical Capability	Capabilities & Standards	Price	Time Schedule	Service	Reliability	Political Situation
	1	A_1^+	(1,2,3)	(1,2,3)	(2,3,4)	(1,2,3)	(2,3,4)	(0.25,0.33,0.5)	(1,2,3)	(1,2,3)	(2,3,4)	(2,3,4)
		A_1^-	(0.33,0.5,1)	(0.25,0.33,0.5)	(0.25,0.33,0.5)	(0.33,0.5,1)	(0.33,0.5,1)	(1,2,3)	(0.33,0.5,1)	(0.33,0.5,1)	(0.33,0.5,1)	(0.25,0.33,0.5)
	2	A_2^+	(1,2,3)	(1,2,3)	(2,3,4)	(1,2,3)	(2,3,4)	(0.25,0.33,0.5)	(1,2,3)	(1,2,3)	(2,3,4)	(2,3,4)
		A_2^-	(0.33,0.5,1)	(0.25,0.33,0.5)	(0.25,0.33,0.5)	(0.33,0.5,1)	(0.33,0.5,1)	(1,2,3)	(0.33,0.5,1)	(0.33,0.5,1)	(0.33,0.5,1)	(0.25,0.33,0.5)

once more by the previous ideal vectors. Maybe some winner alternative becomes less favorable, while another one rises in similarity to the ideal solution. The reason for this development is the readjustment of scales and the relative placement of the alternatives. With a soaring number of entries in the partner database, more precise statements can be given about the quality of the decisions made by the agent. Maintaining a database with reference values of future analysis is an invaluable asset for any agents as it provides the key figures for automatic learning and self-adjustments.

4. Conclusion

The primary objective of this research was to elaborate on a suitable decision-making method for the oil and gas pipe laying projects and to develop PD and IVD databases to compare contractors in future. As the data analysis and findings indicate, it is possible for the firm to achieve cost savings by selecting the right and suitable contractor.

By the researchers' studies conducted in this paper, it was found out that in addition to quantitative factors, qualitative factors play an important role in the ranking of contractors, without which the best contractor cannot be absolutely determined; therefore, MADM models were preferably used. The paper introduced a contractor selection process which was conducted using the hybrid MADM model, including Swing method and TOPSIS model extended by the fuzzy approach. In fact, to overcome problems such as uncertainty, ambiguity, inaccurate information, etc., the fuzzy approach is implemented in the proposed model.

The proper evaluation of the contractor/vendor selection process and categories is needed in order to successfully operate at a low cost and high quality and to manage the contractor database. According to the IOEC's managers, the proposed model itself shows great potential for the selection process and makes it possible to analyze the contractors which have been at IOEC's tenders. The proposed model could be applied to understanding of the selected contractors in order to learn from the past decision-making processes in some rounds and to support additional improvement in the selection process. In the current work, the proposed model was conducted for two post-layout survey tenders, in which DANIEL Company was announced in the first bidding and RAL Company in the second bidding by the proposed model.

Taking the above explanations into account, this work has two contributions. The first contribution is combining two MADM methods, namely Swing and xTOPSIS, to solve the vendor selection problem. Secondly, this research is the first

effort at IOEC to implement a scientific procedure for vendor selection instead of the traditional ones.

The authors believe that using the proposed model helps the analysts of the IOEC's vendor selection deal with its complicated activities and projects in a most effective and productive manner. The process is now conducted by only the trading commission unit at IOEC. Thus, it is recommended that the evaluation should be made in all the teams cooperating in such a way that each department should be responsible for its category. Finally, to minimize perplexities and to increase the understanding of a given rank, interpreting discussion of and guidelines on ranking are recommended.

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The Moderating Effect of Firm Value and Liquidity on the Relationship between Managerial Overconfidence and R&D

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ABSTRACT

Overconfident managers, who tend to overestimate their capabilities, underestimate the possibility and impact of side effects in projects. The purpose of this study is to review the influence of managerial overconfidence on research and development (R&D) expenditures and the moderating effect of firm value and liquidity on this relationship. To this end, 51 companies were chosen from oil, gas and petrochemical companies listed on the Tehran Stock Exchange over the period of 2012-2017. This research, within three basic hypotheses, is analyzed by Eviews software and shows that managerial overconfidence has a positive effect on research and development. Company liquidity has also a direct effect on relationship between managerial overconfidence and R&D, but the firm value does not meaningfully affect the relationship between managerial overconfidence and R&D.

1. Introduction

Nowadays, R&D is the key to compete with the rivals and access the world new technologies. Technology and advancement of technology can change the nature of production processes as well as product quality in different countries, can improve the competition power of goods, and can increase their export. The infrastructures required for producing a product can be divided into three types: hardware, software, and humanware; then, the expertise of different countries show that the determinants of international competitiveness are software and humanware factors (Badi and Baltagi, 2014). Competition is the main motivation for the growth and development of companies. Increasing competition and improving performance have led many organizations into concentrating their activities on core products and capabilities, which require investment in research and technological innovation. In organizations, researches are made with the aim of supporting innovation; R&D activities for improving the performance and motivation for surviving must lead to developing new business opportunities, or organizational changes must occur to make a transition from the current state to some desired future state (Khanagha Barzegari et al., 2017).

Overconfidence is one of the most important concepts of modern behavioral finance used to explain some behaviors of managers and investors which are not in compliance with traditional finance theories and make human beings overestimate their knowledge and skills and underestimate the risks; they exaggerate the managers' abilities in controlling events and make them feel they have control over issues, but this may not be true (Ahmad, 2013). The overconfident managers systematically overestimate the future return of investment projects and make overestimation of input liquidity in their investment project, so they are confident about their abilities to achieve a proper performance. Therefore, regarding the competitive market, as well

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as companies' high demands for development and presenting divers and new products, studying whether overconfident managers are optimistic about investing in research and development in terms of their behavioral characteristics is among the gaps and research needs.

The purpose of this paper is to study the effect of managerial overconfidence on R&D costs. The behavioral financial issues have robust presence in managers' decisions, and the effects of such decisions on the performance of companies are significant. Considering that oil, gas, and petrochemical companies are among the well-known industries in terms of their volume of activities and cash flows, R&D costs in such companies are important and necessary due to their effects on raising and developing the future income resources of oil and gas. Managers' precise attention to R&D costs, which prevents imposing unnecessary expenditures under this headline, has not been investigated so far. Therefore, the current work is innovative in its kind since we are addressing the question of "do the overconfident managers in Iran tend to invest in R&D which is somehow a long-term investment?". In addition, the moderating effect of firm value and liquidity on the relationship between managerial overconfidence and R&D is investigated.

2. Literature Review

Managers are strategic decision makers in big companies; therefore, the psychological impact of their "illogical" confidence will affect all the aspects of the company. These impacts are more likely to rely on judgments based on management prediction; one of these issues is investment in company's R&D. The psychological impacts of managerial overconfidence may assume three forms in R&D costs:

1. Self-motivation: innovative activities have a high profit, a high risk, and somehow a long cycle. In normal conditions, managers tend to avoid risks, but they have innovative investment activities; to avoid this narrow-minded behavior, an external motivation like managerial motives (monetary compensation and stock incentives) is needed. For example, the overconfident managers tend to overestimate the innovation advantages and underestimate their risks; this self-motivation makes them consider themselves successful.
2. Innovation motivation: innovation is constantly considered to be an important index of the company's competition and potentiality. The success of the innovation will bring not only high returns but good credit to the company, and this is a symbol of power and view. Galasso et al. (2011) believed that executives show their abilities to control the market with innovation. Moreover, Hirshleifer et al. (2011) found that managers use false confidence to adopt innovation plans in technology as a way of showing their view and abilities; therefore, the overconfident managers have greater motivation for innovation because overconfidence enables them to control innovations with higher risks.
3. Representation costs: managers are not generally keen on innovative activities because this contradicts the stakeholders' long-run interests and increases the representation costs; however, overconfident managers' view is quite different. Fairchild (2005) found that overconfident managers are more diligent and help to represent problems. Therefore, overconfident managers protect the stakeholders' interests and are more loyal to them; they also follow the high return of R&D to improve the value of the company. Gervais et al (2011) stated that, from the viewpoint of the future cash flow, overconfident managers expect to achieve a higher future cash flow of investment projects and can make much riskier decisions; as a result, there will be no need to spend more resources, which justifies the motivation of most overconfident managers for R&D activities in comparison to logical managers (Gervais et al., 2011).

Regarding the robust presence of behavioral financial issues in the decisions of managers and decision makers in recent decades and the significant effects of such decisions on income and cost performances, research hypotheses are as follows:

1. Managerial overconfidence has a meaningful effect on R&D.
2. Firm value has a meaningful effect on the relation between managerial overconfidence and R&D.
3. Company liquidity has a meaningful effect on the relationship between managerial overconfidence and R&D.

Many researchers such as Wang et al. (2018) have studied the effect of political ties and managerial overconfidence on the intensity of R&D investment. They concluded that, unlike the previous researches, a high level of managerial interference increases the intensity of R&D. Chen (2017) investigated the impact of managerial incentives on R&D investments and cash flows and reported that risk-taking motivations may increase both risky investments and the financial limitations to R&D investment. Zavertiaeva et al. (2018) also studied the effect of managerial overconfidence on enterprise R&D and stated that those companies overcontrolled by managers invest more in R&D costs;

the countercontrol of R&D do not improve the effect of R&D financial determinants such as enterprise liquidity or profitability. However, determined managers do not invest effectively in R&D, and the costs may have a negative impact on the firm value. A great part of the literature shows that managerial overconfidence and optimism may affect R&D, but Zavertiaeva et al. (2018) found their negative impacts in companies in South Korea, France, Germany, Switzerland, Italy, Spain, and the Netherlands.

Wong et al. (2018) studied the effect of political ties and managerial overconfidence on investment in R&D. Upon examining 1293 Chinese companies with the panel data method, they concluded that powerful political ties decrease the intensity of investment in R&D, but the managerial overconfidence intensifies R&D activities. The result of the last hypotheses indicates that overconfidence has a positive effect on the relationship between political ties and R&D and changes the negative impact of political ties into a positive influence. Marina et al. (2018) also investigated the relationship between managerial overconfidence and R&D costs and confirmed that the R&D cost of the companies run by overconfident and optimist managers are higher. Managerial overconfidence enhances the influence of liquidity and firm value on R&D. However, overconfident managers do not make effective investment in R&D, and the costs can have a negative effect on the firm value. Garkaz et al. (2017) reported the impact of managerial overconfidence on abnormal return. Their research is of quasi-experimental and post-event type based on real information obtained from stock market and companies financial statements listed in stock exchange. The work is of applied type in terms of purpose, and, in terms of content, it is of correlative type; regression analysis was used to test the hypotheses. Their results confirmed that there is a positive and meaningful relationship between managerial overconfidence and abnormal return. Keivani et al. (2017) also studied the relationship between operating profit and R&D investments and cash flows. Their findings show that there is no meaningful relation between operating profit and R&D investment, but operating profit and cash flows corelate meaningfully. Arjmand et al. (2017) considered the relation of political ties and managerial overconfidence with R&D investment. They stated that the relation between political ties and R&D investment is meaningful and that managerial overconfidence significantly influences the relation between political ties and R&D intensity.

3. Methodology

Since this is an applied research from the purpose point of view, managers of oil, gas, and petrochemical industries may use this paper and apply its findings to their decisions; in addition, it is a correlative and regression research from the viewpoint of method. Regarding the fact that the main data are achieved based on past performance and historical data, this is a post-event research (Hafeznaya, 2008). To analyze the information, descriptive inferential statistics and the panel multiple regression method are used.

3.1. The Model

Following Zavertiaeva et al. (2018), this research employs Equation 1 to test the hypotheses.

$$RD_{it}=\beta_0+\beta_1 OverConf_{it}+\beta_2+FV_{it}+\beta_3 Liq_{it}+\beta_4 OverConf\times FV_{it}+\beta_5 OverConf\times Liq_{it}+\beta_6 LEV_{it}+\beta_7 ROA_{it}+\beta_8 Size_{it}+\varepsilon_{it} \quad (1)$$

Table 1- Variables descriptive indices

Variable	R&D Investment	Managerial Overconfidence	Firm Value	Size	Return on Assets	Liquidity	Leverage
Symbol	RD	OVER	FV	SIZE	ROA	LIQ	LEV
Average	0.037	0.298	0.298	13.136	0.072	1.286	0.574
Mediator	0.026	0.000	0.212	13.031	0.084	1.153	0.580
Maximum	0.129	1.000	0.612	18.023	0.290	2.866	0.921
Minimum	0.004	0.000	0.112	10.025	-0.279	0.565	0.276
Deviation	0.032	0.458	0.351	1.547	0.132	0.541	0.153
Kurtosis	1.141	0.879	0.357	0.559	-0.975	1.342	-0.082
Skewness	0.322	0.773	1.855	3.279	4.051	4.687	2.514
Remarks	306	306	306	306	306	306	306

R&D is a dependent variable which is obtained from R&D costs divided by total assets. Managerial overconfidence is an independent variable used as a scale to measure a manager's overconfidence. Following Huwan et al. (2011), Lynn et al. (2005), and Park and Kim (2009), it can be calculated by subtracting the real profit from the annual projected earnings. If during a case, the number of management profit overestimations exceeds the number of underestimations, the manager is overconfident; in this case, the variable is equal to one, otherwise the variable is considered to be zero. Liquidity (total current assets to total current debts) and firm value (the logarithm of market value of the company's equity) variables were classified as a moderator, and their effects were measured because they directly affect the relationship between the independent and dependent variables of R&D costs. The three variables, including assets return (the ratio of after-tax profit to total assets), company size (logarithm of total assets at the end of fiscal year), and financial leverage (the ratio of the book value of debts to the book value of assets) were defined as control variables, and we assumed that their effects were constant since they might indirectly influence R&D costs.

3.2. Statistical population and sample

The statistical population of this research consists of all oil, gas, and petrochemical companies listed on the Tehran Stock Exchange during 2012-2017. The companies with incomplete data and companies with a fiscal year apart from March 19 were eliminated, and finally 51 companies were selected.

Table 2- Results of the normality test of errors of the research hypothesis model

Variable	Symbol	Jarque-Bera Test Statistics	Jarque-Bera Test Probability
Sentence errors	Resid	3.337	0.184

Table 3- Collinearity of the independent and control variables

Description	Symbol	Tolerance	Variance Inflation Factor
Managerial Overconfidence	OVER	5.528	1.066
Liquidity	LIQ	11.043	2.212
Firm Value	Firm value	44.729	1.007
Return on Assets	ROA	14.124	1.061
Company Size	SIZE	124.014	1.030
Financial Leverage	LEV	3.307	1.030

4. Empirical Results and Discussions

4.1. Descriptive Statistics of Research Variables

The average and mediator of R&D investment as a dependent variable are respectively about 0.037 and 0.026, which indicates that about half of the companies are above 0.26. The distribution of this variable has a positive skewness and kurtosis. Managerial overconfidence as an independent variable has an average of about 0.298, which indicates the average of managerial overconfidence of companies; the variable mediator also shows that half of the listed companies have overconfidence of about 0.000. The distribution of this variable has a positive skewness and kurtosis. Liquidity and firm value are variable moderators; the average of liquidity ratio is about 1.286. Moreover, the variable mediator indicates that about half of the listed companies have a liquidity ratio higher than 1.153. The distribution of this variable has a positive skewness and kurtosis. The average of FV is about 0.298, and the variable mediator indicates that about half of the listed companies have a value more than 0.212. The distribution of this variable has a positive skewness. Furthermore, the average of company size is about 13.136, and the variable mediator indicates that about half of the listed companies have a size larger than 13.031. The distribution of this variable has a positive skewness. The average of financial leverage is also about 0.574, and the variable mediator indicates that about half of the listed companies have leverage above 13.031. The distribution of this variable has a positive skewness but a negative kurtosis. The average of ROA is about 0.072, and the variable mediator indicates that about half of the listed companies have an ROA greater than 0.084. The distribution of this variable has a positive skewness but a negative kurtosis.

4.2. Inferential Statistics

In most parametric tests, there are lots of preliminary assumptions, and if these assumptions are not met, the results of the tests will be invalid. The most important and common assumption is having "normal data". A normal data distribution means that the histogram of the frequency of data is almost a normal curve. Before studying the normal data, it should be noted that, in most cases, the error distribution must be normal; in other words, instead of considering the normality of the data, the error distribution should be checked whether they are normal or not. In this research, Jarque-Bera test is utilized to determine whether the model errors are normal or not; thus, if the probability of Jarque-Bera test is

greater than the error level of 5%, it can be concluded that the errors of the research hypothesis model have a normal distribution, as shown in Table 2.

4.2.1. Normality Test of Sentence in Research Hypothesis Model

Sentence errors in the research hypothesis model have a normal distribution: H0

Sentence errors in the research hypothesis model does not have a normal distribution: H1

Since the amount of Jarque-Bera test probability is more than the level of 5% error, it can be found that the sentence error of the research hypothesis has a normal distribution.

4.2.2. Collinearity Test of Research Variables

Regarding the fact that the tolerance of all the variables is more than 0.2, and the variance inflation factor is less than 5, it can be noted that the independent and control variables are not colinear.

Table 4- Cha Wu test

Statistics	Probability	Test Result	
4.720	0.000	Null hypothesis rejected	Panel model

Table 5- Cha Wu test

Chi-2 statistics	Probability	Test Result	
15.989	0.023	Null hypothesis rejected	Panel with fixed effects

4.2.3. Pattern Selection Test

Regarding the current research literature and the nature of hypothesis, combined data are used in this research. To select a proper model (combined or panel with fixed or random effects) for the hypothesis test, Cha Wu-Hausman test is used.

Cha Wu Test

The results of test F on the regression model used in this research is tabulated in Table 4. The null and alternative hypothesis of Cha Wu test are as follows:

H0: combined data method

H1: panel data method

Regarding the meaningful results of Cha Wu test in Table 4 indicates that assumption H0 (the combined model) is not confirmed. In other words, there are individual or group effects, and the panel data method must be used to estimate the research regression model; Hausman test must be used to determine the type of the panel model (random or fixed effects) subsequently.

Hausman Test

Once it is clear that y-intercept is not the same at different years, the method of estimating the model (random or fixed effects) must be determined; Hausman test is therefore employed. The null hypothesis and alternative hypothesis of Hausman test are defined by:

H0: random effects method

H1: fixed effects method

Hausman test results are summarized in Table 5:

According to the Hausman test results in Table 5, Chi-2 statistics in Hausman test 95% is meaningful, which confirms H1 hypothesis; therefore, regarding the Hausman test, the constant

Table 6- Hausman test

Description		Coefficient	Statistic t	Level of Meaningfulness
Constant number		0.362	3.854	0.00
Managerial Overconfidence	OVER	0.091	14.633	0.00
Firm Value	FV	0.029	2.035	0.04
Managerial Overconfidence in Firm Value	FV*OVER	-0.061	-1.950	0.06
Liquidity	LIQ	0.032	4.343	0.00
Managerial Overconfidence in Liquidity	LIQ*OVER	0.427	3.526	0.00
Return on Assets	ROA	-0.197	-1.761	0.07
Firm Size	SIZE	0.019	2.863	0.00
Financial Leverage	LEV	-0.370	-0.079	0.93
Determination Coefficient		0.774	Statistic F	16.037
Moderated Determination Coefficient		0.726	Meaningfulness	0.000
			Durdin Watson Statistic	1.915

effects method using the panel data model matches the model of this study .

4.3. Empirical Analysis

After reviewing the classic hypotheses, we will examine the research hypotheses in the following., and the regression results and coefficients will briefly be analyzed.

As Table 6 shows, the level of meaningfulness of managerial overconfidence variable (0.00) is less than 5%. Therefore, the first main hypothesis of the research is approved at a confidence level of 95%, and the positive regression coefficient of managerial overconfidence (0.091) indicates a direct relation between the dependent and independent variables. The level of meaningfulness of managerial overconfidence variable in firm value (0.06) is more than the error level of 5%, so the second main hypothesis of the research is not confirmed at a confidence level of 95%. Firm value has no meaningful effect on the relation between managerial overconfidence and R&D. The meaningfulness coefficient of managerial overconfidence variable in liquidity (0.00) is also less than the error level of 5%, so the third main hypothesis of the research is confirmed at a confidence level of 95%. However, the positive regression coefficient of managerial overconfidence in liquidity (0.427) indicates that the company liquidity directly affects managerial overconfidence and R&D. Furthermore, size of the company has a meaningful effect on R&D costs because its meaningfulness level (0.00) is less than the error level of 5%. Based on the moderated determination coefficient of the model, about 73% of changes in R&D costs are explained by this model. Since the amount of Durbin-Watson statistic (1.915) is between 0-4 at an optimum interval, the hypothesis of self-correlation between the variables is rejected. Since the probability of F statistic test (0.000) is less than the error level of 5%, it is confirmed that the fitted regression is meaningful.

5. Conclusion

According to the first main hypothesis, managerial overconfidence has a meaningful effect on R&D costs, and, based on the test, the meaningfulness coefficient of managerial overconfidence variable (0.01) is less than the error level of 5%. Therefore, the first main hypothesis of the research is approved at a confidence level of 95%, and the positive regression coefficient of managerial overconfidence variable (0.091) indicates a direct relation between the independent and dependent variables; as a result, managerial overconfidence has a positive effect on R&D, which means an increase in managerial overconfidence raises R&D costs and vice versa.

As per the second main hypothesis, firm value has a meaningful effect on the relation between managerial overconfidence and R&D costs, and based on the test, the meaningfulness level of managerial overconfidence variable in firm value (0.06) is more than the error level of 5%. Therefore, the second main hypothesis is not approved at a confidence level of 95%, so firm value does not meaningfully affect the relation between managerial overconfidence and R&D costs.

In accordance with the third main hypothesis, the company liquidity has a meaningful effect on the relation between managerial overconfidence and R&D costs, and based on the test, the meaningfulness level of managerial overconfidence variable in liquidity (0.00) is less than the error level of 5%. Therefore, the third main hypothesis is approved at a confidence level of 95%, but the positive regression coefficient of managerial overconfidence in liquidity (0.43) indicates the company liquidity directly impacts on the relation between managerial overconfidence and R&D. Overconfident managers in Iran Stock Exchange tend to invest on R&D, which expresses their optimism about improving future performance through investment in R&D, leading to developing and introducing new products to market, etc. In fact, these managers accept the risk and are optimistic about the future return of investment in R&D.

The result of this research is in agreement with the works of Zavertiaeva et al. (2018) and Marina et al. (2018). Zavertiaeva et al. (2018) showed that those companies managed by overconfident managers make greater investment in R&D costs, but such overconfidence has no impact on moderator variables such as the company liquidity and profitability. Marina et al. (2018) studied the relation between managerial overconfidence and R&D costs and reported that R&D costs are higher in companies controlled by confident and optimistic managers. However, our results contradict the results of Marina et al. (2018), concluding that managerial overconfidence strengthens the effect of firm value on R&D.

Based on the result of the first hypothesis, managerial overconfidence has a positive meaningful effect on R&D costs. It is recommended that other decision makers of

the company should evaluate the future function of the company after managerial overconfidence in investment in R&D to prevent unreasonable decision makings of managers and protect the stakeholders' interests. Regarding the result of the third hypothesis, the company liquidity has a meaningful effect on the relation between managerial overconfidence and R&D costs since the optimistic managers spend the company liquidity on R&D carelessly and irrationally, the outcome of which may increase the company risk. It is recommended that companies should pay special attention to personality traits and non-emotional behaviors when employing managers because a manager's emotional behavior may cause the stakeholders to lose their confidence; Finally, since the continued and increased investment (especially in stock companies with diverse investors) is the economy engine, its consequences may bring serious crisis in the long run.

6. Research Limitations

The research is carried out in oil, gas, and petrochemical companies; therefore, one must be cautious about popularizing the results in other societies.

Due to the high volume of the financial variables, it was not possible to consider all the effective variables.

The data of this research was extracted from Tehran Stock Exchange, and the inefficiency of this stock restricts the research results reliability.

We have a two-digit inflation rate in our country, and there is no standard to adjust the companies' historical financial statements. High inflation and its probable consequences on financial information may undermine the results of the research.

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A Fuzzy Model for Measuring Organizational Strategy Alignment: A Case Study on South Pars Projects of Iran's Oil Industry

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ABSTRACT

For every organizational and project activity, decisions should be made to delegate necessary resources. The objective of the current paper is to assist the oil and gas managers in aligning each functional level of strategy to make decisions on resource delegation. This can be conducted by creating a synergy which increases organizational performance. The methodology used in this research is based on a case study on Iran's South Pars oil and gas zone. The purpose of the present work is to find the alignment pattern classified on social structuralism domain.
This study is explanatory, qualitative, and developmental since it applies the fuzzy set theory to measurements. Presented herein is a comprehensive model according to the systematic and scientific approaches in the field of management. The main purpose of this model is to create organizational strategy alignment in severe environmental conditions and in the presence of external economic sanctions in South Pars oil and gas projects. The statistical society included in this study were the managers and CEO's who had in-depth experience in South Pars projects for more than five years. Since the number of the managers were 43, the possibility of data gathering allowed for not using the sample size. The results show that by increasing strategic alignment (SA) among strategy functions, structure, human resource, and technology, the level of organizational performance rises, and the fuzzy model of SA leads to better statement reality.

1. Introduction

Strategies are tools that organizations can use to achieve their strategic goals (David, 2008). According to some managerial theorists (Simon, 1957 and Mintzberg, 2007), not only are strategies about the organizational strategic goals, but they can create a behavioral pattern in the organization. It is clear that by the emergence of a strategy in behavior and by tracking the strategy in the organizational behavioral patterns, strategists can find a deliberate or emergent strategy pattern. In any case, the goal of a strategy is to maximize all stakeholders' interests (Johnson and Scholes, 2005).

Regarding the status of an organization, different types of strategies may be prescribed for it, but the alignment among the elements of strategy can be considered as an effective way to improve organizational performance. While introducing concepts related to strategy, the purpose of this study is to explain the pattern of establishing strategy alignment in oil and gas organizations.

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Because the researchers believe that the alignment of organizational strategies improve organizational performance, a synchronization and performance model is proposed. Therefore, to introduce reality, it should be noted that there is an absolute harmony and a lack of coordination among strategies, so these extreme spectrums can be understood through the fuzzy analysis and measurements.

The problem from which the research has emerged is the cooperation and significant involvement of the different functional levels of strategy, and the alliance of this toward the environment will cause a better outcome for the oil and gas industry. The questions are as follows:

1- Is the alignment among structure, technology, strategy, and human resources give the CEO's the state that "the organizational elements are right and will be on the right track?"

2- Could the alignment cause the synergy in the organization and have a better outcome?

3- Among research improvement models, is there a model which improves the qualitative analysis of alignments with a quantitative source of data to give better states of reality?

4- What has happened in South Pars oil and gas projects as managerial decisions during the sanctions take effect?

2. The Concept of Strategic Alignment

The main issue of managing the organization is to align the strategy levels with the organization external environment (Mintzberg and Quinn, 1991; Pearce and Robinson, 1991, 1994; Hunger and Wheelen, 2007). Based on many theories of the coordination and integration of the organization, organizations which effectively align the structural factors with the strategic ones show higher effectiveness (Doty, Glick and Huber, 1993). Each of the existing systems at the organizational level of strategy must also align with its subsystems (internal alignment) as well as with its high-level systems and level systems (external alignment). Therefore, this leads to manifesting the management issue and creating directional synergies, thereby achieving the organization goals (Porter, 1985). Some of the strategic alignment theorists consider the alignment of the elements of the organization (structure, technology, culture, human resources, leadership style, and strategy) with environmental conditions (Chorn, 1991; Leavit, 1965; Daft, 2004, Scott, 2002; Itami, 1987; Galbraith and Kkazanjain, 1986; Prahalad and Hamel, 1990; Barney, 1991), while others point to strategic alignment as the elements of the organization aligning with themselves (Woodward, 1965; Chandler, 1962; Andrews, 1987; Balkin and Gomez-Mejia, 1990; Dvir and Shenhar, 1993; Fisher and Govindarajan, 1990; Waterman, 1986). Strategic flexibility is the area in which the organization looks at a strategic capability to change the situation from one strategy to another so as to implement another strategy (Hunger and Wheelen, 2007). During the stability periods in the organization, new strategies are being developed and discussed. However, they maintain their organizational structures until it is time to execute them; the quantum leap is also required to implement strategies (Clarke, 2006). Therefore, strategic flexibility and the quantum theory of strategic change both need a change due to the dynamic alignment. In addition to explaining common patterns of creating strategic alignment in the organization, we will introduce a fuzzy alignment model.

3. Strategic Alignment Patterns

The main question is how the organization can establish a conceptual and strategic alignment. The practical and fundamental research into answering this question has created a new and emerging field incorporating the concepts, theories, and patterns of strategic management. The proposed patterns can be grouped into three types, namely rational, natural, and comprehensive patterns, which will be described in detail. According to the defects of each of these patterns, a new pattern called a fuzzy model is presented to measure the degree of strategic alignment.

3.1. Rational Patterns

Rational planning approach develops the strategy based on formal processes and rational decision making. In this approach, there is a one-way, top-down relationship between the level of the organizational strategy and the lower-level strategies. The lower level strategy is designed according to the organizational level strategy (although not entirely). It includes the goals, strategies, and policies for lower levels, which are

tailored to meet the organization goals. The strategy is like a cascade dropping from above, and, in the process of formulating strategy at the organization level, it addresses the organization needs and a strategy which refers to these needs (Bamberger and Biron and Meshoulam, 2014). The features of the rational model would be as follows. It can be queued even by considering all the factors with equal probability and by establishing a vertical alignment. Despite all the benefits of this model, one cannot ignore its limitations: idealistic and subjective, the requirement of a strategy to be the basis for work. Moreover, if the strategy is false,

Flexible (Results)	Open	Radical	SRP2	The third types of theories and patterns		The fourth types of theories and patterns
Control	System	Change				
Intense (Process)	Closed	Regulatory		The first types of theories and patterns		The second types of theories and patterns
				SRP1		
		Burrell and Morgan, 1979		Objective	Philosophical assumption	Subjective
			Scott, 1981	Rational	Attitudes	Natural
			Hall, 1996	External	Focus	Internal

Figure 1: Synonyms of reference points in categorizing management patterns according to Scott

the crafted strategy encounters the diversion as well as considering all practical obstacles. Therefore, other models are designed to respond to managers' needs to minimize these constraints.

3.3. Natural Patterns

Although theoreticians of rational systems associate organizations with components that have been gathered according to a plan and for specific purposes, the advocates of the natural system believe that organizations cannot be merely the only means of achieving certain goals. However, they are composed of social groups trying to adapt themselves to the specific conditions they are in (Scott, 2002). In this model, in addition to aligning the two levels of strategy, e.g. the corporate strategy and the business strategy, the effective dependent factors affecting both levels of strategy are also identified. The main advantages of this model include being objective and the real variables used in the model. However, complexity, difficulty, and a lack of stability in long run of native models are the main disadvantages. Therefore, based on strategic reference points and a fuzzy measurement model,

Table 1- A summary of related theoretical perspectives

Theoretical perspective	Reference point emphasized	Fundamental prescription	Source
Motivation theory	Internal organization Individuals Groups	Design work and set goals for performance	Latham & Yukl (1975), Nadler & Lawler (1977), Hackman & Oldham (19800
Resource-based view	Internal organization Firm-wide resources Capabilities	Build unique competencies	Werner felt (1984) Prahalad & Hamel (1990) Barney (1991)
Industrial economics	External condition Industry Key competitors	Beat the competition	Bain (1956) Caves (1977) Porter (1980)
Resource dependence	External conditions Suppliers Customers	Minimize constraints on resources	Pfeffer (1972) Pfeffer & Nowak (1976) Pfeffer & Salanicik (1978)
Institutional theory	External conditions Stakeholders Interdependency	Meet the demands of society	Meyer & Rowan (1977) DiMaggio & Powell (1983) Mayer, Scott & Deal (1983)
Corporate identity	Time Past traditions Philosophy	The past shapes what is possible in the future	Westley & Mintzberg (1989) Torbert (1987) Dutton & Dukerich (1991)
Strategic intent	Time Long-term purpose Mission	Strategic intent informs current decisions	Hasegawa (1986) Imai (1986) Hamel & Prahalad (1989)

two general next patterns have tried to reduce these barriers of strategic alignment to a minimum.

3.4. Multipurpose Patterns (application of strategic reference point theory)

Different managerial theorists, based on their views, have considered specific points of reference such as cost reduction (Porter, 1985), quality (Imai, 1986), speed (Stalk and Hout, 1990), innovation (Foster, 1986), customer needs (Ohmae, 1988; Peters, 1987), and stakeholders (Handerson, 1990) for the success of organizations. If each of these reference points is emphasized, the organization will succeed. Table 1 represents multi-dimensional or combined strategic reference points used by some other theorists (Figenbaum and Schendel, 1996).

As summarized in the above table, each dimension is used as a reference point based on a theoretical philosophy from different theorists' viewpoints, and each dimension is explained to provide a specific purpose. All the measurements and choices are compared to the reference point, and strategic reference points are the targets and points of reference which managers use to assess options, to make strategic decisions, and to communicate the priorities of an organization to the key people of their system (Bamberger and Figenbaum, 1996). The organization selects strategic reference points to achieve strategic alignment or to perform appropriate actions and operations (Figenbaum and Schendel, 1996). In other words, strategic reference points are the points of alignment, and if they coordinate all the elements and systems of their organization, a comprehensive alignment will occur. Figure 1 shows the rational foundations of management theories (Scott, Burrell and Morgan, and Hall), which are synonymous with each other, and their reference points are consistent. To characterize the patterns of an organization systems and subsystems, one should select from the reference points referred to as "sustainable point of reference" and then attempt to identify strategy typology. This also applies to the typology of different strategies at each level of the strategy, namely corporate, business, and functional levels of strategy.

One of the major advantages of this model is the inclusion of an integrated and comprehensive model of strategic alignment in the organization. Furthermore, its problems are qualitative and non-adaptable with quantitative variables such as performance, which will be expanded further.

4. Fuzzy Logic Model (An approach to the measurement of strategic alignment)

The classical approaches to the management world are rooted more in the two-dimensional logic and Aristotle's two values. It can be simulated to the real world which has only two dimensions: good or bad, right or wrong, truth or lie, black or white, life or death, guilty or innocent, zero or one, etc. (alignment or non-alignment). This principle encourages us to recognize the world and determine our place therein, and the transparency of our decisions depends on the clarity and transparency of our views (Grint, 1998). It seems that we have based our world on several dichotomies or two-dimensional contrasting spectra, which reduce complexity to an opposite pair.

In contrast, our language does not limit these two values, and it can describe the phenomena on a continuum. Hence, we not only have black and white, but also have gray, dark, light gray, etc. Organizations are fuzzy phenomena, and we define them in a state of being or not being. Therefore, if organizations are fuzzy, the issues related to them should then follow fuzzy patterns. On this basis, it can be explained that both strategic alignment and organizational performance can be categorized into fuzzy phenomena.

The basis of fuzzy logic or uncertainty in quantum issues can be searched. Bertrand Russell (1923), in connection with Aristotelian logic, explained the paradox of ambiguity and considered the procedure used to accept this logic as a habit. Heisenberg, in quantum physics, explained the "principle of uncertainty" to end the conclusion that scientific knowledge was cognitive, definitive, and certain. He showed that even atoms in the brain are uncertain. Heisenberg showed that, even in physics, the truth of propositions is based on a function of degrees (Azar, 2007).

Fuzzy logic shows that many aspects that were previously considered to be immeasurable can be measured. In fact, everything can be measured and evaluated, and this measurement and evaluation are fuzzy. What is proposed in the fuzzy strategic alignment model is to determine the degree of strategic alignment in a subject under study. Conversely, the criterion for evaluating words such as "aligned" and "non-aligned" depends on the individual's view. Therefore, we cannot even set an absolute rule for judging them, even

by doing endless tests (Tanaka,1996). Rahnavard and Nikzad (2010), in the study entitled "The Alignment between Organizational Elements" measured the strategic alignment based on a qualitative analysis of "proximity strategic types" by explaining a qualitative model for determining the degree of alignment in the light of strategic reference points.

The analytical model distinguishes the degree of alignment into three qualitative sections (high, medium, and low). In this study, the matrix of strategic reference points was divided into 256 parts (Figure 2). Moreover, based on "the degree of proximity," the degree of alignment was analyzed qualitatively, and its relationship with organizational performance was measured. Since each dimension of the matrix of strategic reference points is divided into 16 parts; the adjacency of 1 to 64 is considered to be high, and the proximity of 64 to 128 is regarded as medium; from 128 to 256 is also defined as low proximity. This pattern takes into account the alignment in a domain of strategic reference points. Therefore, in this approach, the strategic alignment with the one-to-one correspondence in the strategic reference points matrix can be precisely investigated. On the other hand, the discrete matrix and adherence to Aristotelian logic are the main reasons for the bias in the analysis of the described model.

In the fuzzy pattern, at first, the matrix of the strategic reference points is graded from 0 to 100. This grading will make the matrix of the strategic reference points more continuous (non-discrete). As a result, the dimensions of the matrix are separated into two dimensions, namely process control and outcome control, which respectively focuses on the internal environment and on the external environment; in this grading, four dimensions should be considered as follows:

(1) The degree of outcome control;
(2) The degree of process control;
(3) The degree of focus on the internal environment;
(4) The degree of focus on the external environment.

Each of these four dimensions will be graded from 0 to 100, so there will be a different matrix for grading on each side, which possibly assists with the rising control levels on each dimension (Figure 4). Based on the proximity theory in the continuous matrix of the strategic reference points, the distance from 0 to 71 is considered to be a high alignment, and the distance from 71 to 112 is regarded as a moderate alignment; the distance from 112 to 141 is defined as a low alignment. These limits are obtained by a mathematical relation between two points . According to this theory, the higher proximity (a short distance between the reference points) will cause a higher alignment. Using one of the two matrix dimensions (such as the degree of focus on the external environment and the

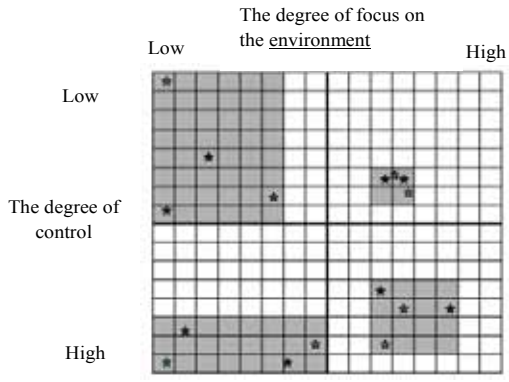

Figure 2: Matrix of discrete strategic reference points

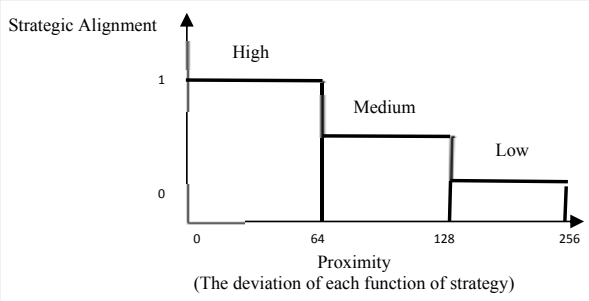

Figure 3: Definitive decisive sets of strategic alignment

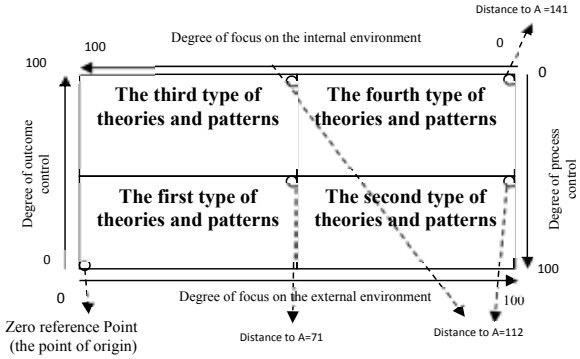

Figure 4: Quantitative strategic reference points and proximity theory

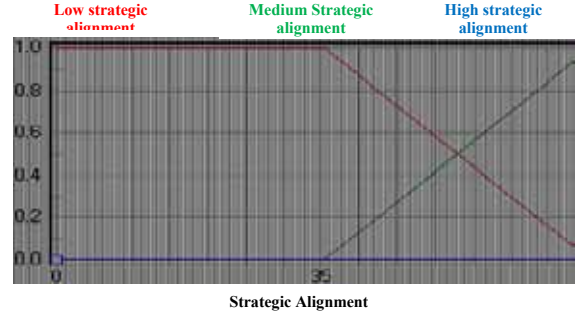

Figure 5: fuzzy sets of strategic alignment

degree of outcome control) is sufficient to determine the reference points. However, assessing the whole dimensions would raise the level of precision.

There is still ambiguity and uncertainty about the distribution of the related sets in the continuous proximity approach. For example, if the distance between two functional strategies was 55, the analyzers would assume that the alignment of these two functions belongs to the top set (high); this allocation is acceptable in terms of Aristotelian logic (Figure 3). In such a case, if, as an example, the deviation of functional strategy is 55, the strategic alignment will then be high. However, this way of partitioning and the determination of an element allocation is different from our language and reality (linguistic world), a world where there is no complete certainty and fuzzy.

Fuzzy sets provide a framework for dealing with ambiguities. The overall framework to face ambiguity is "measures of fuzziness," which is explained by the fuzzy set theory (Azar, 2007). Membership functions represent the functions of fuzzy sets and indicate, to what extent, an element is a member of a fuzzy set.

Table 2- The fuzzy degrees of most influential indicators of South Pars Projects Structure (according to the questioner completed in the phases)

Indicators	Phase 13	Phase 14	Phase 15-16	Phase 17-18	Phase 19	Phase 20-21	Phase 22-23-24	Indicator Average
Formalization	0.65	0.56	0.76	0.86	0.87	0.66	0.46	0.69
Specialization	0.91	0.82	0.75	0.88	0.89	0.76	0.82	0.83
Standardization	0.88	0.85	0.73	0.78	0.91	0.86	0.80	0.83
Hierarch of authority	0.71	0.87	0.87	0.90	0.93	0.67	0.71	0.81
Complexity	0.87	0.92	0.81	0.76	0.93	0.84	0.79	0.85
Centralization	0.81	0.83	0.87	0.71	0.75	0.87	0.82	0.81
Professionalism	0.63	0.87	0.67	0.64	0.82	0.76	0.78	0.74
Personal Ratio	0.72	0.58	0.72	0.62	0.81	0.52	0.82	0.68
Average of Structural Di-mensions (Result Control)	0.77	0.79	0.77	0.77	0.86	0.74	0.75	0.78
Size	0.86	0.87	0.87	0.87	0.81	0.86	0.87	0.86
Organizational Tech-nology	0.88	0.89	0.91	0.82	0.75	0.88	0.89	0.86
Environment	0.78	0.91	0.88	0.85	0.73	0.78	0.91	0.83
Goals and Strategies	0.90	0.93	0.71	0.87	0.87	0.90	0.93	0.87
Culture	0.76	0.93	0.87	0.92	0.81	0.76	0.93	0.85
Average of Contex-tual Di-mensions (Ex-ternal Focus)	0.84	0.91	0.85	0.87	0.79	0.84	0.91	0.86

Membership functions make it possible to choose the degree of an element as a real number between 0 and 1 (Tanaka, 1996). Figure 5 represents fuzzy sets which are intertwined with the degree of the strategic alignment of functions in organizations. For example, if the rate of functions deviation is 55 units, the degree of strategic alignment is equal to 86 (= 141-55) units. In the fuzzy analysis, the strategic alignment is 37% high and 63% moderate .

The degree of strategic alignment is equal to the distance between functional strategy and the deviations of each range from the maximum distance of the matrix of the quantitative strategic reference points. In Figure 5, the maximum distance of the matrix of the quantitative strategic reference points is equal to 141.

Case Study

Management Structure of South Pars Projects: A Structure of the Other Organizational Elements

Herein, we investigate the whole projects of South Pars Oil and Gas Company (POGC) as a case study on a macro-project alignment of Iran's Oil and Gas Industry. Accordingly, the alignment of the company's functional departments will cause to obtain better findings on specific actual progress of the Project Management Body of Knowledge (PMBOK) areas and processes (PMI, 2016, Integration Chapter). The departments of each developmental phase, namely phases 13, 14, 15-16, 17-18, 19, 20-21, 22-23-24, are mostly managed by project managers of the site and the staff department, which are called the matrix structure. The labors, who work for those projects, are commanded by both the staff manager and the site manager simultaneously, which ignores the unity of command of Henri Fayol's principles of management. Therefore, at this level of management, a huge amount of alignment and coordination should occur when the main specifics task is supposed to be done by contractors and sub-contractors. This duty of alignment of efficient knowledge areas is executed by the project management office (PMO) department

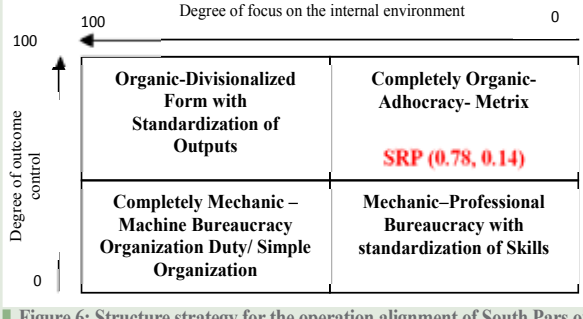

Figure 6: Structure strategy for the operation alignment of South Pars oil and gas projects

as the portfolio managing sectors of POGC. Table 2 tabulates the average result of structure indicators which led the decision-makers to a matrix according to strategic reference points (SRP). As listed in Table 2, there are two dimensions for determining the structure as a portfolio in a project, which are also useful for determining the organizational structure. The first dimension was associated with the structural dimension of that project, while the second one was related to the contextual dimension of a project. By assessing the whole South Pars projects and measuring them with fuzzy sets seen in Figure 5, the result shows that the average structural dimension is 78%. This means that the degree of the result control is characteristically high in Petroleum Ministry, National Iranian Oil Company (NIOC), and Pars Oil and Gas Company (POGC).

This measurement shows the level of formalization which indicates the degree of documents and forms required for managing the process of activities in the projects. The results confirm that the level of formalization is moderate (0.69), which might be due to the flexibility in making the activities most efficient by changing the management and the delegation of project CEO's decision. However, the levels of specialization (0.83), standardization (0.83), the hierarchy of authority (0.81), complexity (0.85), centralization (0.81), and professionalism (0.74) are high, which states why the oil and gas projects are technically managed by basic design but have a high technology to construct and commission. Such characteristics do not need to focus on the process, but require to focus on the results.

The contextual dimensions of the phases implied that whether an organization agreed on the subjective points of view within that structure or not. The measurements show that all the South Pars gas field development phases have a high contextual dimension in structure (0.86). The size of social systems, as a subsystem of the manufacturing process, in every phase was mostly high (0.86). Because the phases were established during sanctions on Iran, a large number of factors surrounded the environmental situation (0.83). The goals and strategies for each mega-project are clear by schedules and objectives, and the culture, as the most influential thing, makes every hard task possible in sanction conditions. The culture has its in-depth effects on these phenomena. For example, new labors in the age range of 30 to 40 years having low experience with managing projects in normal conditions have a high potential

for making impossible things possible by renewing processes. All these contextual dimensions show a high external focus (low internal focus of 0.14) on performing something perfect for the gas field shared between Iran and Qatar.

By applying strategic reference point matrix along with the collaboration of quantitative assessment and proximity theory in Figure 4, the strategies of structure are presented in Figure 6 (Daft, 2015), and the operational structure which is better for executing those strategies is mentioned.

When the fuzzy-SRP was established, a better assessment of reality was achieved. All the organizational aspects should be aligned with the strategic reference points. This model should be aligned with organizational strategy, programs, human resource strategy, and technology strategy as displayed in Figure 7.

Figure 7 shows the alignment model for managing an organization or a project organization applied to the South Pars oil and gas phases (a portfolio). It is composed of the combination of 10 theories (David, 2018; Porter, 1985; Daft, 2015; Mintzberg, 2007; Bamberger, 1996; Woodward, 1965; Figenbaum, 1996; Rahnavard & Nikzad, 2012; Leavit, 1965) or philosophically more theories (Burrell & Morgan, 1979; Scott, 1957; Hall, 2001) to give the oil and gas decision-makers the chance to decide which elements of managing should be changed according to specified SRP's.

5. Conclusion

In South Pars oil and gas phases, the structure accepts the aggressive strategy of the gas field shared between Iran and Qatar to commission the developmental phases as soon as possible with a high priority. This structure is established truly and generates profits for the country. The matrix is aligned with the free agent (contractors/subcontractors)

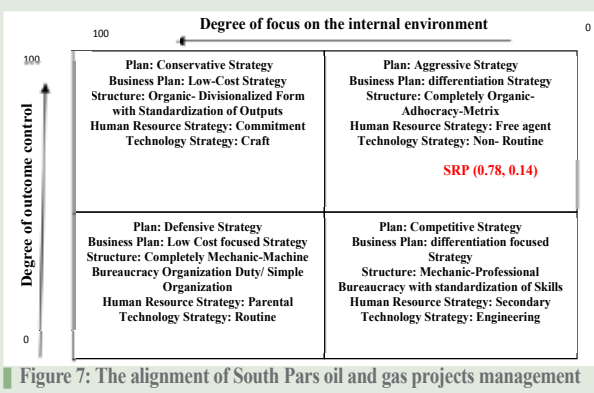

Figure 7: The alignment of South Pars oil and gas projects management

human resource strategy in which every subsystem of human resource supports the whole plan and structure simultaneously.

The core of the decision-making process in Pars Oil and Gas Company (POGC) makes all the processes of managing the portfolio non-routine because of Iran's external barriers and sanctions.

In the fuzzy pattern of strategic alignment, the strategies of the organization seek to determine the exact degree of alignment of strategy types. This method of analysis provides a clear explanation of the available contingency issues for the top executives to improve organizational performance by applying the aligned patterns. The current paper offers a more precise measure for the degree of strategic alignment based on the past researches related to the effect of strategic alignment on organizational performance; moreover, it is a link between performance and direct strategic alignment. By applying this criterion, the relationship between performance and strategic alignment can be determined more precisely, and it is clear how to assess the degree of strategic alignment.

By fuzzy methods, the chief executive managers in the oil industry will have a better understanding of the organization's goals and strategies. In fact, they will have a deep understanding of the goals and strategies chosen by various departments. Furthermore, they will realize that the main goal of this measurement attitude is to combine both theories and mathematical thinking to access the main alignment reality of the departments.

This study demonstrated that the main reason for synergy in POGC is because of the alignments of managerial elements and Iran's petroleum goals. That all the phases have been commissioned is the value of such recent performance.

This method can be applied to both upstream and downstream segments of the oil industry. However, the fuzzy set should be established again for each organization specifically. In fact, the fuzzy sets will not be the standard set for all organizations but will be a true applicable method for that segment of the oil industry.

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Evaluating and Prioritizing Asset Management Excellence Model Based on Critical Criteria Using the Combination of DEMATEL and ANP Techniques

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ABSTRACT

Today for installations management in equipment-based industries, such as oil and gas industry, the physical asset management development based on the ISO-55000 requirements is generally the most common issue in the world and particularly in Iran. Since this standard only expresses the requirements, many physical asset management excellence models have been designed by researchers or research institutes around the world to develop and strengthen physical asset management. Therefore, due to the diversity of models, organizations face problems of choosing a suitable model. Based on this issue, the main purpose and innovation of this work is evaluating and prioritizing popular and sometimes reference physical asset management excellence models according to 6 critical criteria based on DEMATEL and ANP techniques. Cost, risk, performance, sustainability, simplicity, and knowledge were identified as the critical criteria. First, 4 criteria were taken from the ISO-55000, and 2 critical criteria were then identified through interviewing oil and gas experts. The approach of this research is quantitative, and the method of data collection is descriptive-survey. Uptime, Institute of Asset Management (IAM), life cycle engineering (LCE), and asset integrity management (AIM) models are the main popular and/or reference physical asset management excellence models in the world. The finding shows that the IAM, LCE, AIM, and uptime models are respectively prioritized based on these critical criteria.

1. Introduction

In 1976, the Alpha Platform was deployed at PIPER's Oilfield in the North Sea as one of the largest offshore platforms in the world at that time. A sudden explosion on 6 July 1988 led to capsizing the platform and to the death of 167 operational personnel at an estimated cost of $4 billion. The Alpha catastrophe started with a preventive maintenance activity, and afterwards, a committee was set up to investigate the causes of this incident. Three errors, namely design error, human error, and system error, were reported as the causes of this tragedy by this committee. All these errors relate to the platform's lifecycle and show that asset lifecycle management is an important approach to obtaining the maximum values from physical asset (A. Schuman, Charles, 2015). Ultimately, this catastrophe led to the emerge of physical asset management which was derived from the name of catastrophe assessment committee (Explosion on North Sea oil rig, 2018).

After several years of research by IAM[1], finally the BSI- PAS55[2] standard for the asset management was published in 2004. IAM, through receiving feedback

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[1] British Institute of Asset Management (IAM)
[2] British Standard Institute- Publicly Available Spesification 55 (BSI-PAS55)

from industries, upgraded its old version in 2008 after four years. A little later in 2014, the International Organization for Standardization published ISO-55000 standard as the International standard for asset management (PAS55-1, 2015). It should be noted that the ISO-55000 standard is taken from the PAS55 standard. A study shows that the difference between these two standards is less than 10% (A.F.van den Honert, J.S. Schoeman, and P.J. Vlok, 2015). Based on ISO-55000 standard definition, the coordinated activity of an organization to realize value from assets, is called PAM[3] , and the set of interrelated or interacting elements to establish asset management policies, asset management objectives, and processes to achieve those objectives is called PAMS[4] as illustrated in Figure-1 (ISO-55000, 2014). The key message of the ISO-55000 standard is the integrated management of all environmental risks over the equipment and management of all equipment risks over the environment in the four life cycle phases of a physical asset (Wilandri Basson, P.J. Vlok, and J.L. Jooste, 2016).

Accordingly, the life cycle of the physical asset is classified into four periods, including acquisition period, operating period, maintenance period, and disposals period (Canada Correctional service, 2018).

Excellence models are a systematic method of strengthening and developing process or managerial systems (Robin Mann, Musli Mohammad, Ma Theresa A. Agustin, 2010). Hence, AMEM[5] is a systematic method for strengthening and developing the PAM to realize values through the physical asset (Asset Management Center, 2011).ISO-55000 standard has emphasized the PAM requirements but has not mentioned anything about the procedure (PAS55-1-2008, 2015). In other words, this standard talked about "what to do", but it did not mention anything about "how to do" (see ISO-5500 collection, 2018). Therefore, various AMEM models have been designed and presented to industries for "how to do" around the world. The most common, popular, and sometime reference models are Uptime model in Canada by Campbell, IAM model in England by John Woodhouse, LCE[6] model by Life Cycle Engineering Ltd. in the United States, and AIM[7] model in the UK (Examining several examples of physical asset management models, 2018). These four models claim to have the ability to develop PAM based on ISO-55000.

Due to the variety of AMEM models at a world class level, choosing one will create confusion for asset managers in an organization. On the other hand, based on this fact that organizations compete for resources and markets, they must somehow assess the results of their decisions and selection (Alexander Veronese Bents, Jorge Carneir, Jorge Ferreira da Silva, 2011). Accordingly, evaluating and prioritizing these models from critical criteria aspects is an issue for asset managers. This is the main problem which researchers like to solve.

In this work, DEMATEL and ANP techniques are used for the assessment of the criteria and options. DEMATEL and ANP methods have the ability to measure the size and direct impact of the criteria on each other (Sheng-Li Si, Xiao-Yue You, Hu-Chen Liu, and Ping Zhang, 2018). Because the criteria are interdependent, it is necessary to use DEMATEL technique to determine the direction of dependency and to measure the weight of each criterion (Octavian A, Sumantri S.H, Ahmadi, 2017). On the other hand, ANP technique is used to prioritize AMEM based on a combination of six critical criteria.

To recognize the critical criteria, as shown in Figure 2, the development of the organizations in ISO-55000 standard at 4 levels through setting goals at the corporate level; managing asset portfolio through investment, compliance, and sustainability; managing asset system through risk, cost, and performance; and managing individual assets over their lifecycle through efficiency and effectiveness has been conducted.

Figure 1: Definition of asset management and system based on ISO55000 (ISO-55000, 2014)

Figure 2: 6 criteria for the asset management in hierarchy of asset within an organization (Asset Management an Anatomy, 2015)

[3] Physical Asset Management (PAM)
[4] Physical Asset Management System (PAMS)
[5] Asset Management Excellence Model(AMEM)
[6] Life Cycle Engineering(LCE)
[7] Asset Integrity Management(AIM)

This is a new approach to managing physical assets (IAM asset management an anatomy, 2015). Based on this explanation, 4 critical criteria of cost, risk, performance, and sustainability have been taken from ISO-55000 standard according to Figure 2. Because compliance criterion is related to the steps after the selection of AMEM, it was deleted from the list of criteria for AMEM evaluation. Next, 2 criteria were identified through interviewing oil and gas experts. As it is evident, a large number of criteria can be employed to assess a model. However, the three issues of simplicity of the model, knowledge of the model, and a number of documentary criteria needed for evaluation and selection are important. To evaluate AMEM models based on a limited number of criteria, to reduce the complexity of the problem, and to enhance the effectiveness of these criteria, ISO-55000 documents and industry experts' interviews were used in this approach. Concerning the selection of interviewees, 2 issues were addressed. First, the experts should have been involved in the processes of four lifecycles of physical assets. Moreover, these people should also have a high profile in the management of equipment and installations. These issues have resulted in a maximum sample size of ten people. Also, to explain the criteria selection in detail, ISO 55000 states that asset management is based on four fundamentals of value, alignment, leadership, and assurance (ISO-55000, 2014). Assets have an actual or potential value to an organization, and the values of an organization are part of its operating context and act as constraints on or enablers for its activities.

Although individual assets can contribute value to an organization, when they are usually connected together as an asset system or a larger entity, they generate value for an organization. Figure 2 illustrates the contributions to value typically made at various levels of an asset hierarchy. Therefore, values at an asset portfolio level are investment, compliance, and sustainability, and values in an asset system are performance, cost, and risk; in individual, assets over their life cycle are efficiency and effectiveness. With this description, the critical criteria at three levels of PAM consisting of individual asset, asset system, and asset portfolio are cost, risk, performance, sustainability, which are directly related to PAM development (Asset Management an anatomy, 2015). Next other criteria, as displayed in Figure 2, are related to the period after the selection of AMEM, so they are deleted.

In the current work, the main objective is evaluating and prioritizing AMEM based on the six critical criteria through DEMATEL and ANP techniques. The second goal of this study is to identify the capabilities of the four above models in each of the critical criteria alone. Why are some organizations more sensitive to some of these criteria sometime? For example, oil and gas production units are more sensitive to the risk. Thus, based on the research issue and the research objectives, the following are research questions and should be answered.

1- What is the AMEM prioritization based on six critical criteria?

2- What is the priority of the Uptime, IAM, LCE, and AIM models based on each of the cost, risk, performance, sustainability, simplicity, and knowledge criteria?

2. Research Literature

In 1994, Campbell and his Colleagues presented Uptime maintenance management excellence pyramid. This model, according Figure 1, is designated in 4 subjects and ten activates. Four subjects and 10 activities are considered to evaluate the maturity level of maintenance management in this model. The main subjects include leadership, control, continuous improvement, and quantum leaps. The main activities of the Uptime model are designed in ten groups. Each activity is assessed by a researcher-centered questionnaire (John D. Campbell, Andrew K. S. Jordin Joel McGlynn, 2015). A remarkable point in this model is the model approach. Uptime model approach is maintenance management and focuses on one of four

Figure 3: Uptime maintenance management excellence pyramid (John D. Campbell, Andrew K. S. Jordin Joel McGlynn, 2015)

Figure 4: IAM asset management excellence model (AMCL Ltd., 2016)

life cycles of physical assets. However, an important part of the ISO-55000 requirements in the acquisition, utilization, and disposal period has not been addressed.

In 2004, IAM presented AMEM model in 6 main subjects according to Figure 5. IAM model includes strategy and planning; asset management decision-making; asset lifecycle delivery; asset information enabler; organization and people enabler; and risk and review. The IAM Institute's AMEM is based on PAS55 standard, which was originally developed with 23 activities; after being reviewed in 2008, PAS55 standard was designed with 39 activities; these 39 activities are considered as PAM enablers. These enablers are defined at 5 levels of maturity. The IAM model is known as the reference model for PAM worldwide. ISO 55000 standard is written in accordance with PAS55 standard. It should also be noted that this model covered all the periods of the lifecycle physical asset (AMCL Ltd., 2016).

From South Carolina, Life Cycle Engineering Company has been engaged in a reliability engineering approach in the United States for more than three decades. The LCE model has been designed and developed business processes at five levels, including principles, organizational culture, management processes, optimization, and sustainable states as shown in Figure 6 according ISO-55000 requirement. This model begins at the first level with two activities, including commitment management and functional partnership. The second level consists of 6 activities, including administrative principles; goals; organizational structure; budgeting and cost control; health and safety; and manpower management.

The third level includes 8 activities in maintenance operations, and the fourth level has 7 activities in the field of optimization and methods; finally, the fifth level is composed of 6 activities in the field of sustainable states according to Figure 6. In general, the focus of the LCE model is on reliability engineering, lifecycle management, and sustainability, and it has 27 activities (The Reliability Excellence Model, 2018).

Based on the classical engineering approach, reliability is defined as the ability of a system to perform the tasks required under specified conditions for a specified period of time. Accordingly, a more comprehensive view is required to achieve a level of excellence. To this end, the traditional reliability of physical assets obtained through maintenance management should be expanded through increased business reliability, the reliability of work processes, and employee's empowerment. Effective leadership and change management support these three basic concepts (Risk Management and Assessment for business, 2018). These three basic concepts are evident in the design of this model.

In 2006, AIMS has been developed in the UK under the name of asset integrity management house. In this plan, the asset integrity management house is considered in three subjects and 12 activities. The second subject dealing with integrity, reliability, and process safety assessment includes integrity assessment; risk and reliability management; process hazard analysis; and safety case analysis. The third subjects called performance assurance include maintenance; inspection; testing and data analysis; and performance improvement, and are generally developed under the title of asset integrity management house, as displayed in Figure 7.

The first topic is divided into four activities consisting of asset integrity philosophy; asset integrity management system; process safety management system; and monitoring, auditing, and management. The AIM system was deployed to increase the safety and efficiency of equipment through the integration of technical systems in the organization (TUV Rhineland Group, Risktec Solutions, 2018).

In 2018, an investigation was conducted on a hybrid model for selecting the best project manager by Ekhtiar Khodadadi and his colleagues. Choosing the best executives from several suggested alternatives is one of

Figure 5: LCE asset management excellence model (The Reliability Excellence Model, 2018)

Figure 6: AIMS excellence model (TUV Rhineland Group, Risktec Solutions, 2018)

the key factors in project success. The act of choosing a department depends on a number of parameters including qualitative and quantitative criteria which may be ambiguous or create conflict. Therefore, the complexity and importance of the problem require to use analytical methods rather than intuitive decisions (Ekhtiar Khodadadi, Mehdi Aghabeigi, 2018).

Another research entitled "Supplier Evaluation and Selection in Fuzzy Environments: A Review of MADM Approaches" was conducted by Mehdi Keshavarz Ghorabaee and his colleagues in 2017. They reported that the AHP and TOPSIS methods are the most popular approaches (Mehdi Keshavarz Ghorabaee, Maghsoud Amiri, Edmundas Kazimieras, 2017).

Another work entitled "Building Criteria for Evaluating Green Project Management: An Integrated Approach of DEMATEL and ANP" was performed at the Department of Business Administration in Tung Hai University in 2017. The empirical results show the interrelationship structure and the priority of each dimension and each criterion in a green project management. The findings of this study provide important implications for both managers and academic researchers (Ying-Chyi Chou, Chia-Han Yang, Ching-Hua Lu, Van Thac Dang, 2017).

The application of multi-criteria decision-making methodology to taking decision was also studied in

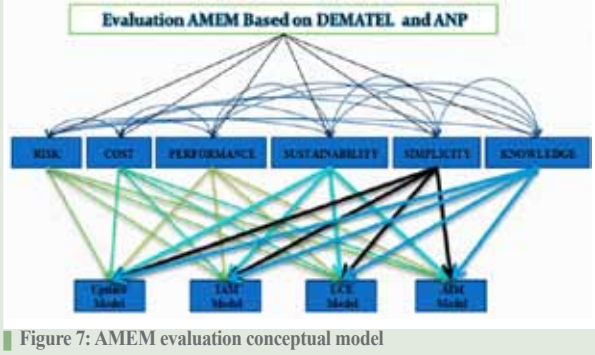

Figure 7: AMEM evaluation conceptual model

Table 1- The steps of DEMATEL and ANP method

Row	Model	Activities
1	DEMATEL Technique	1- Prepare the list of criteria
		2- Direction relation matrix
		3- Normalized relation matrix
		4- Total relation matrix
		5- Create R,J and R+J, R-J vector
2	ANP Technique	1- Al-SAATI linguistic spectrum table
		2- Creating pair-wise comparison matrix
		3- Calculate the inconsistency rate
		4- Creating super normalized matrix

2016. In multi-criteria decision-making methodology, the material ranking method (called VIKOR) was introduced as an applicable method for implementation in MCDM; it was designed to optimize multi-purpose complex systems. However, few articles on contradictory (competitive) criteria are discussed with affiliation to and feedback on the compromise solution method. Therefore, this study proposes and presents applications of a new model using the VIKOR-based DEMATEL and ANP techniques to solve the problem of conflicting metrics with dependency and feedback. An example is also presented to illustrate the application of the proposed method. The results show that the proposed method is appropriate and effective in real world programs (Elena ROKOU, Konstantinos Kirytopolos and Dimitra Voulgaridou, 2016).

A work entitled "Evaluation of the Importance of 39 Subjects Defined by the Global Forum for Maintenance and Asset Management" was carried out at the Department of Engineering and Technology Management of University of Pretoria, South Africa in 2015. The results of the survey indicated that the five most important subjects are asset management strategy and objectives; asset management policy; strategic planning; asset management planning; and asset management leadership from 39 subjects (J.K. Visser, T.A. Botha, 2015).

Ozer Uygun and his colleagues studied "An Integrated DEMATEL and Fuzzy ANP Techniques for Evaluation and Selection of Outsourcing Provider for a Telecommunication Company" at Zakary University, Turkey in 2015. The methodology was proposed for outsourcing provider selection and achieved useful results. First, DEMATEL method was used in order to suggest the interrelationship among the main criteria for the outsourcing selection process as determined in the study. Then, the local weights of the sub-criteria and sub-sub-criteria were calculated by fuzzy ANP approach on the basis of cause-effect relationships obtained by DEMATEL method (Ozer Uygun, Hassan Kacamak, Unal Ataken, 2015).

Another work titled "Applying DEMATEL-ANP to Assessing Organizational Information System Development Decision" was done in 2013. More and more enterprises expect to improve operating efficiency and managerial decision-making effectiveness by introducing information systems into the operational procedures. The results showed that companies with limited resources prefer to choose an outsourcing implementation model in order to save labor, cost, and time, while insuring the stability of the system

after implementation. Consequently, the competitive advantages of sustainable operation can be enhanced (Kuang-Husn Shih, Wan-Rung Lin, Yi-Hsien Wang, Tzu-En Hung, 2013).

In 2013, Yu-PingOu Yang and his colleagues studied the evaluation of information security management and presented a risk assessment model for information security control, which can improve the security of information for companies and organizations. A MCDM model was proposed combining VIKOR, DEMATEL, and ANP techniques. In this research, evaluation criteria have a significant relationship, and, to demonstrate the proposed method, an empirical method is used to evaluate risk controls. The results state that the proposed method can help information technology (IT) managers to validate the effectiveness of risk control (Yu-PingOu Yang, How-MingShieh, Gwo-HshiungTzeng, 2013).

Based on the explanation in literature review, a conceptual model for this research is according to what is presented in Figure 8. As mentioned in problem statement, we have 6 critical criteria and 4 options in this evaluation process. Hence, the criteria are interrelated and linked to options. A conceptual model according to Figure 8 is designed for this meaningful relation.

It should be noted that, due to the relationship between the criteria, their weights should be calculated by DEMATEL method. Furthermore, because of the relationship between the options, ANP model is employed to rank them. As a result, we cannot use AHP model.

Table 2- DEMETEL and linguistic phrase

Linguistic Phrase	Definite Numbers
Extremely effective	4
Highly effective	3
Effective	2
Almost effective	1
Ineffective	0

3. Research Method

This research is practical in terms of purpose, and, in terms of data collection method, it is a descriptive survey. In this work, the structure of excellence models is examined through documentary studies. The excellence models mentioned herein are evaluated based on six strategic criteria outlined in ISO-55000 and according to the interview with 10 experts in oil and gas industry. As it is predictable by intuition, these criteria are not independent and they interrelate. Hence, from DEMATEL5-degree method is used to determine the weight of each criteria and to detect the cause and

Table 3- Direct relation matrix/ DEMATEL

Criteria i/j	Cost	Risk	Performance	Sustainability	Simplicity	Knowledge	Sum
Cost	0	1	1	2.3	1	1	6.3
Risk	3.79	0	3.55	2.44	1	1	11.78
Performance	3.23	3.21	0	1	1	1	9.44
Sustainability	3.21	2.87	1.45	0	1	1	9.53
Simplicity	3.78	3.21	1	1	0	3.11	12.1
Knowledge	2.89	2.48	3.21	3.11	1.59	0	13.28
SUM	16.9	12.77	10.21	9.85	5.59	7.11	

Table 4- Direct relation matrix/ DEMATEL

Criteria i/j	Cost	Risk	Performance	Sustainability	Simplicity	Knowledge
Cost	0.00	0.08	0.10	0.23	0.18	0.14
Risk	0.22	0.00	0.35	0.25	0.18	0.14
Performance	0.19	0.25	0.00	0.10	0.18	0.14
Sustainability	0.19	0.22	0.14	0.00	0.18	0.14
Simplicity	0.22	0.25	0.10	0.10	0.00	0.44
Knowledge	0.17	0.19	0.31	0.32	0.28	0.00

effect criteria. In order to evaluate the relationship between the criteria and their relative weight according DEMATEL method, a pair-wise comparison matrix is required (Sheng-Li Si, Xiao-Yue You, Hu-Chen Liu, and Ping Zhang, 2018).

These criteria will be compared by employing 10 experts in Iran oil and gas industry. The main reason for the limitation to the number of interviewees is the lack of experts in the field of physical asset management. The main indicators of the interviewees in this study are an experience of more than 25 years in the oil industry and familiarity with oil and gas repair and maintenance systems. Therefore, after identifying the relationships between the criteria by DEMATEL technique, ANP model is used to prioritize options based on these criteria.

The reason that ANP technique is used instead of AHP is the direct relationships between the options; in fact, AHP model is used for a one-way hierarchical state (Fikret K. Turan, Natalie M. Scala, Mary Besterfield-Sacre, 2009). The pair-wise comparison matrix of criteria and options are prepared through a questionnaire. The size of the sample is 10 experts in the physical asset management of the oil and gas industry according DEMATEL interviewees.

Based on the structure of DEMETL and ANP techniques, the related activities are done in accordance with Table 1.

Al-Sati linguistic spectrum table of the pair-wise comparisons between the criteria, the linguistic phrase table, and the definite numbers are defined according to Table 2.

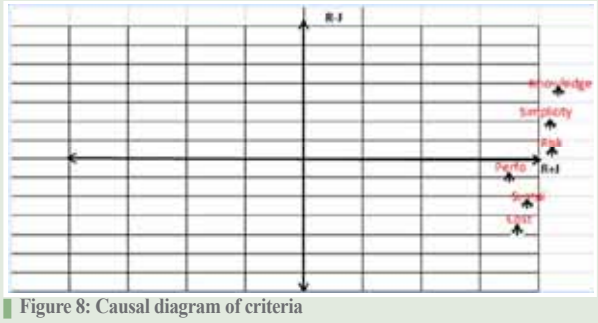

Figure 8: Causal diagram of criteria

4. Research Findings

According to Table 1, the following activities will be done in order to evaluate the excellence models in 7 steps, according to the following tables. The first and sixth steps are presented in the research method; thus, here, we start from the third step.

Direction Relation Matrix: The numbers in Table 3 are calculated based on geometric mean of questionnaire responses from 10 oil and gas industry experts interviewed to examine the relationship between the criteria.

Normalized Direct Relation Matrix: The normalized direct-relation matrix is obtained by dividing all the elements of the direct relation matrix to the sum of each

Table 5- Direct relation matrix/ DEMATEL

Criteria i/j	Cost	Risk	Performance	Sustainability	Simplicity	Knowledge	R
Cost	1.07	1.05	0.93	1.18	0.96	1.01	4.03
Risk	1.87	1.54	1.63	1.74	1.40	1.52	7.43
Performance	1.45	1.40	1.01	1.27	1.11	1.18	5.76
Sustainability	1.45	1.38	1.14	1.18	1.11	1.19	5.89
Simplicity	1.88	1.76	1.43	1.64	1.26	1.77	7.5
Knowledge	2.00	1.87	1.73	1.96	1.61	1.54	8.21
J	7.66	6.95	6.04	6.74	5.40	6.03	

Table 6- R, J, R+J, and R-J Vectors/DEMATEL

Criteria i/j	Cost	Risk	Performance	Sustainability	Simplicity	Knowledge
R	4.03	7.43	5.76	5.89	7.5	8.21
J	7.66	6.95	6.04	6.74	5.40	6.03
R+J	11.69	14.38	11.80	12.63	12.90	14.24
R-J	-3.63	0.48	-0.28	-0.85	2.10	2.18

Table 7- Primary super matrix

(I/J)	Cost	Risk	Performance	Sustainability	Simplicity	Knowledge	Sum	Normalized	Max
Cost	0.00	0.04	0.05	0.12	0.07	0.06	0.34	0.11	0.12
Risk	0.14	0.00	0.17	0.12	0.07	0.06	0.56	0.19	0.17
Performance	0.12	0.14	0.00	0.05	0.07	0.06	0.44	0.15	0.14
Sustain	0.12	0.12	0.07	0.00	0.07	0.06	0.44	0.15	0.12
Simplicity	0.14	0.14	0.05	0.05	0.00	0.17	0.55	0.19	0.17
Knowledge	0.10	0.11	0.15	0.16	0.11	0.00	0.63	0.21	0.16
Uptime	0.09	0.06	0.16	0.06	0.09	0.10	0.56	0.18	0.16
IAM	0.12	0.17	0.17	0.19	0.23	0.20	1.14	0.36	0.23
LCE	0.10	0.11	0.10	0.13	0.16	0.16	0.76	0.24	0.16
AIM	0.08	0.10	0.09	0.12	0.14	0.15	0.68	0.22	0.15

column according to Table 4.

Total Relation Matrix: It is calculated by equation N $(I-N)^{-1}$ according to Table 5.

Measuring the R, J, R+J, and R-J Vectors

✓ If R>J, Then R-J>0 and the factor is a definitive influence and is considered as a causative variable.

✓ If R<J Then R-J<0 and the factor is definitive and is considered to be an impacted variable.

Therefore, the causal diagram can be obtained by plotting the ordered pairs (R+J, R-J) and is valuable for decision making, as displayed in Figure 8.

Therefore, according to the diagram illustrated in Figure 8, the risk, simplicity, and knowledge criteria are the causative ones in the model, and the performance, sustainability, and cost are the effective criteria in this evaluation based on DEMATEL method. In other words, the analysis of DEMATEL method in the current study states that the cost, sustainability, and performance are cause variables, and knowledge, simplicity, and risk are effect variables in this evaluation. As also listed in Table 4, the cost, risk, performance, sustainability, simplicity, and knowledge criteria respectively have a weight of 12%, 19%, 14%, 15%, 19%, and 21%. Thus, as one of the important findings of this work, we confirm that knowledge has the highest impact and cost has the lowest impact on ranking asset management excellence model in oil and gas industries.

5. Creating Pair-Wise Comparison Matrix/ANP

In order to provide a pair-wise comparison matrix in ANP model, a questionnaire was designed which took into account the relationships of all the variables in the system. The relationship between the criteria was obtained from the DEMATEL questionnaire. At this point, the relations extracted in the DEMATEL phase are considered based on Table 7. The inconsistency coefficient is calculated as 0.04, which is smaller than 0.1, so the consistency survey is acceptable.

6. Primary Super Matrix

In reply to the first research question, as shown in Table 8, the ranking of AMEM models based on the calculation by ANP model are respectively IAM with a relative importance of 36%, LCE with a relative importance of 26%, AIM with a relative importance of 22%, and Uptime with a relative importance of 18%. Moreover, in answer to the second research question, Uptime with the greatest impact on performance, IAM with the greatest impact on simplicity, LCE with the greatest impact on knowledge, and AIM with the greatest impact on knowledge have the greatest impact on the criteria and are sensitive to them.

7. Conclusion

The aim of this work is evaluating and prioritizing asset management excellence models according to critical criteria based on DEMATEL and ANP multi-criteria decision-making techniques. The critical criteria consist of cost, risk, performance, sustainability, simplicity, and knowledge. The first four criteria are directly chosen based on ISO-55000 requirements, and the last two ones are selected according to the interview with oil and gas experts.

In response to the first question, according to Table 7, IAM with a coefficient of 36%, LCE with a coefficient of 24%, AIM with a coefficient of 22%, and Uptime with a coefficient of 18% are respectively prioritized based on the critical criteria. In reply to the second question, IAM, AIM, LCE, and Uptime models are respectively most sensitive to simplicity, knowledge, knowledge, and performance criteria.

According to Table 7, cost criteria affecting risk by 4%, performance by 5%, sustainability by 12%, simplicity by 7%, knowledge by 6%, and the system by a total of 11% is the one of the least effective criteria. However, knowledge criteria affecting cost by 10%, risk by 11%, performance by 15%, sustainability by 16%, simplicity by 11%, and the system by a total of 21% is the one of the most effective criteria.

Nowadays, equipment-based industries, such as oil and gas industry, need to use modern production support systems to create value for the stakeholders. Selection of support systems has become a major challenge for executives due to their diversity. One of the most important production support systems is the physical asset management system with a lifecycle management approach. Since the ISO Organization has published general standards for the physical assets management development in 2014, various executive models have been designed and introduced to the industries. Choosing the excellence model to develop and strengthen the physical asset management is one of the most important decisions managers face.

In the current work, a hybrid decision-making method based on DEMATEL and ANP techniques is presented to evaluate and prioritize the excellence models. These models, which are widely used in industries, consist of Uptime, IAM, LCE, and AIM. Therefore, where these six critical criteria are top priority for an organization, it can use the related models based on the available funds to manage its physical assets.

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بررسی تأثیر سیاست مالیات زیست محیطی بر رفتار سرمایه گذاران در انرژی های تجدید پذیر با استفاده از رویکرد داده های تلفیقی پویا

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چکیده

گسترش مصرف انرژی های تجدیدپذیر به عنوان یک اصل مهم برای دستیابی به سیاست‌های زیست‌محیطی در جهان تبدیل شده است. در حال حاضر، سوخت های فسیلی با شدت انتشار کربن بالا، بیشترین سهم از سبد انرژی جهان را به خود اختصاص داده است. بنابراین، ایجاد انگیزه در سرمایه گذاران به منظور افزایش سرمایه گذاری در بخش انرژی های تجدیدپذیر در راستای حرکت به سمت اقتصاد کم کربن امری ضروری است. از این رو، پیاده سازی سیاست‌هایی هم‌چون اعمال مالیات بر روی مصرف انرژی های فسیلی و نیز استفاده از وسایل نقلیه می تواند راه‌گشا باشد. این مقاله به بررسی تاثیر سیاست های مالیاتی زیست محیطی بر روی رفتار سرمایه گذاران در بخش انرژی های تجدید پذیر برای ۱۳ کشور منتخب توسعه یافته و در حال توسعه در بازه ی زمانی سال های ۲۰۰۴ تا ۲۰۱۶ می پردازد. براساس تئوری اقتصادی، بازگشت سرمایه برای سرمایه گذاری در صنایع انرژی سرمایه بر طولانی مدت می باشد. تحقیق حاضر به منظور در نظر گرفتن این ویژگی و ارزیابی روابط پویای سرمایه گذاری در بخش انرژی های تجدیدپذیر، از مدل تعدیل جزیی پویای بهره گرفته و مدل مزبور را باروش گشتاورهای تعمیم یافته برآورد نموده است. نتایج این مطالعه نشان می دهد که اعمال مالیات بر روی مصرف انرژی سوختهای فیسلی و نیز استفاده از وسایل نقلیه با سوخت های فسیلی، به ترتیب اثرات منفی و مثبت معناداری بر سرمایه گذاری در بخش انرژی تجدیدپذیر به همراه داشته است. علاوه بر این، نتایج تجربی تحقیق بیانگر آنست که رابطه منفی و معنی داری میان نرخ بهره و سرمایه گذاری در بخش انرژی های تجدیدپذیر مشاهده می گردد.

اطلاعات مقاله

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شناسایی و اولویت بندی ابعاد و مؤلفه های تأثیرگذار بر ارزش گذاری منابع انسانی (مطالعه موردی: شرکت ملی نفت ایران و شرکتهای تابعه آن)

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چکیده

هدف این تحقیق که در سالهای ۱۳۹۶ و ۱۳۹۷ انجام شد، شناسایی و اولویت بندی عوامل کیفی و کمی تأثیرگذار بر ارزش گذاری منابع انسانی در شرکت ملی نفت ایران و شرکتهای تابعه آن می‌باشد. با استفاده از روش نمونه گیری گلوله برفی یا زنجیره ای، ۲۸ نفر خبره از بین روسای منابع انسانی، مالی و برخی از کارکنان متخصص شرکت ملی نفت ایران و شرکتهای تابعه آن انتخاب شد. به منظور شناسایی ابعاد و مؤلفه های تأثیرگذار بر ارزش گذاری منابع انسانی، مرور جامع ادبیات تحقیق در سطوح بین المللی و ملی، مصاحبه با افراد خبره و سه مرحله توزیع و جمع آوری پرسشنامه با استفاده از روش دلفی فازی صورت گرفت. سپس دو مرحله پرسشنامه مقایسه زوجی مربوط به روش دیمتل فازی جهت تبیین و ارزیابی روابط علت و معلولی میان ابعاد با یکدیگر و مؤلفه ها با یکدیگر تدوین و در اختیار خبرگان قرار داده شد. مؤلفه ها و ابعاد مشخص شده با استفاده از روش دیمتل فازی، اولویت بندی شدند. با استفاده از روش دلفی فازی، ۱۵ بعد و ۱۰۱ مؤلفه مؤثر بر ارزش گذاری منابع انسانی در شرکت ملی نفت ایران و شرکتهای تابعه آن شناسایی شد. با توجه به اصل ۲۰-۸۰ پارتو، ۲۰ مؤلفه به عنوان مؤلفه های تأثیرگذار بر ارزش گذاری منابع انسانی در شرکت ملی نفت ایران و شرکتهای تابعه تعیین شد. با استفاده از روش دیمتل فازی، ۱۵ بعد و ۲۰ مؤلفه مشخص شده اولویت بندی شدند. مطابق نتایج به دست آمده در این تحقیق، مهم ترین بعد و مؤلفه تأثیرگذار بر ارزش گذاری منابع انسانی در شرکت ملی نفت ایران و شرکتهای تابعه آن به ترتیب رضایت شغلی و انگیزه و مداومت در انجام تکالیف کارکنان است.

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ارزش گذاری، شرکت ملی نفت ایران و شرکتهای تابعه آن، دلفی فازی، دیمتل فازی، منابع انسانی

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یک روشی ترکیبی سوییِنگ تاپسیس فازی: کاربردی در رتبه بندی تامین کنندگان در شرکت مهندسی و ساخت تاسیسات دریایی ایران

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چکیده

بـه دلیل ایـن که بخش بزرگی از پروژه های نفت و گاز، مشـتمل بر مبحـث زنجیره تامین می باشـند، انتخاب پیمانکاران و تامین کنندگان بسـیار حایز اهمیت است. در محیط پروژه ها، پیمانـکاران باید کالاهای مورد نیاز خود را از تامین کنندگان و تولیدکنندگانی دریافت نمایند که مورد تایید کارفرما باشـند. این در حالی اسـت که خیلی از شـرکت های ایرانی، از جمله شرکت مهندسی و ساخت تاسیسـات دریایی ایران (IOEC)، رویکرد مشخصی برای پایبندی به این موضوع ندارند. لذا هدف مهم این تحقیق عبارت اسـت از تمهید یک رویه مشـخص و عملیاتی به منظور رتبه بندی تامین کنندگان و پیمانکاران و انتخاب بهترین گزینه در شـرکت IOEC. بـه منظـور نیل به این هدف، یک روش ترکیبی مبتنی بر تاپسـیس فازی و سـوییِنگ طراحی گشـته و در نمونه واقعی استفاده شده اسـت. داده های واقعی دریافت شده از خبرگان مربوط به مساحی بعد از نصب و خطوط لوله داخلی میدان در فازهای ۱۳، ۱۴ و ۲۲ طرح توسعه پارس جنوبی می باشند.

اطلاعات مقاله

تاریخ ارسال: ۱۸ خرداد ۱۳۹۷
تاریخ اصلاح: ۷ مرداد ۱۳۹۷
تاریخ پذیرش: ۲۵ مرداد ۱۳۹۷

واژگان کلیدی:
انتخاب تامیـن کننـدگان، تصمیم گیری چندمعیاره، نفت و گاز، IOEC، تاپسیس، فاز، خطوط لوله.

نقش تعدیل‌کنندگی ارزش شرکت و نقدشوندگی بر رابطه بیش‌اطمینانی مدیریت و مخارج تحقیق و توسعه

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چکیده

مدیـران بیش‌اطمینان که اعتماد بیش از اندازه به تواناییهـای خود دارند، احتمال وقوع و اثر نتایج نامطلوب حاصل از پروژه های سـرمایه گـذاری را کمتر از واقع برآورد می‌کنند. هدف این مقاله بررسـی اثر بیش‌اطمینانی مدیریت بر مخارج تحقیق و توسعه و نقش تعدیل‌کنندگی ارزش شـرکت و نقدشوندگی سهام روی این رابطه اسـت. برای این منظور ۵۱ شرکت از بین شرکتهای نفت، گاز و پتروشیمی پذیرفته شده در بورس اوراق بهادار تهران برای سالهای ۱۳۹۱ تا ۱۳۹۶ انتخاب شدند. پژوهش حاضر در قالب سه فرضیه و با استفاده از نرم افزار ایویوز نشان داد که بیش‌اطمینانی مدیریت اثر مثبت بر مخارج تحقیق و توسعه دارد. بعلاوه نقدشوندگی اثر مثبت بر رابطه بیش اطمینانی و مخارج تحقیق و توسعه داشته اما ارزش شرکت اثر معناداری بر رابطه مذکور ندارد.

اطلاعات مقاله

تاریخ ارسال: ۱۳ خرداد ۱۳۹۷
تاریخ اصلاح: ۱۱ مرداد ۱۳۹۷
تاریخ پذیرش: ۱۰ شهریور ۱۳۹۷

واژگان کلیدی:
بیش‌اطمینانی مدیریـت، مخارج تحقیق و توسعه، نقدشوندگی، ارزش شرکت

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الگوی فازی اندازه گیری همسویی استراتژی‌های سازمانی (مورد: پروژه های پارس جنوبی صنعت نفت ایران)

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چکیده

هدف از ارائه این مقاله کمک به مجموعه مدیران حوزه نفت و گاز بوده تا از طریق ایجاد همسویی در هر سطح از سطوح مدیریت استراتژیک بتوانند با هماهنگی و هم‌افزایی بین این سطوح، عملکرد سازمانی را بهبود بخشند. روش تحقیق مورد استفاده در این مقاله مبتنی بر مطالعه موردی بوده و مورد بررسی پروژه های نفت و گاز منطقه پارس جنوبی ایران می‌باشد. این تحقیق در حوزه ساختارگرایی اجتماعی قابلیت طبقه بندی دارد. این تحقیق توصیفی، کیفی و توسعه‌ای است زیرا از تئوری مجموعه‌های فازی در اندازه گیری های متغییرهای سازمانی بهره برده شده است. مدلی که در این مقاله ارائه شده، یک الگوی جامع از منظر رویکردهای سیستماتیک، فرآیندی و علمی به مدیریت بوده و هدف اصلی این مدل ایجاد همسویی در استراتژی‌های سازمانی در پروژه‌های پارس جنوبی می‌باشد. این مهم به خوبی در شرایط غیر عادی محیطی یعنی شرایط تحریم توسط شرکت نفت و گاز پارس انجام شده است. جامعه آماری این تحقیق شامل مدیران ارشد سازمان و طرح‌ها که پنج سال یا بیشتر بطور متوالی در پروژه‌های پارس جنوبی تجربه داشته‌اند، بوده است. از آنجا که تعداد این مدیران ۴۳ نفر بود، امکان جمع آوری داده‌ها مبتنی بر نمونه آماری نبود. نتایج پژوهش نشان می دهد که با افزایش همسویی استراتژیک در بین کارکردهای مختلف استراتژی، ساختار، منابع انسانی و فناوری سطح عملکرد سازمان افزایش می‌یابد و همچنین، مدل فازی همسویی استراتژیک تبیین بهتری از واقعیت را نشان می‌دهد.

اطلاعات مقاله

تاریخ ارسال: ۱۴خرداد ۱۳۹۷
تاریخ اصلاح: ۲۸ مرداد ۱۳۹۷
تاریخ پذیرش: ۶ شهریور ۱۳۹۷

واژگان کلیدی:

همسویی استراتژیک، منطق فازی، نقاط مرجع استراتژیک کمی، عملکرد سازمانی

ارزیابی و اولویت‌بندی مدل‌های تعالی مدیریت دارایی فیزیکی براساس معیارهای بحرانی با استفاده از ترکیب تکنیک‌های دی متل و ای‌ان‌پی

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چکیده

امروزه برای مدیریت صنایع مبتنی بر تجهیزات مانند صنایع نفت و گاز ، شایع ترین مسئله به طور کلی در جهان و به ویژه در ایران، توسعه مدیریت دارایی فیزیکی بر اساس الزامات ISO-55000 است. از آنجایی که این استاندارد فقط الزامات را بیان می کند، تعداد زیادی مدل‌های اجرایی برای مدل تعالی مدیریت دارایی فیزیکی که برای تقویت و توسعه مدیریت دارایی فیزیکی است، توسط محققان یا مؤسسات علمی تحقیقاتی در سراسر جهان طراحی شده است. بنابراین، با توجه به تعدد و تنوع مدل‌ها، سازمان‌ها برای انتخاب مدل مناسب با مشکل روبرو هستند. با توجه به این موضوع، هدف اصلی این تحقیق ارزیابی و اولویت‌بندی مدل‌های تعالی مدیریت دارایی فیزیکی براساس ۶ معیار مهم از طریق تکنیک‌های DEMATEL و ANP است. هزینه، ریسک، راندمان، پایداری، سادگی و دانش به عنوان معیارهای مهم جهت ارزیابی مدل‌ها شناسایی شدند. ۴ معیار اول از ISO-55000 گرفته شده و ۲ معیار آخر نیز از طریق مصاحبه با کارشناسان نفت و گاز مشخص شده است. این پژوهش کمی است و روش گردآوری داده ها از نوع توصیفی - پیمایشی می‌باشد. مدل‌های LCE، IAM، Uptime و AIM پرکاربردترین و بعضا مدل‌های مرجع مدل تعالی مدیریت دارایی فیزیکی در دنیا هستند. یافته‌های تحقیق نشان می دهد، مدل‌های LCE AIM، IAM و Uptime براساس معیارهای تعیین شده در اولویت قرار گرفته‌اند. از آنجا که ارزیابی و اولویت‌بندی مدل‌های تعالی مدیریت دارایی فیزیکی بر اساس ۶ معیار برای اولین بار در این تحقیق انجام شده است، این امر می تواند یک نوآوری تلقی شود.

اطلاعات مقاله

تاریخ ارسال: ۸ خرداد ۱۳۹۷
تاریخ اصلاح: ۲۹ تیر ۱۳۹۷
تاریخ پذیرش: ۲۰ مرداد ۱۳۹۷

واژگان کلیدی:

مدل تعالی مدیریت دارایی فیزیکی ، سری استاندارد ISO-55000، تکنیک دی‌متل و ای‌ان‌پی

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