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Analyzing the Critical Risk Factors Associated with Oil and Gas Pipeline Projects in Iraq

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ABSTRACT

Although Oil and Gas Pipelines (OGPs) are a safe and economical mode of transportation of petroleum products around the world, they face challenges caused by risk factors including safety, security, design, construction and operational risks due to Third Party Disruption (TPD) and acts of terrorism, particularly in developing and unstable countries like Iraq. A lack of knowledge about managing such risks and the scarcity of past data about pipeline failures, are hindering OGP risk management systems. This paper, therefore, focuses on identifying and analyzing the risks caused by TDP in order to develop a holistic Risk Management Model (RMM). A semi-structured questionnaire was designed, using 30 risk factors identified through a comprehensive literature review, distributed to OGP stakeholders in Iraq, via an online survey tool, to collect the research data. SPSS was used to analyze the data and evaluate risk factors which were ranked in order of probability and severity level using a risk index method. A conceptual framework for the RMM is presented, based on the literature review and survey findings. The results reveal that terrorism, sabotage and theft are the most critical safety risks, official corruption and lawlessness the most influential factors for regulatory risks. Pipeline location "Hot-Zones" also have a serious impact on the failure of pipelines. A computer-based risk management model will be developed at the next stage of the study using the RMM and the results of the numerical risk analysis.

Keywords- *Pipelines; risk evaluation; risk management model; safety risk and third-party disruption.*

1. Introduction

Oil and gas pipelines (OGPs) are considered a safe and economical mode of petroleum product transportation, however they are subject to a range of hazards and accidental damage that have severe consequences on projects and people's lives. Long-distance pipelines mainly suffer from mechanical, operational and natural hazards [1], design flaws, misuse, corrosion damage and third-party disruption (TPD) [2]. Muhlbauer [3] defines TPD as any individual or group action that obstructs the functionality of the infrastructures' systems in any direct or indirect manner. Peng *et al*. [4] add any action that accidentally damages OGPs, such as human error, natural phenomena, soil movement (e.g. foundation collapse, landslides, floods and mudslides), and surface loads as a result of illegal building, blast construction and live ground loads that compress pipelines. In this paper, TPD refers to all individual and group actions that result in expected or unexpected pipeline damage, at any stage of the pipeline project. At the present time, globally insecure situations are adding more cause for concern and potentially serious consequences to OGP projects. This is especially the case in countries with low levels of security where OGPs often suffer malicious terrorist attacks. Such hazardous environments make OGP risk management challenging and complex.

OGP projects are complex and risky but crucial. Consequently, the risk management challenges and difficulties facing OGPs are increasing day by day due to the vast range of problems that are facing pipeline projects because of an unstable global environment. Proper attention needs to be given to OGP risk factors because neglecting these will result in casualties in terms of disturbance to business activities and economic losses. In the OGP risk management field, problems related to proper understanding, data availability and risk evaluation facilities have been noticed, particularly in developing and unstable countries like Iraq. This implies that risk management studies must be conducted and translated into formats that can be reviewed, understood and analyzed in order to maintain safe and secure construction and operational environments [5].

Even though risks to OGPs cannot be entirely avoided, dealing with each risk as severe is resulting in losses in expenditure [6] and time. Reasonable and accurate risk evaluation measures can contribute to a reduction in the overall risk of pipeline failure [2]. Risk management works to control risk factors and minimize risk impact, this process including four steps: (i) risk identification; (ii) risk analysis; (iii) risk response and mitigation, and (iv) risk monitoring and control [7]. Step 1, risk identification, is carried out to identify the factors that

62 affect OGP project success, both positively and negatively. This step is fundamental because
63 risk management is based on the premise that risk factors are identifiable as defending a system
64 from unknown risk is almost impossible [8]. Step 2, risk analysis, is about evaluating the
65 influence of identified risk factors on the project in terms of the chances of it happening,
66 frequency or likelihood, severity and the degree of impact. Both risk identification and analysis
67 depend on an appropriate and accurate knowledge base and real data as these provide the
68 required level of input for a successful risk evaluation [9]. In order to prioritize hazards that
69 need managerial attention, risk registers should contain all analyzed risks [10,11]. Because of
70 this, the current trend in risk management is to take a holistic and comprehensive approach to
71 projects [12], ensuring that adequate 'risk registration' and 'risk assessment' facilities are
72 available for effective risk evaluation. Step 3, risk response and mitigation, are about how to
73 respond to risk and choose actions that will reduce hazards and minimize consequences. Step
74 4, risk monitoring and control, are continuous processes carried out to identify and analyze new
75 risk factors, re-evaluate current risk factors and improve existing risk responses to ensure
76 adequate risk management.

77 Existing OGP risk management studies (for details see Table 1) do not focus on all types of
78 risk factors at a time, despite the fact that there are many different types of risks which can
79 affect the OGP. This is especially the case in countries where OGPs face unique risks due to
80 TPD, sabotage, acts of terrorism, civil war and rules and regulations. These risk factors have
81 not been effectively studied to date. While accurate risk factor probability and severity values
82 are required to manage OGP risks, these values are still imprecise, deficient and vague [13]
83 meaning that current analytical methods cannot calculate the probability and severity of TPD
84 and other similar factors.

85 One of the reasons why it is difficult to manage risk more effectively is because a historical
86 database has not yet been established [4,14]. This implies that current OGP risk evaluation
87 studies and tools are inadequate due to the lack of an acceptable knowledge base and a lack of
88 data. This situation is causing significant challenges for developing and unstable countries like
89 Iraq, as well as general issues around less effective OGP risk management systems. There is,
90 therefore, a vital and urgent need for an effective risk analysis study that can help to identify
91 and analyze OGP risk factors in a more effective way.

92 This study, therefore, aims to provide a thorough review about the risk factors applicable to
93 OGPs in countries where these projects are suffering severe consequences from terrorist attacks

94　and sabotage in addition to other risk factors. The main objective is to identify and analyze the

95　risk factors specific to Iraq. In doing so, it will address the current shortage of data and provide

96　relevant information for OGP risk management studies, such as a list of risk factors and the

97　degree to which they influence pipelines. This paper will actively contribute to the field of OGP

98　risk management in Iraq and other countries that are suffering the same kinds of risks, through

99　the provision of real data about pipeline failure based on OGPs stakeholders' perceptions that

100　reflect the reality of the problem. Moreover, the evaluation of the impact of each risk is a

101　fundamental step for any risk management study.

102　Moving forwards, this paper has been organized as follows. The methodology, risk factors

103　identification, data collection and questionnaire development are described in section 2.

104　Section 3 presents the results, section 4 the discussion and section 5 the conclusion moreover,

105　the evaluation of the impact of each on and suggestions for future research.

106

2. Methodology

108　A pragmatist paradigm is adopted to obtain meaningful results from both the qualitative and

109　quantitative approaches used in this research. The methodology that has been followed in this

110　research is based on a holistic framework of a Risk Management Model (RMM), which has

111　three phases as illustrated in Fig. 1. Phase I is about identifying OGP risk factors through an

112　available database or through a review of the previous literature, if there is no database

113　available. This phase could help researchers overcome the problems caused by the shortage of

114　available data. The findings from Phase I will be presented in Table 1. Phase II is about risk

115　analysis and data gathering. In this phase, a questionnaire survey will be designed and

116　distributed amongst OGPs stakeholders in Iraq to collect their perceptions about the probability

117　and severity levels of OGPs risk factors. To determine the numerical values of Risk Probability

118　(RP) and Risk Seventy (RS) descriptive statistical analyses are applied to the survey. Phase II

119　results will be presented in Table 3. Finally, phase III is about simulating risk factors using a

120　mathematical algorithm and computer-based model based on the findings from phases I and II.

121　The developed RMM will allow a comprehensive and systematic approach to OGP risk

122　identification and evaluation, specifically for governments or organizations at the beginning of

123　their management efforts in terms of risk factor identification, data registration and systematic

124   risk management. In this research, moreover, a new database will be created to store the

125   findings and recommendations from this research to be used for future research.
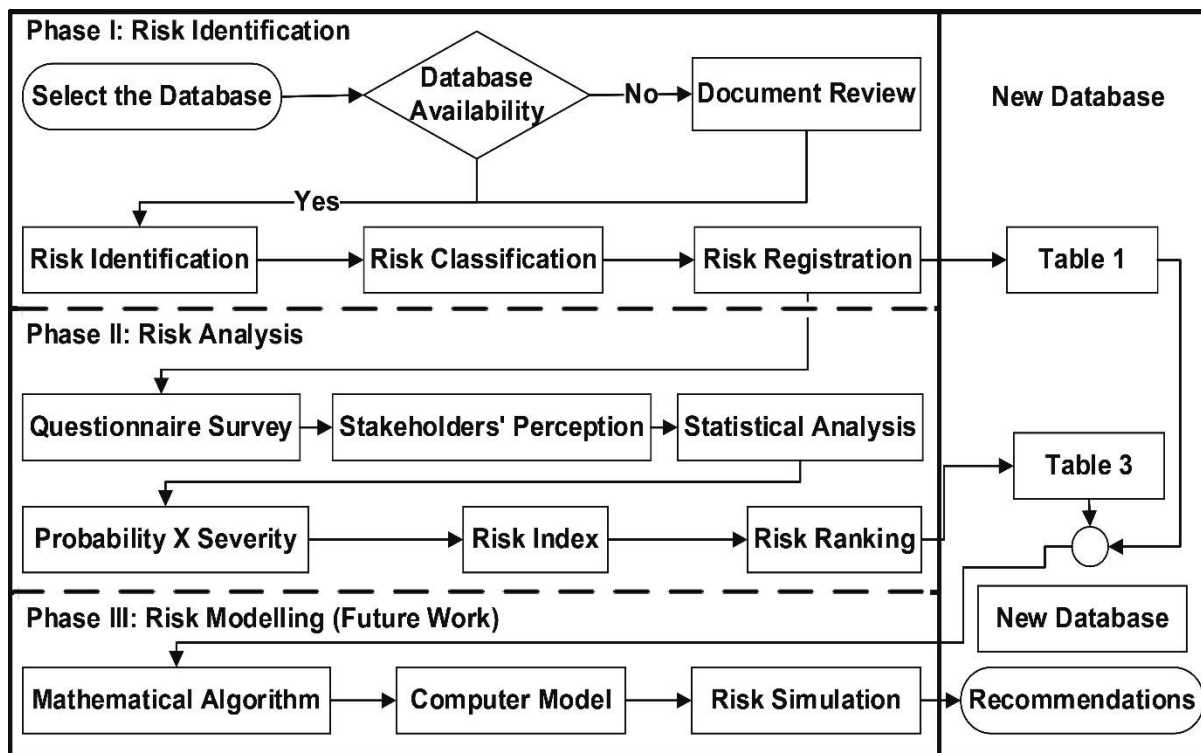
126

127   Figure 1: The Framework of the RMM.

128

129   Following the design of the RMM, section 2.1 details the process for phase I, sections 2.2 to

130   3.3 the process for phase II, and section 5 explains future work (phase III).

131   *2.1. Risk factor identification*

132   In Iraq, and other developing countries under similar situations, OGP risk management is

133   hampered by a shortage of data. To overcome this problem, a comprehensive document

134   analysis has been carried out here to identify the common causes of pipeline failure in different

135   countries, and under different circumstances, around the world. Pipeline risk factors at the

136   planning, design, construction, operation and maintenance stages have been identified,

137   classified by type and listed in Table 1.

138

139

140   Table 1: Critical OGP risk factors from the reviewed literature.

Risk Factors	Author	Risk Type
Socio-political factors such as education level and poverty	[2,9,15-17]	Security and societal (S&S)
Low levels of the general publics' legal and moral awareness	[4,18]	S&S
Thieves	[16,17]	S&S
Terrorism and sabotage	[9,15-17,18-20]	S&S
Threats to staff (kidnap and/or murder)	[21]	S&S
Leakage of sensitive information	[6,22]	S&S
Geographical location like 'Hot-Zones'	[6]	Pipeline location (PL)
Conflict over land ownership	[23,24]	PL
Accessibility of pipelines	[6]	PL
Geological risks like soil movement and landslides	[2,15,25]	PL
Vehicle accidents	[4]	PL
Animal accidents	[15,21]	PL
Lack of compliance with the safety regulations	[2, 16]	Health & safety and environment (HSE)
Non-availability of warning signs	[2,26]	HSE
Lack of proper maintenance and regular inspection	[2,9,5,11,16,20]	HSE
The opportunity to sabotage exposed pipelines	[21]	HSE
Inadequate risk management methods	[5,16]	HSE
Natural disasters and weather conditions	[9,15-17]	HSE
Weak ability to identify and monitor the risk factors	[16]	Operational constraints (OC)
Shortage of high-quality and modern IT services	[15,16]	OC
Corrosion and lack of anti-corrosive action	[2,6,11,16,19, 20,25]	OC
Design, construction, material and manufacturing defects	[2,11,19,20,25,27]	OC
Operational errors e.g. human error and equipment failure	[2,5,11,15,16,19,20]	OC
Hacker attacks on the operating or control systems	[6]	OC

The law not applying to saboteurs (lawlessness)	[4,15]	Rules and regulations (R&R)
Stakeholders are not paying proper attention	[16]	R&R
Few researchers are dealing with this problem	[16]	R&R
Lack of historical records about accidents and risk registration	[5,16]	R&R
Lack of proper training schemes	[5,16]	R&R
Corruption	[16]	R&R

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142   30 risk factors have been identified and classified into five types as follows: (i) Security and

143   societal. This type of risk includes terrorism and sabotage; thieves; public, legal and moral

144   awareness; socio-political dimensions such as education level and poverty; threats to staff, and

145   leakage of sensitive information about risks. (ii) Pipeline location. This includes risk factors

146   like "Hot-Zones"; easy access to pipelines; conflict over land ownership; geological risks such

147   as groundwater and landslides, and vehicle and animal accidents. (iii) Health & Safety and

148   Environment (HSE). This incorporates improper safety regulations; improper inspection and

149   maintenance; sabotage opportunities due to pipelines that are exposed as laid above ground;

150   limited warning signs; inadequate risk management, and natural disasters and weather

151   conditions, and (iv) Operational constraints. This includes corrosion and a lack of protection

152   against it; the weakened ability to identify and monitor threats; a shortage of IT services and

153   modern equipment; design, construction and material defects; operational errors, and hacker

154   attacks on the operating or control systems. (v) Rules and regulations covering corruption; laws

155   which do not apply to saboteurs and thieves; a lack of attention paid to circumstances by

156   stakeholders; a lack of proper training; a lack of historical and risk registration, and a paucity

157   of research addressing these problems.

158   *2.2. Data collection and questionnaire development*

159   Risk factors are characteristically vague, random and uncertain often accommodating a more

160   personal style of thinking, processing capability and cognition [2]. For these reasons,

161   stakeholders' perceptions and observations are both valuable and vital when identifying the

162   problems associated with OGPs and to evaluate risk factors. Stakeholders' perceptions are

163   based on their actual experience and knowledge about OGPs, making them well qualified to

164 monitor existing pipeline risks. Therefore, a quantitative industrial survey has been carried out

165 with stakeholders to analyze the probability and severity of risk factors in Iraq.

166 An online questionnaire survey was used in this research because it is one of the most widely-

167 used methods of additional data collection, are easy to manage, quick and inexpensive [28].

168 The survey targets participants who have relevant experience with OGP projects such as

169 consultants, planners and designers; construction, operating and maintenance workers;

170 administrators; owners and clients, and researchers. There are however, some

171 disadvantages/limitations associated with online services that could result in a low response

172 rate such as a lack of accessibility to the internet, issues regarding computer literacy, web

173 security and anonymity and knowledge about the website [29]. That said, authors like Bertot

174 [30] and Czaja and Blair [29] have concluded that this kind of survey is the easiest form of data

175 collection as real cooperation is provided via open-ended questions.

176 Before carrying out the main survey, a pilot survey was conducted to assess the clarity of the

177 survey and all questions which were found to be vague were revised or discarded. The revised

178 survey was distributed via an online survey tool to OGP stakeholders in Iraq. To ensure a

179 widespread distribution of the survey, the snowball sampling technique was applied [31,32]

180 whereby the survey was initially distributed to a number of previously identified participants

181 who were also asked to forward it to others until the required number of responses is reached

182 [31]. This technique can help to collect data from a large number of participants. Participants

183 were promised that their answers will be analyzed with confidentiality and anonymity.

184 The survey includes 12 questions comprising 95 items in total. Questions 1 to 6 are discussed

185 in this paper. Questions 7 to 12 are related to the future risk modelling work and simulation

186 therefore, they are not included here. Questions 1, 2 and 3 concern the participant's occupation,

187 experience and level of education in relation to OGP projects. Questions 4 and 5 are multi-

188 choice, five-point Likert rating scales. Question 4 asks respondents to evaluate risk factors in

189 order of probability of occurrence on a scale of 1 to 5 where (1) = rare, (2) = unlikely, (3) =

190 possible, (4) = likely and (5) = almost certain. Question 5 asks participants to evaluate risk

191 factors in order of severity on a similar scale where (1) = negligible, (2) = minor, (3) = moderate,

192 (4) = major and (5) = catastrophic. Question 6 is a drop-down question to compare the five

193 types of risk factors by ranking these types from 1 to 5 regarding their impact and consequences

194 on OGPs.

3. Results

3.1. Reliability and Validity

To assess the questionnaire's reliability, Cronbach's alpha correlation coefficient (α) has been calculated to measure the reliability and average correlation, or internal consistency, of survey items [31, 33, and 34]. Different levels of reliability are required depending on the purpose and nature of the study. Pallant [35] recommends an alpha value of 0.7 as a minimum level of reliability.

The α values are shown in Table 2 where it can be seen that all α values are well above the acceptable value of 0,7. In this paper, reliability testing was carried out for questions 4 and 5 as these were rated on a Likert rating scale. Regarding individual questions, reliability testing is not applicable, as question 1, 2 and 3 are asking about demographic information and question 6 is asking about participants' personal opinions about ranking risk factors types where no scale is applicable.

Table 2: α case processing summary.

Case Processing Summary	Total (N)	Number of items	Valid		Excluded *		α
			N	%	N	%	
Question No. 4	194	30	194	100	194	0	0,918
Question No. 5	194	30	194	100	194	0	0,863

* List wise deletion based on all variables in the procedure [36].

3.2. Sample demographics

194 responders completed the questionnaire. As shown in Fig. 2, a wide range of OGP stakeholders are represented in the sample.
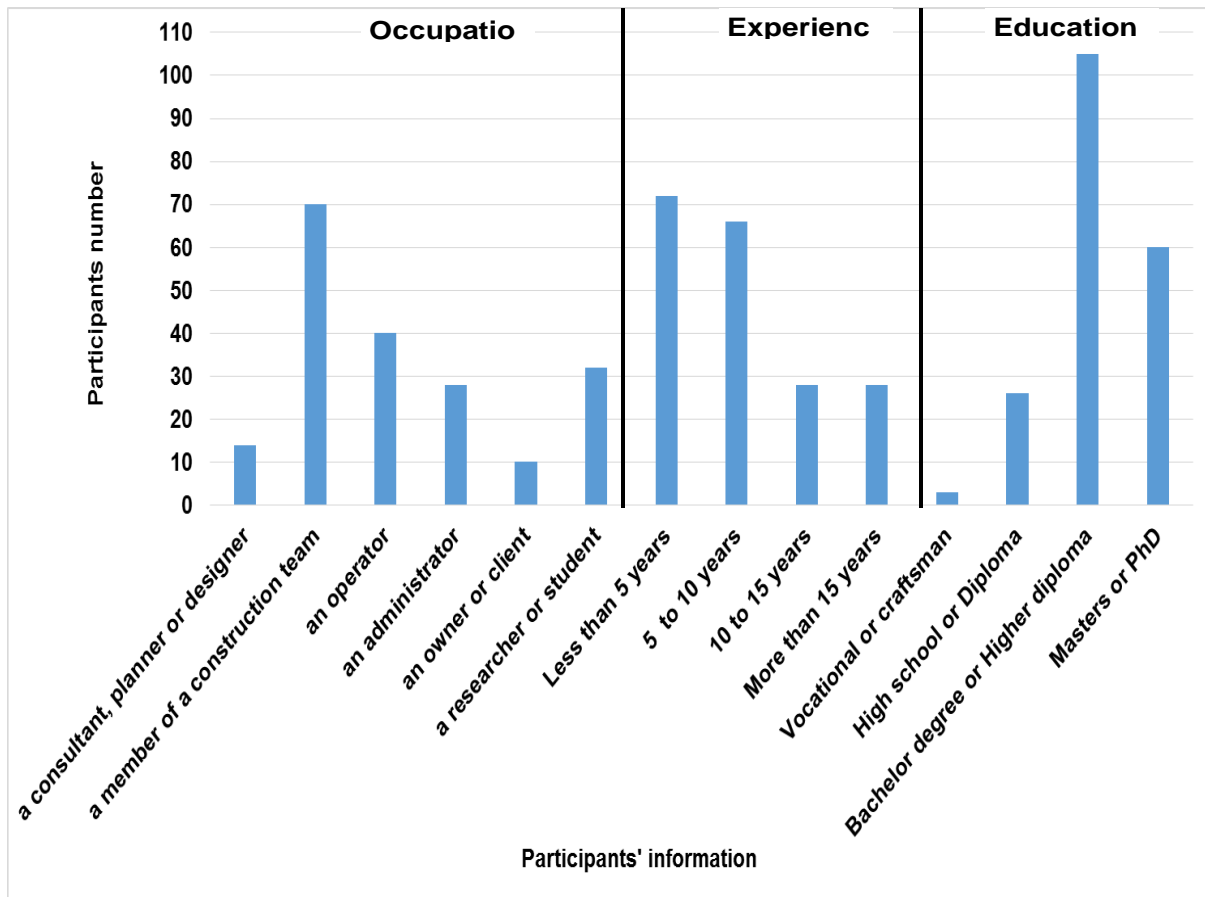
Figure 2: Participants' demographic information

Where * means occupation, ** means experience and *** means level of education.

RP and RS values have been calculated by determining the mean of the 5-point Likert rating scales. The RI value for each risk factor has been calculated using Eq. (1) [37-39].

$$RI = (RP \times RS)/5 \qquad\qquad ... (1)$$

Based on the statistical analysis of survey, the risk factors have been ranked according to their values of RI as presented in Table 3.

In Table 3, column 2 shows the probability of the risk factors and column 3 ranks the factors by their degree of probability. Column 4 shows the severity of the risk factors and column 5 ranks the factors by their degree of severity. Column 6 shows the RI values for each risk factors. Regarding the rank of the risk factors, there are two columns of risk ranking, column 7 shows the overall ranking of risk factors and column 8 shows per type risk factors ranking. The ranking for each of the five types of risk factors is as follows: (I) Regarding S & S risk factors, the survey results revealed that terrorism and sabotage actions are the most critical risk factors.

228 This is followed by theft; reduced legal and moral awareness by the public; threats to staff,

229 socio-political factors such as education level and poverty, and leakage of sensitive information.

230 (II) Regarding pipeline location risk factors, hot-zones are the riskiest, while animal accidents

231 factor the lowest. The 2nd, 3rd, 4th and 5th factors are pipeline is easy to access, conflict over

232 land ownership, geological risk and vehicle accidents, respectively. (III) HSE risk factors are

233 ranked as follows: improper safety regulations; inadequate maintenance and inspection;

234 pipelines above the ground and exposed; limited warning signs; the weak nature of risk

235 management, and natural disaster and weather conditions. (IV) Corrosion is the major

236 operational issue facing pipelines. This is followed by an inadequate ability to identify and

237 monitor risk factors; limited availability of IT; design, construction and material defects, and

238 operational constraints. Problems caused by hacker attacks on operating or control systems

239 have the least impact on pipeline systems in Iraq. (V) From R & R risks, corruption has the

240 highest impact, the remaining rules and regulations factors ranked as the law does not apply to

241 saboteurs and thieves; stakeholders are not paying proper attention; a lack of proper training;

242 the lack of an accident database and historical records, and little research on this subject.

243

244 Table 3: Risks factor probability, severity, index and ranking.

Risk Factors	RP	R1 *	RS	R2 *	RI	R3 *	R4 *
Terrorism and sabotage	3,985	1	4,485	1	3,574	1	S&S 1
Corruption	3,959	2	4,309	2	3,412	2	R&R 1
Geographical location e.g. "Hot-Zones"	3,696	4	4,093	4	3,025	3	PL 1
The law does not apply on the saboteurs and thieves	3,593	16	4,191	3	3,011	4	R&R 2
Thieves	3,680	6	4,067	5	2,994	5	S&S 2
Corrosion and lack of protection against it	3,691	5	3,979	6	2,937	6	OC 1
Improper safety regulations	3,675	7	3,938	8	2,895	7	HSE 1
Improper inspection and maintenance	3,649	10	3,923	9	2,863	8	HSE 2
Low public legal and moral awareness	3,711	3	3,840	11	2,850	9	S&S 3
Weak ability to identify and monitor the threats	3,624	12	3,876	10	2,809	10	OC 2

Stakeholders are not paying proper attention	3,521	18	3,943	7	2,777	11	R&R 3
Lack of proper training	3,629	11	3,753	13	2,724	12	R&R 4
The opportunity to sabotage exposed pipelines	3,655	9	3,665	16	2,679	13	HSE 3
Shortage of IT services and modern equipment	3,660	8	3,634	19	2,660	14	OC 3
Limited warning signs	3,624	13	3,665	17	2,656	15	HSE 4
The pipeline is easy to access	3,608	15	3,639	18	2,626	16	PL 2
Lack of historical and risk registration	3,552	17	3,696	15	2,625	17	R&R 5
Little research on this topic	3,624	14	3,577	22	2,593	18	R&R 6
Design, construction and material defects	3,320	21	3,830	12	2,543	19	OC 4
Conflict over land ownership	3,474	19	3,598	20	2,500	20	PL 3
Threats to staff	3,309	22	3,727	14	2,467	21	S&S 4
Socio-political effects such as poverty and level of education	3,428	20	3,397	24	2,329	22	S&S 5
Operational errors	3,072	24	3,588	21	2,204	23	OC 5
Inadequate risk management	3,206	23	3,387	25	2,172	24	HSE 5
Leakage of sensitive information	2,964	25	3,485	23	2,066	25	S&S 6
Geological risks such as groundwater and landslides	2,732	26	3,175	26	1,735	26	PL 4
Natural disasters and weather conditions	2,639	27	3,057	27	1,613	27	HSE 6
Vehicles accidents	2,443	28	2,706	29	1,322	28	PL 5
Hacker attacks on the operating or control systems	2,227	29	2,948	28	1,313	29	OC 6
Animals accidents	1,892	30	2,026	30	0,766	30	PL 6

*Where R1 = RP ranking, R2 = RS ranking, R3 = RI ranking and R4 = ranking per type.

According to the survey results, the five types of risk factors have been ranked as follows. Security and social type is the most critical risk factor, followed by pipe location; HSE; rules and regulations and operational constraints, as presented in Table 4, where rank 1 represents the highest impact and 5 the lowest impact amongst risk factors types.

251   Table 4: The ranking of risk factors types.

Risk factors type	Mean	Rank
Security and societal factors	2,155	1
Pipe location factors	2,634	2
HSE factors	3,134	3
Rules and regulations factors	3,536	4
Operational constraints	3,541	5

252

4. Discussion

253

254   Iraq has an extensive pipeline network used to transport oil products for local consumption and
255   for exports through ports and neighboring countries. To handle increases in oil production and
256   exports, a substantial number of new pipelines have to be built, both inside and outside of Iraq.
257   As well as, much of the existing pipelines are in need of repair and expansion [40]. At the same
258   time, there is an urgent need for the country to overcome the many formidable challenges and
259   risk factors that work to obstruct pipeline performance and the development of new projects
260   [40, 41]. A risk index that identifies risk factors and evaluates the probability and severity of
261   each risk is fundamental for risk management. Understanding and evaluating OGP risk factors
262   will help stakeholders, decision makers, policymakers and researchers to adopt a sustainable
263   risk management strategy during the different stages of pipeline projects.

264   The holistic RMM framework developed here aims to support the identification, analyses and
265   ranking of OGP risk factors more comprehensively and systematically. As such, this paper is
266   based on an extensive literature review which serves as its foundation providing a
267   comprehensive overview about OGP risk factors especially those in insecure environments.
268   OGPs risk factors have been analyzed and ranked based on the real observations of the
269   stakeholders. The RMM developed here provides a holistic and systematic approach to risk
270   management. It also provides a new database that supplies the data essential for risk
271   management processes, such as a potential list of risk factors and the probability and severity
272   of these factors. This paper's findings and recommendations are suitable and applicable for
273   OGPs in Iraq and many other countries under similar situations. OGP stakeholders could use

274 this paper's findings, specifically Tables 1 and 3 and Fig. 1, to improve risk management during
275 the pipeline projects' stages.

276 The questionnaire results were found to be reliable as all α values are above 0,7, as shown in
277 Table 2. The demographic information about the 194 responders reflects the diversity of the
278 sample, as shown in Fig. 2. This level of diversity means the questionnaire has reached the
279 target population as all categories of stakeholder are represented. Correct sampling facilitates
280 more realistic risk identification and enhances the results of the evaluation. The top risk factors
281 in Table 3 indicate that terrorism and acts of theft are the first and fifth most pressing factors.
282 Corruption is the second top risk factor, followed by geographical location e.g. "Hot-Zones"
283 and law as not applicable to saboteurs and thieves, all of which are obstructing pipeline projects.
284 Table 4 reveals that Iraqi OGP stakeholders are most concerned with security and societal risk
285 factors, the geographical location of pipelines and HSE factors. To establish an effective OGP
286 risk management approach in Iraq, stakeholders' perceptions are crucial to help identify and
287 analyze OGP problems because they are based on real experience of pipeline projects and
288 existing problems in the field. For these reasons, both the literature findings and survey results
289 will provide a clearer understanding of OGP risk factors.

290

5. Conclusion

292 Risk management is a continuous process of risk identification, analysis, evaluation and risk
293 response actions. Based on an extensive literature review, a list of thirty risk factors relevant to
294 OGPs, were identified and used to design a questionnaire and conduct an industry-wide survey.
295 A total of 194 participants were recruited using a snowball approach, the risk factors ranked
296 based on RP, RS and RI values. The results indicated that the risk factors with the highest
297 impact are terrorism and sabotage, corruption, "Hot-Zones", lawlessness regarding saboteurs,
298 and thieves. Geological risks, natural disasters and weather conditions, hacker attacks on
299 operating and/or control systems, and vehicle and animal accidents are the risk factors with the
300 least impact. The results of the statistical analysis show that the TPD is mostly responsible for
301 OGP failure in Iraq. It is concluded that TPD should be given priority in order to mitigate and
302 limit damage to OGPs in Iraq.

303 The findings support OGP risk management systems specifically in developing and unstable
304 countries like Iraq. OGP stakeholders could use the results provided in Tables 1, 3 and 4, as a

database to overcome the problem of data availability, using the research as a risk evaluation tool for monitoring and prioritizing risks during design, re-design, construction, operation, inspection and maintenance activities.

Looking to the future, this paper presents the initial findings of a PhD research which mainly focuses on identifying and analyzing the risks associated with OGPs and to present the initial framework for an RMM. These findings will be used to develop a computer based risk management model in the next stage of study, where the numerical results will be used as key input for the model.

Acknowledgements

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