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Structural modelling of internal risk factors for oil and gas construction projects

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Abstract

Purpose – Project failure is the result of one or a combination of several causes of risk factors that are very important to identify for effective performance. This study aims to focus on studying the fundamental relationship between internal risk factors and the negative effect on oil and gas project success in Yemen using the partial least square structural equation modelling (PLS-SEM) method.

Design/methodology/approach – Data collection was carried out using a formal questionnaire survey of the oil field sector in Yemen by companies involved in mega-oil and gas construction projects. A hierarchical model for determining causative internal risk factors and their effects was developed and evaluated using SEM method by SmartPLS3 software technology.

Findings – The findings of analyzing model indicate that all categories have a significant effect on project success, while the most significant affected categories in the internal risk factors are project management factors, feasibility study-design and resources-material supply with a path coefficient value of 0.213, 0.197 and 0.186, respectively. Moreover, for the hypotheses test, the positive relationship means that all experimental hypotheses are accepted according to path coefficient value analysis. In addition, the internal risk factors research model shows the ranking of effects on project success starting with project stoppage (loading factor 0.841), cost overruns (loading factor 0.818), time overruns (loading factor 0.726) and project target failure with loading factor 0.539.

Research limitations/implications – The research was limited to the oil and gas construction projects in Yemen.

Practical implications – Interpreting the relationship between internal risk factors and their impact on the success of construction projects in the oil and gas sector will assist project team and oil companies in developing risk response strategies and developing appropriate plans to mitigate the effects of risks, which is presented in this paper.

Originality/value – The paper explains the relationship between cause and effect of internal risk factors in oil and gas projects in Yemen, and is expected to be a guideline for the oil companies and future academic research in the risk management area.

Keywords Construction projects, Internal risk factors, Oil and gas projects, PLS-SEM, Structural equation modelling, Project management, Risk analysis, Mail questionnaires, Construction, Modelling, SMART PLS

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Introduction

There exist many perspectives on risk, and traditionally some of the perspectives have been seen as representing completely different frameworks, making the exchange of ideas and results difficult based on Aven (2009). Oil and gas are essential for any nation and play a key role in economic development. Project risk management is one of the critical aspects of project management because of uncertainty of construction risks; risk-related failures directly impact the benefits of all project stakeholders (Issa *et al.*, 2015). Internal risk factors are project-related factors resulting from the relationship between stakeholders and project management, as well as material, human and project resources in terms of the feasibility study, design preparation, tenders and contracts, and the ability to control them is crucial to study these factors. Through the project management team and mitigate the effects of risk factors on the oil and gas sector construction project's progress. The structural equation modelling (SEM) approach was adopted to analyze these factors because of the lack of evaluation of the causal relationship of internal risk factors and the effect on project success.

Like other developing countries, Yemen is also facing a severe issue of risks in the construction industry (Alrashed *et al.*, 2014; El-Sayegh *et al.*, 2018; Issa *et al.*, 2015; Jayawardane and Gunawardena, 2010; Sambasivan and Soon, 2007). Moreover, according to Niven (2015) regarding investigation of the recent Ernst and Young report on 365 oil and gas companies' capital projects, SpotLight on Oil and Gas Megaprojects, revealed that 73 per cent of oil and gas companies' large capital projects fell behind schedule, 64 per cent came in over budget and 59 per cent of the projects were exceeded the original budget plan. According to Ahmad *et al.* (2013), results show that 47 per cent of completed projects in Yemen had time overrun, whereas 40 per cent of total projects were overrun by costs in Yemen. Construction risk had become a significant concern for investors, in particular in the petroleum and gas sector, which needs proper consideration and extensive research to resolve this issue because of its close connection to operations and production processes.

According to Abdul Rahman *et al.* (2013), SEM is known to be an extension of structured regression modelling used to resolve incorrectly defined independent variables and is ideally suited for many research problems in the construction engineering and management fields. The aim of this study is to develop a structural model of internal risk factors that can be controlled by project management and thus to develop a strategy for responding to these risks by attenuating or sharing risks with project stakeholders or avoiding risks. In addition, this paper is also a model for the investigation of risk factors affecting the success of the project. In the end, the findings of this study provide practitioners, mainly clients and contractors, with a clear understanding of the risk factors affecting the success of the project.

Literature review

All life choices involve risks, and there is a risk of uncertainty because of a lack of data, knowledge or experience (Jannadi and Almishari, 2003). According to Choudhry and Iqbal (2013), risk is an internal or external event or circumstance that may influence and alter the initial status of a project and its time and cost, whereas Chandra (2015) defines risk as an unpredictable occurrence that could affect the objectives of the project, including scope, timeline, cost and quality parameters. Another distinction between uncertainty and risk, as discussed by Hillson (2003), comes from the analysis of the consequences because of uncertainty without consequences that do not result in risk. In addition, the risk can be described from different points of view depending on the point of view of the process; the risks are variables that may influence the fulfilment of the goals, leading to unintended consequences. In other words, from the point of view of the test, because it is considered detrimental, the hazard is an unpredictable, unknown and undesirable outcome. The threat, therefore, plays a key role in decision-making and can influence the project's performance based on Wiguna and Scott (2005).

Yemen's construction industry faces many obstacles and problems that need more government support to improve its policies and strategies. A case study was done by Gamil *et al.* (2017). It has been possible to detect most of the failure of causative factors because of government policies and the absence of stakeholder accreditation programs. A national system of codes, standards and contract guidelines is urgently needed in Yemen. Thus, more studies should be carried out to explore opportunities for improving Yemen construction industry. According to Fallahnejad (2013), in research on risk triggers in Iran's gas pipeline projects showed that the ten leading factors were: imported materials, unrealistic project timesheduale, customer-related supply materials, land expropriation, change orders, contractors' choice methods, contractors' compensation, licensing, suppliers and cash flow of contractors. As a consequence, the literature pays close attention to lengthy approval processes, poor planning and scheduling, environmental problems, exhaustion and human error, low quality of manufactured products, adjustments in design and poor communication between project parties. More studies should be carried out on these risk factors because they hold a great opportunity to be the root causes. In turn, the handling of these variables can result in positive results for both owners and contractors, as well as for the entire project.

Yemen's economy depends heavily on oil and gas income; however, the oil and gas industry faces significant administrative and technical challenges (World Bank, 2015; EITI, 2014). According to U.S. Energy Information (2013) and Salisbury (2011), shipments of liquefied natural gas (LNG) from Yemen to South Korea and the USA originally intended to begin in December 2008 have been delayed until at least August 2009, resulting in costly penalties for the export company, Yemen LNG, and more than US$100mn in lost revenue for the Republic of Yemen Government. Factors in the ongoing startup delay include the ROYG's lag in providing adequate coastal defence for the liquefaction plant at Belhaf, a dispute with the upstream ROYG gas provider, tribal unrest during the pipeline construction phase and the Ministry of Oil's insistence that YLNG hires unqualified local tribesmen to operate advanced machinery. These headaches may scare away much-needed foreign investment in the oil and gas industry. Another instance, the construction project of the central production facilities (CPF) in Sector S2 of OMV oil company in Yemen failed to achieve objectives on time, which began in 2010 and is supposed to end in 2014, according to World Bank (2015), while the project did not exceed 50 per cent of the project progress until 2019 because of several risk factors.

The most significant stakeholder is the project owner or client, who not only sets project specifications, expectations and work performance but also manages contracts and designs; the project's target is customer satisfaction (Fallahnejad, 2013). The acts of the owner towards the company, however, cause a lot of risks to the project. Because contractors are a source of essential risk, if they do not have the expertise and experience in executing and maintaining the worksite to achieve the highest percentage of completion, the wrong choice of the contractor during the tender process will cause project failure. In addition, the project's feasibility study and design preparation is a crucial stage during the project's life cycle and can be considered as a source of critical risk factors that subsequently affect project execution or increase costs Asrilhant *et al.* (2004). Motiar Rahman and Kumaraswamy (2005) suggested that setting up a team of owners, consultants, contractors, subcontractors and suppliers could improve the management of contractors' schedules (Table I).

Construction risks frequently result in overruns of time and costs and impacts on project targets. Therefore, most programs were delayed or exceeded their estimates, because project managers could not successfully manage risk, according to Thuyet *et al.* (2007). In contrast,

Table I.
Internal risk factors for construction projects based on a literature review

No.	Risk categories	References
1	Client-related risk factors (CL)	Mahamid *et al.* (2015), Issa *et al.* (2015), Assaf and Al-Hejii (2006), Al-Momani (2000), Aziz (2013), Emam *et al.* (2015), A. Kassem *et al.* (2019b)
2	Contractor-related risk factors (CO)	Sidawi (2012), Alashwal and Al-Sabahi (2019), Hamzah *et al.* (2012), Rahman *et al.* (2013), Mahamid (2013), Dey (2012)
3	Consultant-related risk factors (CN)	Mahamid (2011), Kassem *et al.* (2019), Assaf and Al-hejji (2006), Famiyeh *et al.* (2017), Petrovic (2017(
4	Feasibility study and design-related risk factors (FD)	Sohrabinejad and Rahimi (2015), Mukuka *et al.* (2014), Karunakaran *et al.* (2018), Bordat *et al.* (2004(
5	Tendering and contract-related risk factors (TC)	Sweis *et al.* (2018), Banihashemi *et al.* (2017), Thuyet *et al.* (2007), Harris *et al.* (2006(
6	Resources and material supply risk factors (RM)	Mahamid *et al.* (2015), Issa *et al.* (2015), Sidawi (2012), Doloi (2012), Assaf and Arabia (2007)
7	Project management-related risk factors (MR)	Adeleke *et al.* (2016), Hatmoko and Khasani (2019), Badiru and Osisanya (2013), Aven (2016)

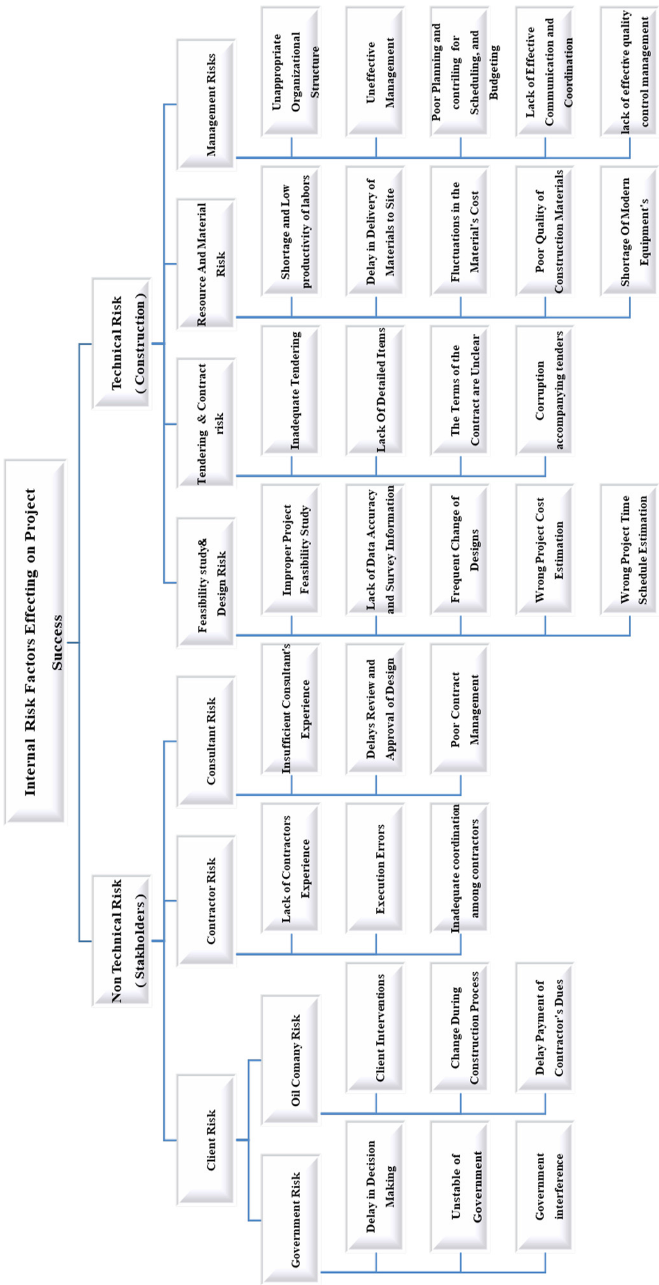
the changing complexity of the economies of developing countries has made these problems seem more prevalent in recent years.

The literature reviewed included papers, conference proceedings and books related to the research area. Identifying all internal risk factors that may effect on project success through a comprehensive literature review in the oil and gas construction project. Such factors vary from critical factors in the management of construction projects to factors that arise from investors, contractors, tendering, material resources, labour productivity, management and so on. In previous research, A. Kassem *et al.* (2019a) categorized risk-based variables for evaluation purposes. Moreover, this classification system consisted of 7 categories of risk factors and 31 internal risk factors, listed in Figure 1.

Methodology

The review of the literature has helped to understand better and collect information on the examination of risk factors that affect project success. The survey approach was introduced to test the hypotheses suggested in this report. A questionnaire survey was developed for respondents to analyze the risk factors influencing project progress in Yemen's oil and gas construction projects. The questionnaire consisted of four sections. The first section at the beginning, including the letter of introduction that established with the research goals. The second section captured respondents' basic profile, including their positions, experiences and business. The third section is designed to identify the risk factors that affect project performance, which can be grouped into client risks, feasibility and risk management, tendering, resource and material supply, contractor, consultant, management risks and their effects on project success.

This part consisted of questions that solicited the perceived agreement of the risk factors that influence project success and the indicators of project success in a five-point Likert scale (1 = very Low, 2 = Low, 3 = Moderate, 4 = High and 5= Very High). Data were analyzed using the Smart PLS software package using a PLS-SEM (partial least square structural equation modelling). The SEM method is a statistical technique that combines a measurement model (confirmatory factor analysis) with a structural model in a single statistical test. These formulas define all the relationships between the buildings involved in the evaluation. The measuring method must be checked in the SEM system because it



Source: Kassem *et al.* (2019)

Figure 1.
Internal risk factors in previous studies

captures the relationship of the structure between latent variables. Reliability of the scale is the internal reliability of a latent factor and is most generally calculated with a coefficient called Cronbach's alpha, where a higher Cronbach coefficient suggests a higher accuracy of the latent variable measurement scale and a minimum value of 0.70. According to the Petroleum Exploration and Production Authority (PEPA) registration, a total of 360 questionnaire sets were distributed to randomly selected oil and gas companies operating in Yemen; of which 323 were received, and 314 were deemed acceptable as shown in Table II; nine of the questionnaire sets were incomplete or partially filled out, which were declared invalid and not appropriate for further analysis.

The majority have more than 10 years of experience in construction projects through the statistical table of participants; while the job title of participants are closely related to the construction project management. The study included more participants from the top five oil and gas sectors, which have megaprojects with few participations from the rest of the other smaller sectors at an acceptable rate.

According to Chin (1998), covariance-based methods as exemplified by software such as LISREL, EQS, AMOS, SEPATH and RAMONA are by far the most well-known among the SEM techniques. Indeed, the covariance-based procedure, too many social science researchers, is tautologically synonymous with the term SEM. Nevertheless, a common alternative technique is also known as PLS for researchers interested in performing SEM-based analysis. Depending on the researcher's objectives and the epistemic view of data to theory; the properties of the data at hand; or the degree of theoretical knowledge and measurement development, the PLS approach can be argued to be more suitable. The covariance-based SEM objective is to reproduce the theoretical covariance matrix, without focusing on explained variance, whereas the PLS-SEM objective is to maximize the explained variance of the endogenous latent constructs (dependent variables) based on Henseler and Sarstedt (2013) and this is the reason to choose the PLS-SEM method for analysis in this study.

Based on the theoretical model shown in Figure 2, we have seven hypotheses in this study as follows:

H1. Client risk factors (CL) have a significant effect on project success.

H2. Consultant risk factors (CN) have a significant effect on project success.

Table II. Demographic characteristic for participants

Demographic characteristic					
Experience in the construction industry	Frequency	Job title	Frequency	Oil company	Frequency
Less than five years	45	Construction manager	33	PetroMasila sector	53
5-10 years	81	Project manager	40	Safer sector	49
10-20 years	102	Project coordinator	23	YLNG sector	74
20-30 years	66	Site engineer (Civil–Electrical–Mechanical–Petroleum)	121	Total sector	47
More than 30 years	20	Site supervisor	50	OMV sector	49
		Others	47	Other sectors	42
Total	314		314		314

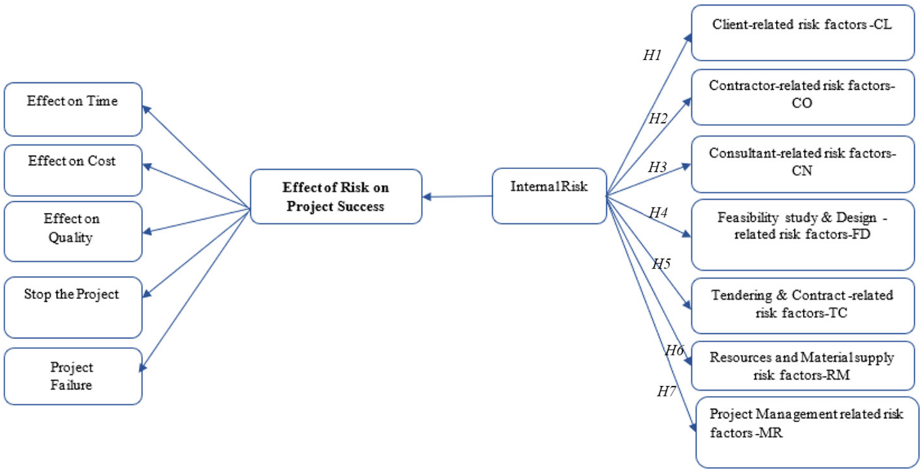


Figure 2.
The hypotheses of the research

H3. Contractor risk factors (CO) have a significant effect on project success.

H4. Feasibility study and design risk factors (FD) have a significant effect on project success.

H5. Management risk factors (MR) have a significant effect on project success.

H6. Resources and material risk factors (RM) have a significant effect on project success.

H7. Tendering and contract risk factors (TC) have a significant effect on project success.

Results and discussion

The theoretical model shown in Figure 3 was analyzed with partial least square estimation approach. Smart PLS 3.0 has been used to estimate the parameters of the measurement and the structural model. There are two main steps processing, while the PLS model criteria were calculated by SmartPLS software, Henseler *et al.* (2009).

The PLS path model evaluation steps are as follows:

- *Outer model (measurement model)* assessment to establish the construct's reliability and validity, according to Hulland (1999). This can be measured by analyzing each item's individual load, internal composite quality and discriminating validity Chin (1998).
- *Inner model (structural model)* evaluation of the relationship between exogenous and endogenous latent variables (independent latent variables and dependent variables) in relation to the variance accounted for Hulland (1999). The hypotheses were evaluated in the structural model by testing the "standardized beta or path coefficients" (Abdul Rahman *et al.*, 2013). According to Shahriar and Hani (2011), to test the hypothesis and obtain the standard estimate errors, non-parametric bootstrapping with 5,000 replications was applied.

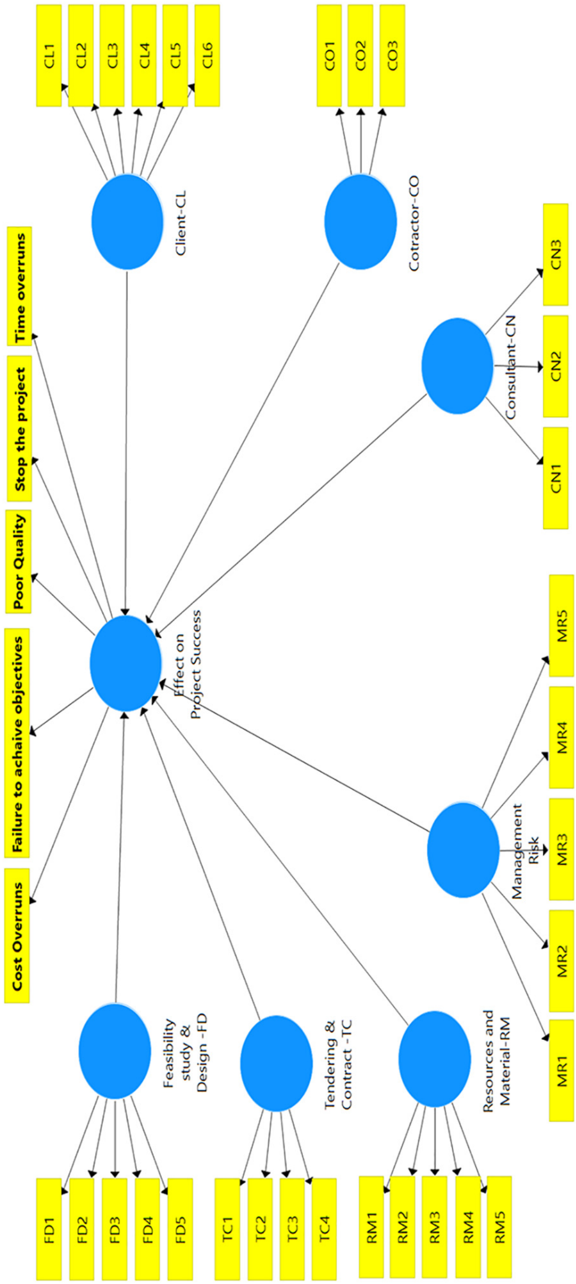


Figure 3.
Internal risk factors and effects on project success relationship model using PLS-SEM methodology (research model)

Assessment of measurements model

According to Hair *et al.* (2014), the evaluation of reflective measurement models includes three crucial tests: composite reliability for assessing internal consistency, individual indicator reliability and average variance extracted (AVE) for assessing convergent validity, Fornell–Larcker criterion and cross-loadings for assessing discriminating validity. In the following sections, we will explain each criterion for evaluating reflective measurement models.

Convergent validity

The convergent validity test is the scale to which a measure positively correlates with appropriate measurements of the same construct using the model of domain sampling, indicators of a reflective construct handled as various approaches to measuring the same construct. Therefore, a high proportion of variance will overlap or share the things that are indicators (measures) of a particular structure. Individual item reliability is the degree to which measurements of latent variables measured on a multi-item scale mainly reflect the actual score of latent variables relative to the error (Hulland, 1999). Researchers will consider the outer loads of the variables as well as the AVE to find convergent validity Sarstedt *et al.* (2017).

The first criterion is an internal consistency assessment, usually reliability. It is the traditional standard of the internal consistency of Cronbach's alpha, providing a reliability estimate based on the indicator variables of the intercorrelations note. Alpha Cronbach is considered that all indicators are significantly reliable (i.e. all indicators with equivalent construction external loads). In addition, Cronbach's alpha appears to underestimate the quality of internal consistency for the sensitivity of the number of elements in the table. This method of reliability takes into account the various outer loads of the indicator variables and is determined using the below equation:

$$\rho_c = \frac{\left(\sum_{k=1}^{k} l_k\right)2}{\left(\sum_{k=1}^{k} l_k\right)2 + \sum_{k=1}^{k} Var(e_k)} \tag{1}$$

where l_k symbolizes the standardized outer loading of the indicator construct k of a specific construct measured with K indicators, e_k is the measurement error of indicator variable k and var(e_k) denotes the variance of the measurement error, which defined as $1-l_k^2$.

Composite reliability. The composite reliability limitation varies from 0 to 1, with higher values indicating higher reliability levels. It is usually interpreted the same way as the Cronbach's alpha. In particular, composite reliability values from 0 to 0.60 are unacceptable. A value of 70 is acceptable in exploratory research, whereas values between 0.70 and 0.90 can be considered satisfactory in more advanced phases of research based on Nunally and Bernstein (1994). Finally, a lack of internal consistency reliability indicates composite reliability values below 0.60.

Cronbach's alpha. The Cronbach's alpha is the second measure of the reliability of internal consistency that assumes the same thresholds but yields lower values than the reliability of the composite. This statistic is defined as follows in its standardized form, where K represents the number of indicators of the construct and r^- the coefficient of correlation of the average nonredundant indicator (i.e. the mean of the lower or upper triangular matrix):

$$\text{Cronbach's } \alpha = \frac{K \cdot \bar{r}}{[1 + (k - 1) \cdot \bar{r}]}. \tag{2}$$

According to Sohrabinejad and Rahimi (2015), where Cronbach's alpha is higher than 0.7, questionnaires are generally accepted as accurate. In PLS-SEM, Cronbach's alpha is the lower bound, whereas in PLS-SEM, Cronbach's alpha is the upper bound for internal accuracy performance.

Average variance extracted. The last step in the analysis of reflective measurement models under convergent validity is the degree to which the construct converges its indicators by describing the variance of the objects. Convergent validity measured by the derived average variance (AVE) across all construct-related items is referred to as commonality. According to Sarstedt *et al.* (2017), the AVE calculated the mean of each indicator's square loads associated with a construct (for standardized data):

$$\text{AVE} = \frac{\sum_{k=1}^{K} l_k^2}{K} \tag{3}$$

where l_k and K were defined earlier.

Hair *et al.* (2014) reported to using the same logic as that used with the individual indicators, and AVE value of 0.50 or higher shows that more than half of the variability of its measures is explained by the build on average. Conversely, an AVE of less than 0.50 indicates that, on average, more variance remains in the error of the items than in the variance explained by the construct; all data for convergent validity are summarized in Table III.

Based on Hulland (1999), throughout social science experiments, researchers often find weaker outer loadings, mainly when newly developed scales are used, rather than merely eliminating indicators when their outer load is below 0.70; and researchers carefully examine the effects of removing items on structural quality as well as on the validity of the structure's content. Nevertheless, indicators with outer loads between 0.40 and 0.70 should only be considered for exclusion from the scale when removing the indicator results in an increase in the quality of the component or the average variance obtained above the suggested threshold. Another question of whether an indicator should be removed in this situation. For instance the poor-quality indicator element calculating the endogenous constructs is between 0.4 and 0.7, and when we delete it, the AVE is above 0.5, which is appropriate as Table IV.

The outer loading indicators (below 0.40) should always be excluded from the scale, according to Hair *et al.* (2011). Figure 4 shows the outer loading of all internal items, all of which are above 0.7 and all of which are acceptable values.

Discriminant validity

Discriminant validity based on Hair *et al.* (2014) is the degree to which the concept distinguishes itself from other constructs through empirical criteria. Nevertheless, establishing discriminating validity means that the construct is unique and encompasses phenomena that are not described by other constructs in the model.

Fornell–Larcker test. Fornell–Larcker is a second and more traditional approach to the assessment of discriminating validity (Hair *et al.*, 2014). This applies the AVE square root to

Second-order constructs	AVE	CR	Exogenous constructs	Items	Loadings	AVE	CR	Alpha
Internal risk factors	0.570	0.976	Client (CL)	CL1	0.828	0.593	0.897	0.863
				CL2	0.825			
				CL3	0.779			
				CL4	0.728			
				CL5	0.761			
				CL6	0.690			
			Contractor (CO)	CO1	0.883	0.764	0.907	0.846
				CO2	0.806			
				CO3	0.879			
			Consultant (CN)	CN1	0.867	0.735	0.893	0.820
				CN2	0.870			
				CN3	0.885			
			Feasibility study and design (FD)	FD1	0.868	0.768	0.943	0.924
				FD2	0.790			
				FD3	0.896			
				FD4	0.918			
				FD5	0.902			
			Tendering and contract (TC)	TC1	0.762	0.705	0.905	0.86
				TC2	0.850			
				TC3	0.878			
				TC4	0.860			
			Resources and material supply (RM)	RM1	0.841	0.695	0.919	0.889
				RM2	0.767			
				RM3	0.842			
				RM4	0.881			
				RM5	0.830			
			Project management (MR)	MR1	0.880	0.808	0.955	0.941
				MR2	0.891			
				MR3	0.921			
				MR4	0.910			
				MR5	0.893			
Endogenous constructs			Constructs		Loadings	AVE	CR	Alpha
Effect of risks in project success			Cost overruns		0.595	0.491	0.826	0.74
			Failure to achieve the project objectives		0.761			
			Stop the project		0.741			
			Time overruns		0.800			
			Poor quality		0.591			

Table III
Results of measurements model – convergent validity

the latent variable correlations. Usually, the square root of each construct's AVE should be higher than the highest correlation of any other construct. In other words, this criterion can be mentioned as the AVE with any other indicators exceeding the squared correlation. This method's dialectic is based on the idea that a construct shares more variance with its related constructs than with other measures, as shown in Table V.

Cross loading. Two selective validity mechanisms have been introduced. The first method to evaluate discriminating validity is by examining the indicators' cross-loadings. In particular, the outer loading of an indicator on the associated building should be higher than all its loadings on other buildings. A discriminating validity issue is the presence of cross-loadings that exceed the outer loadings of the indicators. Generally speaking, this requirement is considered somewhat progressive in establishing discriminatory validity

Table IV. Results of measurements model – convergent validity iteration 2

Endogenous constructs	Constructs	Items	Loadings	AVE	CR	Alpha
Effect of risks in project success	Cost overruns		0.549	0.549	0.826	0.74
	Failure to achieve the project objectives		0.803			
	Stop the project		0.737			
	Time overruns		0.840			

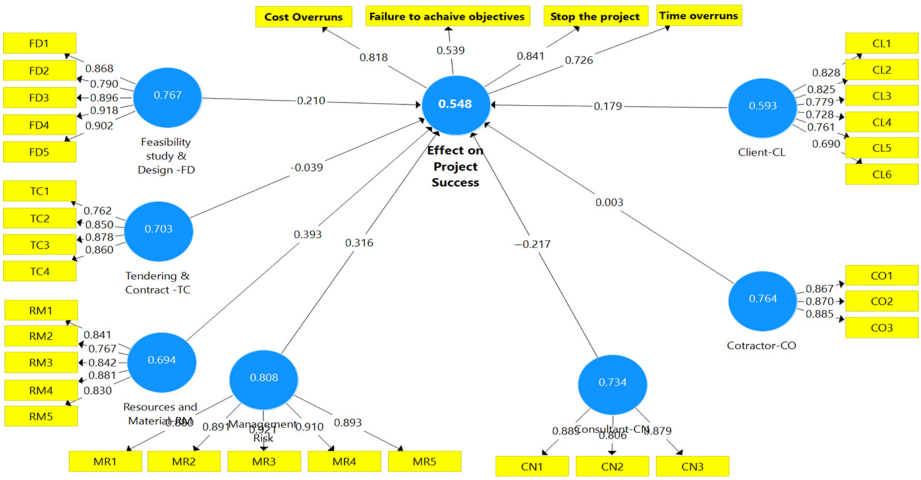


Figure 4. Convergent validity of measurement model – AVE and factor loading

Table V. Discriminant validity – Fornell–Larcker – internal risk factors

Items	CL	CN	CO	FD	MR	RM	TC
Client (CL)	*0.77*						
Consultant (CN)	0.655	*0.857*					
Contractor (CO)	0.768	0.763	*0.874*				
Feasibility study and design (FD)	0.720	0.814	0.775	*0.876*			
Project management (MR)	0.640	0.723	0.787	0.780	*0.899*		
Resources and material supply (RM)	0.743	0.724	0.781	0.770	0.845	*0.833*	
Tendering and contract (TC)	0.747	0.734	0.783	0.819	0.776	0.800	*0.839*

(Hair *et al.*, 2011). It is very likely to indicate that two or more items exhibit discriminant validity, which is shown in Table VI.

Assessment of structural model (inner model)

The next step, once we have established that the measurements of the construction are valid and reliable, is the analysis of the results of the structural model by examining the internal relationships between the dependent variables, which includes examining the predictive capabilities of the model and the relationships between the structures. This process consists of five steps to look at the structural template, as shown in Figure 5.

Hypotheses testing (path coefficient)

By running of the PLS algorithm in estimates of the SmartPLS software program will obtain the structural model relationships analysis (i.e. the path coefficients) representing the hypothesized relationships between the constructs. The path coefficient limit has standardized values from -1 to $+1$. Estimated path coefficients close to $+1$ reflect strong positive relationships (and vice versa for negative values), which are almost always statistically significant. If the estimated coefficients are closer to 0, it considered as the

Items	CL	CN	CO	FD	MR	RM	TC
CL1	*0.828*	0.471	0.551	0.554	0.451	0.588	0.587
CL2	*0.825*	0.449	0.552	0.516	0.462	0.570	0.545
CL3	*0.779*	0.370	0.503	0.412	0.418	0.544	0.505
CL4	*0.728*	0.564	0.586	0.613	0.539	0.538	0.584
CL5	*0.761*	0.607	0.721	0.692	0.626	0.630	0.692
CL6	*0.690*	0.527	0.597	0.494	0.419	0.543	0.506
CN1	0.536	*0.883*	0.685	0.680	0.634	0.617	0.643
CN2	0.511	*0.806*	0.609	0.596	0.572	0.596	0.556
CN3	0.608	*0.879*	0.658	0.797	0.648	0.646	0.676
CO1	0.636	0.582	*0.867*	0.596	0.642	0.647	0.623
CO2	0.694	0.650	*0.870*	0.675	0.666	0.700	0.698
CO3	0.662	0.759	*0.885*	0.753	0.752	0.698	0.735
FD1	0.643	0.758	0.692	*0.868*	0.697	0.676	0.721
FD2	0.528	0.684	0.606	*0.790*	0.596	0.583	0.608
FD3	0.603	0.713	0.666	*0.896*	0.689	0.678	0.702
FD4	0.684	0.719	0.695	*0.918*	0.703	0.719	0.767
FD5	0.663	0.702	0.717	*0.902*	0.723	0.716	0.778
MR1	0.548	0.652	0.703	0.682	*0.880*	0.743	0.661
MR2	0.533	0.615	0.678	0.715	*0.891*	0.736	0.682
MR3	0.615	0.703	0.723	0.742	*0.921*	0.794	0.748
MR4	0.583	0.647	0.720	0.677	*0.910*	0.744	0.685
MR5	0.581	0.632	0.708	0.692	*0.893*	0.773	0.728
RM1	0.627	0.651	0.705	0.725	0.708	*0.841*	0.742
RM2	0.579	0.489	0.529	0.550	0.600	*0.767*	0.612
RM3	0.666	0.616	0.632	0.631	0.680	*0.842*	0.664
RM4	0.588	0.636	0.715	0.680	0.793	*0.881*	0.697
RM5	0.622	0.609	0.650	0.614	0.728	*0.830*	0.626
TC1	0.569	0.608	0.570	0.646	0.540	0.597	*0.762*
TC2	0.614	0.602	0.609	0.680	0.638	0.636	*0.850*
TC3	0.673	0.657	0.728	0.756	0.689	0.713	*0.878*
TC4	0.636	0.602	0.702	0.670	0.725	0.742	*0.860*

Table VI.
Discriminant validity – cross-loading for internal risk factors

weaker relationships, while very low values less than 0 are usually non significant (Hair *et al.*, 2014).

Basically, the path coefficients is significant depends on its standard error obtained by bootstrapping. According to Kushary *et al.* (1997), the bootstrapping routine is applied as for the next step, where we used the procedure to evaluate whether a reflective indicator contributes significantly to its corresponding items. The standard bootstrap error allows the observed *t*-values to be calculated. For example, to estimate the meaning of the path coefficient linking constructs Y1 and Y3, we would enter in the following formula to the original path coefficient estimate (p_{13}) and the standard bootstrap error (se^*_{13}):

$$t = \frac{p_{13}}{se^*_{13}}. \tag{4}$$

It is rational to estimate the *t* distribution for sample sizes greater than 30. To compare the observed *t*-values, we can use the quantiles from the normal distribution as critical values. If the empirical *t*-values are higher than the critical value, we say the coefficient is significant at a certain probability of error (i.e. level of significance); the critical values commonly used for two-tailed tests are 1.65 (level of significance = 10 per cent), 1.96 (level of significance = 5 per cent) and 2.57 (level of significance = 1 per cent). According to Sarstedt *et al.* (2017), studies usually assume a 5 per cent level of significance in marketing, but this is not always the case, as consumer research studies often assume a 1 per cent level of significance, especially when experiments are involved. Based on Hair *et al.* (2014), the results show that all total effects are significant at least at a 5 per cent level. Basically, determining the degree of significance depends on the field of study and the purpose of the analysis. Table VII presents the path coefficient of the research hypotheses.

Figure 6 illustrates the path of risk factors in Yemen's oil and gas construction projects. The figure also shows the most groups of risk factors that affecting on the success of construction projects.

Coefficient of determination (R^2 value)

Another important requirement for the evaluation of the PLS-SEM structural model is the *R*-squared value, also known as the determination coefficient; the most commonly used measure to evaluate the structural model is the coefficient of determination (Henseler *et al.*, 2009). This coefficient is a measure of the predictive accuracy of the model and is calculated as the squared correlation between the actual and predicted values of a specific endogenous construct. The R-squared value reflects the variance ratio in the dependent variable(s) that can be explained by one or more predictors (Elliott and Woodward, 2007; Hair *et al.*, 2010). Although the acceptable level of R^2 value depends on the research context, Hair *et al.* (2010) and Falk and Miller (1992) proposed an *R*-squared value of 0.10 as a minimum acceptable level. Meanwhile, Chin (1998) suggests that the *R*-squared values of 0.67, 0.33 and 0.19 in

Figure 5.
Structural model assessment procedure

Table VII. Path coefficient of the research hypotheses

No.	Hypotheses	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	*t*-Statistics (|O/STDEV|)	*p*-values	Decision
Internal risk factors							
1	Client (CL) → Effect on project success	0.18	0.18	0.07	2.53	0.01**	Supported
2	Consultant (CN) → Effect on project success	0.22	−0.21	0.06	3.75	0.00**	Supported
3	Contractor (CO) → Effect on project success	0.00	0.00	0.09	0.03	0.007**	Supported
4	Feasibility study and design (FD) → Effect on project success	0.21	0.21	0.09	2.43	0.02*	Supported
5	Management risk → Effect on project success	0.32	0.31	0.08	3.84	0.00**	Supported
6	Resources and material (RM) → Effect on project success	0.39	0.39	0.09	4.59	0.00**	Supported
7	Tendering and contract (TC) → Effect on project success	0.04	−0.03	0.08	0.52	0.006	Supported

Notes: $*p < 0.05$; $**p < 0.01$

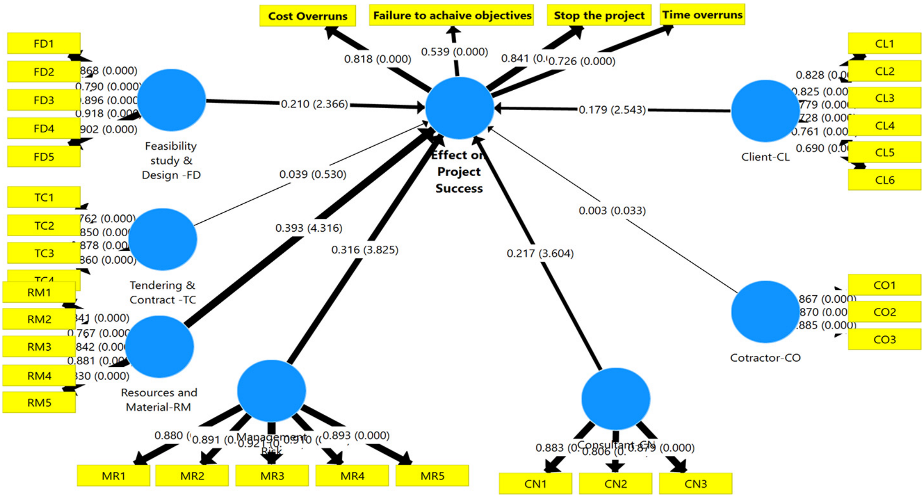


Figure 6.
Path analysis of the research hypotheses – internal factors

PLS-SEM can be considered as substantial, moderate and weak, respectively, and any R^2 values below 0.19 are unacceptable. Table VIII shows the R-squared values of the model.

Measuring the effect size (f^2)

According to Hair *et al.* (2014), a change in the R^2 value of all endogenous constructs when a specified exogenous construct is omitted from the model can be used to assess whether the omitted construct has a significant impact on the endogenous construct. This measure is referred to as the f^2 effect size. The effect size could be expressed using the following formula based on Cohen (1988), Selya *et al.* (2012) and Cohen *et al.* (2007):

$$f^2 = \frac{R^2_{included} - R^2_{excluded}}{1 - R^2_{included}} \tag{5}$$

It was reported by Hussain *et al.* (2018) that effect size is the degree of impact on the endogenous latent construction of each exogenous latent building. It changes the value of the determination coefficient (R^2) when an independent construct is deleted from the path model and defines whether the removed latent exogenous construct has a significant influence on the value of the latent endogenous construct. The 0.35 (strong effect), 0.15 (moderate effect) and 0.02 (weak effect) values are based on the 0.02 values (Cohen, 1988). List of f^2 values is provided in Table IX.

Blindfolding and predictive relevance (Q^2)

It was confirmed by Hair *et al.* (2014) the blindfolding procedure used to assess the predictive relevance (Q2 value) of the path model. Thus, the procedure of blindfolding can

Table VIII.
R-square of the endogenous latent variables

Constructs relation	R^2	Result
Effect of internal risks in project success	0.651*	Moderate

compare the original values with the values predicted. The path model has high predictive accuracy if the prediction is close to the original value (i.e. there is a small predictive error). This prediction error calculated as the difference between the correct values and the predicted values, together with a trivial prediction error (defined as the mean of the remaining data), is then used to estimate the value of Q^2 (Chin, 1998). The Q^2 values greater than zero suggest that the model has predictive significance to a specific endogenous structure. The values zero and below, on the other hand, indicate a lack of predictive significance.

According to Hussain *et al.* (2018), the blindfolding procedure applies only to endogenous variables with a reflective model specification as well as to single-item endogenous construct. Q^2 statistics are used to assess the PLS path model's reliability, measured using blindfolding techniques, and performed cross-validated redundancy. The Q^2 criterion recommends that the conceptual model be able to predict latent endogenous construct, as shown in Table X.

The goodness-of-fit of the model – goodness-of-fit

Model goodness-of-fit (GoF) is used as a complete model fit index to ensure that the model adequately describes the empirical data (Tenenhaus *et al.*, 2005), defined as the global fit measure, GoF is the geometric mean of both the extracted average variance (AVE) and the average of the endogenous variable of R^2. GoF's goal is to take into account the research model at both points, namely, measurement and structural model, with a focus on the model's overall performance based on Vinzi *et al.* (2010) and Henseler and Sarstedt (2013). The calculation formula of GoF is as follow:

$$GoF = \sqrt{\left(\overline{R^2}*\overline{AVE^2}\right)} \tag{6}$$

$$GoF = \sqrt{(0.651*0.723\ = 0.471)}$$

Table IX. Assessment of effect size (f^2)

No.	Constructs	Effective size f^2*	Result
Internal risk factors			
1	Client (CL)	0.310	Medium
2	Consultant (CN)	0.042	Small
3	Contractor (CO)	0.239	Medium
4	Feasibility study and design (FD)	0.126	Small
5	Project management (MR)	0.162	Medium
6	Resources and material supply (RM)	0.190	Medium
7	Tendering and contract (TC)	0.031	Small

Table X. Results of predictive relevance (Q^2) values

Endogenous latent variables	SSO	SSE	Q^2 (=1 – SSE/SSO)
Effect of internal risks in project success	1,256.00	844.901	0.327

GoF's requirements for deciding whether GoF values are not suitable, low, medium or large to be considered as a good validation of PLS model have been developed (Wetzels *et al.*, 2009). The table below presents these criteria.

Internal Risk Factors Model. The statistical analysis revealed the seven risk factors affecting project success that may be grouped into client risks, feasibility and design risks, tendering risks, resource risks, contractor risks, consultant and management risks. The results of the structural equation model suggest that the relationship between internal risk factors and project success in oil and gas construction projects can be explained by factor loading of all items which are above the required value 0.7; this means that all internal risk factors under study in this research have a great importance in influencing the success of projects, and the participants in the questionnaire agree with the authors' choices for these factors in terms of their impact on oil and gas projects in Yemen. While R-squared value represents the proportion of variation in the dependent variable(s), that can be explained by one or more predictor variables equal to 0.720 considered as a high value, and it is actually above than the required high value 0.67. Thus, the researchers have been able to get a lot closer in explaining the relationship between risk factors in oil and gas projects in Yemen and their effects on the success of these projects, and that addressing the causes of risks and developing appropriate strategies to respond to these risks will result in a reduction of approximately 72 per cent of cost losses and delay in implementing projects resulting from the effect of internal risk factors.

Moreover, the Q^2 is 0.527 above than zero, which indicates that the proposed model can predict the endogenous latent constructs. Thus, the positive relationship suggests that *H1*, *H2*, *H3*, *H4*, *H5*, *H6*, *H7* and *H14* are supported; this gives oil companies in Yemen a specific set of internal risk factors that lead to the failure of these companies to implement construction projects according to the cost and schedule specified in the contracts and the research shows the most critical factors affecting and has resulted in a model that has accepted all hypotheses were accepted after conducting statistical analyzes of the data collected through the structured questionnaire. The result of the GoF model for our model is 0.638 for internal risk factors' effect on project success, which is higher than 0.36 and considered a substantial value. Furthermore, the beta coefficient (β) value describes the strength between exogenous and endogenous latent constructs. In Table VII and Figure 6, the path coefficient of the research hypotheses test, the management risks (β = 0. 213), resource and materials (β = 0. 186) and feasibility study and design risk factors (β = 0.197) are the most internal factors related to the effect on project success; these factors need to focus more on an effective strategy to respond and mitigate the effects resulting in the cost of the project and the schedule as well as quality.

As reported by Periódico Trimestral (2016), with regard to the investigation of the structural model, it is essential to understand that the PLS-SEM adjusts the model to the empirical data in an attempt to obtain the best estimates of the parameters by maximizing the explained variance of the latent endogenous variable and, therefore, to the detriment of applying GoF measures to the model, the structural model is evaluated on the basis of the proposed model. According to Hair *et al.* (2014), the model was correctly defined, as it predicts the endogenous structures (Rigdon, 2012). The result of GoF for our model is 0.471 for the internal risk factors effect on project success, which is higher than 0.36 and is considered a high value based on Table XI.

Chandra (2015) conducted an essential study under the topic "Structural equation model for investigating risk factors affecting project success in Surabaya", wherein the data from a questionnaire survey of 180 valid responses were analyzed using SEM to predict project success. While the sample size is higher in our study, there are 314 valid responses.

Nonetheless, theoretical results in SEM indicate that the relationship between risk factors and project performance can be described by a standardized coefficient of $\beta = 0.442$ for natural risks; $\beta = 0.257$ for asset risks; $\beta = 0.651$ for financial risks; $\beta = -0.499$ for development risks; $\beta = 0.166$ for legal and regulatory risk factors; and $\beta = -0.197$ for construction factors. Thus, project performance is closely related to cost (standardized 0.878 coefficients), time (standardized 0.804 coefficients), customer satisfaction (standardized 0.884 coefficients), quality (standardized 0.873 coefficients) and revenue (standardized 0.850 coefficients), which is almost similar with our finding of risk factors and effects to project success.

Different authors and institutes have divided responses to risk into different numbers of responses. Most of them focused only on the negative impacts of risk and suggested no reaction at all to the positive impacts. Berkeley *et al.* (1991) and Roger Flanagan (1993) have divided the risk responses to avoidance, reduction, retention and transfer the risk. Ghahramanzadeh (2013) divided the responses into risk avoidance, mitigation, acceptance, share, transfer and monitoring. Likewise, Norris *et al.* (2000) have also focused on the negative impacts of risk and divided risk responses to remove, reduce, avoid, transfer and acceptance of risk.

According to Khodeir and Mohamed (2015), the risk management process also includes risk retention, risk transfer, risk reduction and risk avoidance strategies. Based on the research model for risk factors, we suggest the following responses with a short description of the risk threats presented; in addition, the project management and the circumstances of each company should choose the appropriate response to each risk factor:

Responses to risk factors are as follows:

- *Avoid*: to change several aspects of the scope of the project so that the risk can no longer have an impact or can no longer occur.
- *Reduce*: take proactive action to either reduce or reduce the likelihood of an event occurring.
- *Transfer*: this is another form of "reduce" response to reduce impact only, and mostly only the financial impact (this responsibility is assumed by a third party).
- *Acceptance*: conscious decision to retain the threat.
- *Share*: pain-sharing parties (within pre-agreed limits), typically when the cost plan has been exceeded.

Conclusion

This study examined the risk factors affecting the success of the construction project for the Yemen oil and gas industry. A total of 360 survey questionnaires have been sent to Yemen's oil and gas project teams. Data were analyzed through the Smart PLS software package using SEM. The statistical analysis revealed the six risk factors affecting the success of the project that can be grouped into client risks, feasibility and design risks, tendering risks, resource risks, contract risk, consultant risk and risk management. Analysis of the

Table XI. Value of goodness-of-fit (GoF) of the model

GoF less than 0.1	No fit
GoF between 0.1 and 0.25	Small
GoF between 0.25 and 0.36	Medium
GoF greater than 0.36	Large

structural equation model suggests that the relationship between risk factors and project success in oil and gas construction projects can be explained by the factor loading of all items above the required value of 0.7. While the R-squared value represents the proportion of variation in the dependent variable(s), this can be explained by one or more predictor variables equal to 0.651, which is considered as a medium and is actually close to the required high value of 0.67. In addition, the Q^2 is above 0.327 than zero, indicating that the conceptual model can predict the latent endogenous constructs. The positive relationship, therefore, suggests support for all research hypotheses. The result of the GoF for our model is 0.471 for the effect of internal risk factors on project success, which is higher than 0.36 and considered significant value.

In addition, the beta coefficient (β) value represents the power of latent structures between exogenous and endogenous. Table VII for path coefficient analysis hypotheses check, management risks ($\beta = 0.32$), resource and materials ($\beta = 0.39$) and feasibility study and design risk factors ($\beta = 0.21$) are the most internal factors related to the impact on project success; these factors need more consideration to built effective strategy in order to respond and mitigate the risk factors effects which lead to exceeding project cost and time. In addition, the internal risk factors research model shows the ranking of effects on project success starting with project stoppage (loading factor 0.841), cost overruns (loading factor 0.818), time overruns (loading factor 0.726) and project target failure with loading factor 0.539.

Resource and materials and risk factors for management are the most important factors associated with the impact on project success; these factors need to focus more on an effective strategy to respond and mitigate the effects resulting from project cost and schedule as well as quality. We expect this study to raise awareness of the value of risks for oil companies and investors that want to invest in Yemen's oil sector. Because of the lack of studies and research, especially in Yemen, this study is also a starting point for further research in this field. The study applies to three areas: academia, authorities/governments and the oil and gas sector. This research contributes to the academic sector by identifying the practical benefits and disadvantages of each risk factor in the oil and gas sector. It also identifies and groups risk factors for the more influential risk groups (stakeholders, communication, management of projects, economic, political and safety) that are most widely used (response). This should help future academic researchers look at other classes and examine how they affect other industries. Clearer definitions of risk and the current problems facing the petroleum and gas industries will assist future researchers in advancing and finding solutions. The new theoretical framework for risk in oil and production has not been applied in this study, and the application and development may be considered in future research. The study found limited documentation on projects to build petroleum and gas industries, which is a critical gap to be filled by future research. The next section lists out the suggestions and recommendations to reduce the probability of occurrences of problems and the impact of risk factors before they occur.

The authors believe that such a study will contribute to raising awareness among workers in the projects of oil companies and thus improve performance during implementing them and laying down the necessary plans to respond to the risks as they occur, as the absence of planning to face risks is one of the reasons for the failure of projects.

Recommendations

The following recommendations for minimizing and controlling internal risk factors in oil and gas construction projects are proposed in consideration of the statistically significant SEM for the cause and effects of risk factors:

- The client should develop a risk management plan that includes risk identification and response strategy based on the impact of each factor and then control and monitor risks throughout the project lifecycle and continuously update the information in this system until the end of the project.
- The client (either the government or the companies owning the oil sector) must expedite the decision-making process and reduce the administrative routine, which negatively affects the project time.
- Reducing the frequency of requesting change in the construction project, especially in the contractor's specifics.
- Contractors should recruit qualified and experienced engineers who can perform their functions effectively.
- Their staff should be developed by providing them with training courses and workshops and disseminating a culture of risk assessment and response during project implementation.
- A long-term supply chain plan must be prepared for the project before it is needed long enough, and the project should not be interrupted because of the delayed supply of materials.
- The contractor should have a plan to assess and monitor the risks under his responsibility and develop a strategy to respond to these risks.
- The consulting firm employs experienced and efficient work in oil and gas companies.
- The consultant shall be sufficiently familiar with the project requirements at the site and follow up any updates in drawings, designs and continuous communication with the client and contractor.
- Prepare periodic reports to determine the percentage of completion and the reasons for the possible delay before it occurs.
- Manage the contract efficiently and professionally and directly supervise the progress of work and identify the risk factors likely to face the project.

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