Research Article
A Structural Framework to Assess the Influence of CSFS on Risk Management Case Study: Oil and Gas Sector in Iran

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Abstract: With regard to changing business environment over the last two decades, risk management has become a main area of business practice to define, analyse and control uncertainties. It necessitates identifying critical areas of planning and actions which must be considered to achieve effectiveness named Critical Success Factors (CSFs). The aim of this study is to classify and prioritize the CSFs necessary for risk management in oil and gas sector in Iran. In order to do the research a comprehensive set of CSFs were selected in the existing streams of research. Accordingly ten CSFs were identified named commitment and support, communication, culture, structure, IT, process management, resources, training, strategy and measurement. The quantitative method was employed in data collection by using questionnaire. Then to evaluate the influence of each CSF on risk management, an empirical study was conducted by Principal Components Analysis (PCA) by using SPSS package to classify CSFs and extract main factors. The CSFs are categorized into three components; management, operation and context. Then, the extent to which each CSF impacts on risk was measured through a structural model by using Confirmatory Factor Analysis (CFA) by applying Smart PLS package. Consequently, the obtained results indicated that two components; management and context had eigen value greater than one, acceptable reliability (Cronbach's alpha and Dillion-Goldstein's ρ (D.G.'s ρ) >0.7) and validity (AVE>0.5). Furthermore, this framework showed a satisfactory fitness (GoF = 0.76). This study provides with top managers key insight into the CSFs influencing risk management to proper resource allocation.

Keywords: Confirmatory factor analysis, critical success factors, principal components analysis, risk management

INTRODUCTION

During the last two decades, a major surge of interest has been emerged to improve the ability of an organization to encounter with uncertainties arising from internal or external business environment, especially with its negative impacts at the organizational level. As a result, risk management has been highlighted as a main area of business practice with the aim of identifying, analysing and controlling causes and effects of uncertainty and risks in an organisation (EIU, 2009). Factors on how risk management should be successfully implemented called critical success factors which defines by Rochart (1979) as" the limited number of areas in which results, if they are satisfactory, will make sure successful competitiveness and high performance for an organisation". Saraph *et al*. (1989) viewed them as the critical areas of managerial planning and actions which must be considered to achieve effectiveness.

Due to rapidly changing business environment, organizations encounter with a high number of risk sources arising from internal or external business environment originated from markets, competitors, infrastructure, partners, business processes and so on. It seems that there is a lack of holistic view on literature about the extent to which each CSF impacts on risk originating from different spheres (IT, infrastructures, human resource, market, etc.) hardening risk management process (Nikonov and Kogan, 2009). However, no comprehensive approach exists on characterising a collective set of CSFs to manage risk effectively, so a more deliberate study to manage risk effectively is essential.

In the body of related literature various CSFs have been emphasized which consider different features of risk management. As a case in point, Dembo and Freeman (1998) discuss a number of CSFs which are potentially influential in risk management. These factors include executive support, integrating risk management into decision-making process, creating efficiencies in procedures and controls and a common risk language. Grabowski and Roberts (1999) examine the problem of risk mitigation and propose a process to

support high performance in an organization. Consequently, organizational structure and design, communication, organizational culture and trust have been identified as CSFs to achieve these goals. Galorath (2006) focuses on the importance of risk management and evaluates processes which are needed to implement risk management. He considers the factors affecting risk management as top-level executive support, entire management of structure and processes, cultural imperative and a pattern for measurement.

Most experts (Hillson, 1997; Artto and Hawk, 1999) agree that one of the most significant CSFs for effective risk management implementation is an appropriate risk culture. Moreover, Bruesh (2010) presents a methodological procedure with four cultural aspects; values, leadership, human resource success policies and organizational learning including the corresponding critical success factors as; ethics/values/aims, responsibility/liability, strategy/limitation, skills/resources, perception/expectation, learning, trust/transparency.

NSW department of state and Regional development (NSW, 2005) provides a guideline to help organizations with risk management implementation which comprises appropriate commitment to risk management, clear goals and objectives of risk management, reasonable resource allocation, appropriate training and systems to monitor and review risks.

A comprehensive survey conducted by EIU (2009) by enquiring about the most important elements for risk management in organizations followed by an attitude towards risk monitoring systems and processes, reveals 9 CSFs comprising; strong culture and awareness of risk throughout the organisation, clearly defined risk appetite, well-defined systems and processes to monitor ongoing risks, support from executive board, clear ownership of risk, systematic framework for enterprise risk management, IT systems that support the aggregation and analysis of risk data, alignment of risk management with internal audit processes and engagement with external stakeholders.

A study conducted in Thai financial industries to provide CSFs for risk management procedures indicates seven CSFs consisting of commitment and support from top management, communication, culture, organisational structure, trust, information technology and training (Na Ranong *et al.*, 2009). Top management support and commitment has been emphasized as a crucial part of risk management to improve decision making in order to manage risk (Young and Jordan, 2008; Henriksen and Uhlenfeldt, 2006). Communication is emphasized as another facilitator of risk identification, assessment process and supports within the organization being challenged when necessary (Finniston, 1975; Carey, 2001). DeLoach (2004) focuses on organizational structure as responsibilities and authorities assigned to appropriate personnel. Some researchers highlighted the role of IT

and IT architecture for risk management (Shin, 1999). In other words, IT enables prompt searches, access to and retrieval data and support communication in an organization (Mutsaers *et al.*, 1998). It makes information more valuable and secure which increases the reliability of business lines and hinders business activity and individual risks (Lee and Choi, 2003). Process management is another CSF which is a substantial element to identify potential risks involved in the way which processes and activities will be handled, measured and decided on the way the risks would be mitigated (Muehlen and Rosemann, 2005; Rikhardsson *et al.*, 2006).

National Treasury (2002) refers to resources as an essential CSF to make balance and operational stability as soon as risks rise in short term as well as enhance efficiency and effectiveness in the operations of an organization in long term. Furthermore, Salierno (2003) believes resource allocation for risk response should be at the appropriate level given the severity of the risk and should take into account any necessary trade-offs due to resource constraints. Symons (1995) suggests training programs for staff and risk management team if risk management is to be brought to the organization. Carey (2001) shows that the ability to respond to changing conditions in an organization relates to the development of risk training courses and the involvement of staff in reacting to the early warning systems. In fact, the major reason behind training programs is not only to ensure that members which are comfortable with the system, but also to upgrade their skills and knowledge when they face with various risks (NSW, 2005).

Frigo (2009) proposes a framework for strategic risk management which describes the type of business strategy and activities required to drive superior performance which provides valuable insight into risk management to realize the cause-and-effect linkages in critical risk scenarios and reveals how those scenarios would play out in the business strategy and impact revenue, earnings and share value.

Kaplan and Norton (2008) underline to found a framework to evaluate business strategy identify and assess risk in their strategic plans. That is, companies should develop a strategy and conduct strategic risk assessment and formulate strategic risk management plans as a part of their strategies.

Feurer and Chaharbaghi (1995) consider the performance of risk management as an information system which enables the organization and the associated parties to measure the strength of the entire business. Acharyya and Johnson (2006) present a framework to provide three key areas where the performance of risk management needs to be concentrated. The first area illustrates the operational activities of a risk management. The second area focuses on the corporate objectives (financial, operational and strategic) and the third area is related to the expectations of the stakeholders.

As mentioned, various CSFs have been recommended as main part of successful risk management. Hence, the focal point of this research is to identify and evaluate the most influential CSFs on risk management and their importance in order to facilitate decision making processes to tackle main challenges and obstacles in this area.

The main objective of our research is therefore to identify critical success factors necessary for successful risk management. In other words, the purpose of this study is to answer to these questions:

- Which CSFs have the most effects on risk management?
- How much the extent to which each CSF impacts on risk management?

In fact, the interest of this research is to discern whether there is a comprehensive set of CSFs on risk management in oil and gas sector and if so, what the relationships between them and risk management are.

MATERIALS AND METHODS

With standing the fact that external factors such as environment, consumers and so forth cannot be taken into account due to little control of organisations over them, CSFs in this study are considered as internal factors which can be controlled.

As illustrated in Table 1, researchers have considered various CSFs covering different aspects of risk management. Hence, in this research most frequent CSFs have been selected as a comprehensive set of major elements influencing and covering risk management. In this regard, a conceptual model which indicates theoretical background between more important CSFs and risk management has been illustrated in Fig. 1 to respond research questions. Ten CSFs are selected comprising commitment and support, communication, culture, structure, IT, process management, resources, training, strategy and measurement.

Population and sample: The survey is based on quantitative method and questionnaire is used as the tool of data collection.

Using the database of Petroleum Ministry, a sample of 180 managers, experts and consultants that work at various parts of upstream, midstream and downstream facing risks was selected.

Participants were contacted by a group-email outlined the purpose of the questionnaires. Respondents' perceptions were captured by using a seven-point Likert scale which enabled respondents to indicate their opinion on various CSFs required for risk management. In total, 129 useable responses were received (72% response rate). Regarding to the response rate, as a general rule, the more acceptable size would have a ten to one ratio to avoid over fitting the data, which suffices for this study (Hair *et al.*, 1998).

Questionnaire and components: The questionnaire was developed on the base of literature review. In addition, the questionnaire was pre-tested with several subsidiaries to eliminate any ambiguity and difficulty in the required questions.

Table 1: Proposed CSFs for effective risk management by different researchers

CSFs	Dembo and Freeman (1998)	Grabowski and Roberts (1999)	Galorath	Brüesch (2010)	NSW (2005)	EIU (2009)	NA Ranong et al. (2009)	Young and Jordan (2008) and Henriksen and Uhlenfeldt (2006)	Finniston (1975) and Carey (2001)	Deloach (2004)	Shin (1999)
Commitment and support	*		*			*	*	*			
Communication	*	*		*		*	*		*		
Culture		*	*	*		*	*				
Structure		*	*	*		*	*			*	*
IT					*	*	*				*
Process management	*		*			*					
Resources				*	*						
Training				*	*		*		*		
Strategy				*	*	*					
Measurement			*			*					
Miscellaneous		Trust		Perception/expectation		Engagement with external stakeholders					

CSFs	Mutsaers et al. (1998)	Lee and Choi (2003)	Muehlen and Rosemann (2005) and Rikhards son et al. (2006)	National Treasury (2002)	Salierno (2003)	Symons (1995)	Frigo (2009)	Kaplan and Norton (2008)	Feurer and Chaharbaghi (1995)	Acharyya and Johnson (2006)
Commitment and support										
Communication										
Culture										
Structure										
IT	*	*								
Process Management			*							
Resources				*	*					
Training						*				
Strategy							*	*		
Measurement									*	*
Miscellaneous										

Fig. 1: Conceptual model on influence of CSFs on risk management

Analysis: To analysis the data principal components analysis was used to define appropriate number of factors converged by the set of proposed CSFs as Manifest Variables (MVs). A manifest variable loads highly if its loading coefficient is above 0.60 and does not load highly if the coefficient is below 0.40. The number of factors selected is the number of factors with an Eigen value exceeding 1.0. Bartlett's test of sphericity was conducted to ensure if data are appropriate for exploratory factor analysis and the Kaiser-Meyer-Olkin (KMO) was used as a measure of sampling adequacy and to determine the factorability of the matrix (using SPSS package) (Hair *et al*., 1998).

In order to define CSFs which have the most impact on risk, a confirmatory factor analysis was employed and factor loadings of CSFs on the related construct were specified. In fact, convergent validity is shown when each of the measurement items loads with a significant t-value on its latent construct. Typically, CSFs with significant t-values (t>1.96) and factor loadings more than 0.4 at the alpha protection level ($\alpha = 0.05$) were selected as the most influential CSFs on risk (Fornell and Larcker, 1981). Then, loading pattern of each CSF on the latent construct was specified by using confirmatory factor analysis conducted by Smart PLS package.

The reliability of the study was assured by using the Cronbach's alpha ($\alpha > 0.7$) and Dillon-Goldstein'rho (D.G.'s ρ) as a measure of composite Reliability ($\rho > 0.7$). Moreover, validity of the study was tested by AVE which measures the variance captured by a latent construct AVE shows the ratio of the sum of its measurement item variance and should be at least 0.50 (Chin, 1998).

Goodness of Fit (GoF) index was employed in order to take into account the model performance in both the measurement and the structural model. This index is bounded between 0 and 1. There is no inference-based threshold to judge the statistical significance of their values, the more GOF closes to 1, the better fitness is indicated (Tenenhaus *et al*., 2004).

RESULTS AND DISCUSSION

Exploratory factor analysis: The ten CSFs were treated to Principal Components Analysis. A Varimax rotation was run and the scree plot indicated three clear factors given the following names:

Factor 1: Management (accounting for 29.63% of the variance revealed by the rotated sums of squared loading)
Factor 2: Operation (accounting for 24.65% of the variance)
Factor 3: Context: (accounting for 24.22% of the variance)

Principal components analysis yielded a three factor model that accounted for 78.51% of the total variance.

Barlett Test of Sphericity (BTS) and Kaiser-Meyer-Olkin (KMO) test of appropriateness were carried out accordingly. The results of the KMO

Table 2: Principal components analysis results

Items and classification (manifest variables)	Components (latent variables)		
	1	2	3
Management (factor 1)			
Communication	0.920		
Structure	0.860		
Strategy	0.780		
Commitment and support	0.700		
Operation (factor 2)			
Measurement		0.910	
IT		0.900	
Process management		0.810	
Context (factor 3)			0.850
Resource			0.810
Culture			0.740
Training			
Eigen values	2.960	2.470	2.420
Cronbach's alpha	0.898	0.843	0.814
Notes: n = 129, KMO = 0.76	Approx. chi-square = 882.63	d.f. = 45	Sig. = 0.000

Table 3: Primary factor loadings and t-value of the construct

CSFs	Components		Total scale	
	Factor loading	t-value	Factor loading	t-value
Communication	0.885	31.090	0.780	18.542
Structure	0.865	28.226	0.788	16.024
Strategy	0.897	42.279	0.861	32.378
Commitment and support	0.865	35.976	0.849	41.863
Measurement	0.874	1.399	0.042	0.191
IT	0.983	1.580	0.124	0.554
Process management	0.529	0.851	0.029	0.116
Resource	0.861	39.279	0.739	17.796
Culture	0.817	21.117	0.661	9.475
Training	0.886	44.746	0.798	16.231

Table 4: Homogeneity and uni-dimensionality of blocks

LV name	Cronbach's alpha	D.G.'s ρ	AVE
Management	0.898	1.58	0.77
Context	0.814	1.40	0.73
Total scale	0.825	0.85	0.62

Table 5: Secondary factor loadings and t-value of the construct

CSFs	Components		Total scale	
	Factor loading	t-value	Factor loading	t-value
Communication	0.885	29.975	0.781	16.336
Structure	0.863	28.424	0.793	16.114
Strategy	0.898	48.230	0.864	36.418
Commitment and support	0.866	38.469	0.856	45.633
Resource	0.860	42.573	0.743	20.934
Culture	0.819	24.431	0.665	11.632
Training	0.885	48.285	0.806	21.461

measure of sampling adequacy were 0.76 and significant level of Bartlett's test indicated the data set is suitable for exploratory factor analysis. Results have been presented in Table 2.

Confirmatory factor analysis: In order to identify the extent to which management, operation and context components (latent variables) impact on risk, a CFA on the whole sample was performed. In fact, the factor loadings and t-values of each CSF should be calculated to define CSFs which should be taken into account (t>1.96, factor loadings >0.4). After calculation of the factor loadings and t-values of CSFs, each CSF of the second component (operation) had the factor loading less than 0.4 and t-values less than 1.96. Consequently, these three CSFs and accordingly the second component were omitted. Results have been illustrated in Table 3.

To ensure reliability and validity of the proposed construct, first, reliability and validity of each component were checked. Table 4 shows measures employed in checking the validity and reliability of the proposed construct. Results indicate that the eigen values of each block is greater than one; moreover, the first and third components have Cronbach's alpha >0.7, D.G.'s ρ>0.7 and AVE >0.5. Finally, this construct on Risk data shows a value for the GoF equal to 0.76.

Looking at the construct, all the relationships have high factor loadings (the smallest loading has a value of 0.66, See Table 5). On the other hand, the quite high value of the GoF index also suggests that homogeneity among the measurement units (CSFs) can be assumed.

CONCLUSION

This study tries to find out the critical areas and actions, called CSFs, which must be taken into account to achieve effectiveness in risk management in oil and gas sector. In order to investigate the influence of each CSF on risk management, a comprehensive set of CSFs proposed by different researchers in the related literature were viewed. First, a principal components analysis was conducted to provide a better understanding of the structure of CSFs and a way to simplify analysis of CSFs. Consequently, three components were identified as management, operation

and context. Second, in order to define highly influential CSFs on risk, a confirmatory factor analysis was employed and factor loadings of CSFs on the related construct were specified. The proposed construct which assesses risk and relates risk to components is composed of seven CSFs as, Commitment and support, communication, strategy, structure, culture, resource and training. Reliability and validity of each component were checked by Cronbach's alpha, D.G.'s ρ and AVE measures. Eigen value of each component is greater than one; in addition, the first and third components have acceptable reliability (Cronbach's alpha and D.G.'s ρ>0.7) and acceptable validity (AVE>0.5). Furthermore, this construct shows a satisfactory fitness (GoF = 0.76).

As a result, it provides with top managers key insight into the construct of the CSFs influencing risk management in oil and gas sector. According to the results, there are clearly three separate and distinct dimensions of CSFs in risk management (management, operation and context) which two of them (management and context) impact risk directly and effectively, so risk consultants and managers can now discuss plans revolving around these two areas according to their importance instead of having deal with the separate CSFs. Therefore regarding the findings, some recommendations could be suggested to establish an effective risk management system as follows:

- Definition and endorsement the risk management policy to ensure that decision making, including the development and setting objectives are aligned with the outcomes of risk management processes
- Alignment risk management objectives with the objectives and strategies of the organization
- Commitment to prepare the necessary resources allocated to risk management to assist those accountable and responsible for risk management
- Making appropriate communication to clarify the benefits of risk management to all stakeholders the way in which conflicting interests are dealt with
- Making sure that the organizational culture and risk management policy are aligned
- Identification and assignment responsibilities and accountabilities to the people at all levels for risk management
- Holding information and training sessions to rationalize staff in risk management process

At this point of the research, the construct was confirmed as one of the possible acceptable constructs, since the confirmed constructs does not necessarily indicate that the best one has been found. Thus, further research can consist of more rigorous tests by generating different acceptable constructs and competing alternative models. Since Paradigm shifts towards competing models strategy can provide far stronger results.

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