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Claims prevention and control in large-scale construction projects: A case study

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Abstract

Effective claims management is essential in construction projects, particularly in the oil and gas sector, where disputes can lead to significant cost and schedule overruns. This study focuses on identifying and preventing claims in oil and gas piping construction projects—a critical yet underexplored area. A systematic methodology was employed, beginning with the identification of potential claims through expert consultation, followed by prioritization using a probability-impact analysis based on survey data collected from 70 industry professionals. The study then proposes practical preventive strategies derived from expert interviews and aligned with PMBOK risk response principles. Results indicate that delays in material delivery, design changes, and contractual ambiguities are among the most critical claims. The proposed strategies, including improved work breakdown structures, timely issuance of drawings, and enhanced communication protocols, can significantly reduce disputes and improve project performance. These findings provide actionable insights for project managers and contribute to the broader discourse on risk and claim management in complex industrial projects.

1. Introduction

Construction projects are inherently unique and complex, making them highly susceptible to changes and unforeseen conditions. Consequently, claims often arise as frequently as project events themselves. Although a well-drafted contract can significantly reduce the likelihood of future claims, it cannot eliminate the risk of conflicts [1]. Claims can derail projects from their primary objectives, leading to time and cost overruns and deteriorating stakeholder relationships [2-4]. As Kisi et al. [5] observed, claims and disputes are costly, time-consuming, and damaging to project morale. They frequently result in schedule delays, budget escalation, and strained professional relationships [6]. To mitigate these adverse effects, project teams must fully understand claim settlement processes. Ignorance of contractual terms, inadequate planning, and poor communication often contribute to project-wide losses [7, 8]. Disputes are almost inevitable in construction projects [9]; therefore, understanding the most prevalent claim types and their preventive measures is essential for effective claim resolution [10]. Given the significant increase in claims, an effective claim management procedure is critical [10]. Optimal claim management enhances project performance and helps control time and cost overruns, which are common outcomes of construction claims [11]. Although numerous studies have examined causes of claims in general construction projects, there is a notable gap in research focused specifically on oil and gas piping projects. This study addresses this gap by identifying and prioritizing the most critical claims in such projects and proposing practical prevention strategies.

The findings of this research are applicable to other oil and gas construction projects, though claim prioritization may vary by context. Industry professionals can leverage these insights to proactively manage claims and reduce disputes.

1.1. Relationship between claim and risk

Claims can be considered project risks [1]. A claim is an uncertain event that can threaten project goals; therefore, probability and ranges of impact can be used to prioritize identified claims [1]. Prior research has shown connections between payment risks and claims [12], significant correlations between risk groups and disputes in subcontracting [13], and claim identification as a subprocess of risk management [14].

1.2. Causes of claims in construction projects

To decrease the deleterious effects of claims, studies have identified delays, payment related claims, change orders, scope change, site conditions, acceleration, inconsistencies in specifications and drawings, unforeseen conditions, and contractual claims as the most common categories [2–5, 15–23]. These principal claim categories and their supporting references are summarized in Table 1. Zaneldin [15] identified the most important causes of claims in the UAE through data collected from 124 claims for a variety of projects and presented some practical implications to reduce/prevent claims in the construction industry. Mehany and Grigg [16] specified the major common reasons of claims based on data collected from the Department of Transportation in Colorado and summarized that delays are the most significant causes of construction-related claims. The results also showed that projects with fixed completion dates faced more claims than projects with more flexible due dates. Dastyar et al. [10] proposed approaches for claim prioritization and management and also offered practical recommendations for reducing claims and preventing them. Kisi et al. [5] discussed dispute resolution in road-related construction contracts in Nepal and summarised that claims related to changes, site conditions, and delays are the major types of disputes. Ilter and Bakioglu [13] illustrated a feasible model to analyse the relationship between risk and dispute in subcontractor contracting systems. Mahamid et al. [17] investigated the time performance of road construction projects in the West Bank to recognize the causes of delay and their severity by participating contractors and consultants through a questionnaire survey. Assaf and Al-Hejji [18] studied construction projects in Saudi Arabia and emphasized that the most common cause of delay by all three parties, i.e., the owner, consultant, and contractor is change order. Kadry et al. [19] studied the causes of delays that may be encountered in countries with high geopolitical risks and presented the most important root causes of any potential claim that may arise in the construction industry. Cheung and Pang [20] focused on three factors that cause construction disputes: contractual incompleteness, people, and tasks. Hassanein and El Nemr [24] reported that change order claims accounted for 54% of total claims in Egypt. Al-Qershi and Kishore [25] determined the main causes of claims and their sources in the Indian construction industry and provided recommendations and suggestions to avoid/mitigate claims. Mohamed, Khoury, and Hafez [26] introduced the term contractor's bidding system by analysing potential claim damages. Scott and Harris [21] argued common types of claims in the UK construction industry, concentrating on four options: the weather conditions, early completion projects, and quantification of the costs connected to an approved extension of time, and simultaneous delays.

1.3. Causes of claims in oil and gas industry

Oil and gas projects have a special place due to specific complexity, high costs, project size, and importance. Given the vast amount of budget spent in the oil and gas projects, a small deviation from this budget will impose much damage to the project. Since the claim increases project costs [27, 28], it is necessary to recognize the relevant project claims and provide preventive solutions before project implementation. Accordingly, many types of research have focused on claims and disputes in oil and gas construction projects.

Oil and gas projects feature high complexity, cost, and risk. Prior research emphasizes external risks [1], quantified piping claims via Monte Carlo [22], prioritized cost/time drivers via AHP [29], and analyzed dispute resolution modes [23, 30]. A summary of these previous studies, including their project types, key claim causes, and methodologies, is presented in Table 2.

Hasheminasab et al. [1] extracted a list of important and frequent claims in oil and gas industry projects in Iran and concluded that the external risks, such as political, social, cultural, and economic issues, are the most important causes of claims in this industry. Raeisi and Bagherpour [22] identified that claims in oil and gas projects were quantified through Monte Carlo simulation, leading to the estimation of their impact on project costs. Khanzadi and Yousefi [29] employed an analytical hierarchy process (AHP) to prioritize the causes of claims in the oil and gas field. They concluded that "inflation and increase in the wage, price of materials and equipment" is the most important claim. Connerty [23] identified the types of disputes that can arise in the oil and gas industry and the dispute resolution methods in use, including litigation in national courts, alternative dispute resolution (ADR), and expert judgment. Mills and Karim [30] worked on disputes in the oil and gas sector in Indonesia.

Table 1. Main causes of claims in construction projects

No.	Reasons for claim	References
1	Delays	[2–5, 15–22]
2	Payment-related claims	[6–13]
3	Contractual claims	[5, 14, 15, 32]
4	Change the scope of the project	[5, 6, 13, 16]
5	Acceleration	[5, 6, 13, 32]
6	Different site conditions	[4-6, 13]
7	Change order claims	[1, 17–22]
8	Inconsistencies in specifications and drawings	[4, 5, 14, 21, 23]
9	Unforeseen conditions	[27, 28, 31, 33–38]

Table 2. Summary of previous research on claims in oil and gas projects

Author(s)	Year	Project Type	Key Claim Causes Identified	Methodology
Hasheminasab et al.	2014	Oil, gas & petrochemical	External risks, political & economic factors	Survey analysis
Raeisi & Bagherpour	2016	Piping projects	Design changes, material delays	Monte Carlo simulation
Khanzadi & Yousefi	2009	Oil & gas infrastructure	Inflation, wage & material cost escalation	AHP
Connerty	2002	Oil & gas sector	Contractual disputes, risk allocation	Legal analysis
Mills & Karim	2010	Oil & gas projects	Regulatory and contractual disputes	Case-based analysis

Although many studies have been performed to identify the causes of claims in oil and gas projects worldwide, no study identifies the most actionable claims in oil and gas piping construction projects. In an onshore oil and gas engineering, procurement, and construction (EPC) project, piping construction accounts for more than 40% of the total work volume (Jo et al. [31]). As of 2017, approximately 3,800 transmission (long-distance) pipelines were in operation worldwide with a total length of 1.21 million mi. Oil and gas construction projects are mainly distributed in Asia, Russia, Europe, North America, Latin America, and Africa [39]. Recent research has emphasized the importance of probabilistic techniques such as Monte Carlo simulations in project risk analysis, particularly in estimating cost and schedule uncertainties. Grobbelaar [33] demonstrated how a free Excel-based Monte Carlo simulation tool can be effectively used to model project cost and schedule risks using triangular input distributions and Weibull output distributions. The study showed that such models can provide budget estimates with defined confidence levels, offering a more informed basis for decision-making than traditional methods such as PERT or fixed contingency percentages.

Recent studies published by Alemu and Thakur [40] and Yıldız et al. [41] emphasize the importance of structured delay analysis, risk assessment, and improved communication in construction project performance. Their findings support the need for systematic approaches to identifying and mitigating delay- and coordination-related risks, which aligns with the focus of the present study on actionable claim drivers in oil and gas piping projects.

1.4. Distinctive characteristics of claims management in oil and gas projects

Claims management in oil and gas construction projects differs significantly from that in general building or infrastructure projects due to the industry's high capital intensity, technical complexity, and strict safety and regulatory environments. Oil and gas projects are commonly executed under EPC or EPCF contracts, involving extensive risk transfer to contractors. Long lead procurement items, complex multidisciplinary interfaces, frequent design development during construction, and stringent health, safety, and environmental requirements increase both the likelihood and impact of claims. As a result, proactive claim identification, strict adherence to contractual notice provisions, and comprehensive documentation are essential to effective claims management in oil and gas projects.

1.5. Significance of the study and research question

Despite extensive research on construction claims, limited attention has been given to actionable and discipline specific claims in oil and gas piping construction projects. Piping works account for a substantial portion of project cost and schedule exposure and are particularly vulnerable to coordination issues between engineering, procurement, and construction activities. Therefore, the significance of this study lies in its focus on identifying, prioritizing, and preventing claims that can be practically managed by project teams in oil and gas piping projects. The study addresses the following research question: *Which claims are most critical in oil and gas piping construction projects, and how can these claims be effectively prevented using a structured risk based approach?*

1.6. Claim process

Construction claim management includes claim identification, quantification, prevention, and resolution [42, 43]. This process ensures that potential claims are recognized early, evaluated systematically, and managed to minimize negative impacts on project time, cost, and contractual relationships. In large scale construction projects, claims often arise from design changes, schedule deviations, site conditions, procurement issues, and differing interpretations of contract clauses.

1.6.1. Construction claim identification

Identifying claims is the first important step of analyzing the whole claims management process. Most claims arise from field conditions, project delays, or contract interpretation. However, a claim situation must be recognized and identified as soon as it happens [35]. Construction Claim identification should be handled in timely and accurate detection. This is the major important phase of the claim process. For example, some construction claims are ignored individually due to the failure of identifying them [36]. Claim identification starts in cases where a change in scope or contract terms is seen. Appropriate identification involves a well-documented description in excess of the contract terms [43].

Al Khaldi et al. [37] used data mining techniques to accurately predict and rank the causes of construction claims. Various feature selection methods were used to compare the overlap of rated causes with those identified in the previous studies.

He and Chen [14] presented a process control-based model that the claims risk analysis, contract situation analysis, and schedule analysis should be done altogether in aggregation with the system of identifying claim opportunities at the contract initial stage, execution phase, and at completion stage.

Dastyar et al. [10] investigated claims and proposed methodologies for their identification, prioritization, and management. This research used a statistical sample of 117 participants in the construction industry due to the similarities of construction projects. They categorized related factors in 6 groups and, as a result, presented practical implications for managing claims and preventing them in the construction industry.

1.6.2. Construction claim prevention

The best way to manage claims is to avoid them. Thus, the emphasis should be on preventing claims from the initiation stage. A well-documented, risk-reduced contract will likely handle any claims. So, most owners and contractors perhaps do their best to achieve this goal [43]. A practical evaluation of potential disputes can lead to equitable risk allocation and decreased disputes and claims. Some tools have been improved to assist parties with such assessments. For example, the Construction Industry Institute's (CII) Dispute Prevention and Resolution Task Force has explained the Dispute Potential Index (DPI) to predict the likelihood of various types of disputes. The software breaks down factors that contribute to disputes into three general groups: people, process, and project [25]. Alaloul et al. [38] reviewed the present methodologies used in construction projects to prevent and resolve disputes. They presented the advantages and disadvantages of the methods and identified the best-fit methods for specific situations. Stojadinovic [44] proposed methods for quantifying time and cost and provided recommendations for claim prevention from the investor's and contractor's perspectives. Zaneldin [15], Al-Qershi and Kishore [25] determined the causes of claims in the construction industry and provided recommendations and suggestions to prevent claims. Lekarapa and Grobbelaar [45] emphasized that traditional budgeting methods — such as history-based, value-oriented, and analytical approaches — often fail to capture the high uncertainty inherent in heritage building projects. They advocate Monte Carlo simulation as a practical, user-friendly tool that incorporates uncertainty into cost predictions. By enabling probabilistic forecasting and confidence-level budgeting, Monte Carlo simulation can support more accurate planning and reduce the likelihood of claims arising from budget overruns. Further, Lekarapa and Grobbelaar [45] found that project managers involved in heritage building restoration perceive the Monte Carlo Method as a promising tool for improving budget forecasting. Their study revealed that although the method is not widely used, it could significantly enhance the accuracy of cost estimates and help mitigate risks associated with uncertainty — aligning closely with broader goals of claim prevention through improved planning and risk analysis.

1.7. Claims under FIDIC EPC Contracts

The projects examined in this study were executed under FIDIC based EPC (Silver Book) arrangements, in which contractors assume greater responsibility for design completeness, site conditions, and unforeseen events, with claims governed by strict notice and documentation requirements. Within this framework, the high ranking claim categories we identified—such as delays in drawing issuance, material delivery issues, and contractual ambiguities—reflect FIDIC's risk allocation and procedural obligations. Accordingly, our methodology evaluates claim probability and impact in the context of these FIDIC duties (early identification, timely notification, and rigorous record keeping), and our conclusions propose preventive strategies (e.g., clearer contract drafting, coordinated drawing release, inventory aligned work fronts) that align with FIDIC EPC claim management principles.

2. Methodology

The present research seeks to examine claims and offer solutions in order to manage them in oil and gas piping projects. Piping is an integral part of every oil and gas project. In addition to the typical claims occurring in construction projects, there are specific claims that may arise in piping construction projects; accordingly, this research tends to identify them in a specialized way and suggests useful strategies to prevent known claims.

At first, a list of actionable claims of oil and gas piping projects has been prepared. Then, a questionnaire is prepared that includes questions about probabilistic claims in oil and gas piping construction projects. The selection of people is based on their communication skills and involvement in projects, especially piping projects, their individual experiences, and practical views on construction in the oil and gas industry. Finally, answered questionnaires are collected for claim analysis and monitoring.

The questionnaire evaluated two factors of "probability" and "impact", and as a result, the required data are collected. To find the significance or magnitude of causes, both factors of the probability of claim occurrence and the chance of claim success (intensity of claim occurrence) are evaluated. The questionnaire questions have been designed to enable the desired examination and to establish the required relationship between the researcher and the respondents. According to the 5-point Likert scale (very low, low, moderate, high, very high), the rate for each index for each claim is polled and scored [46].

To find the most probable and effective causes of claim occurrence, they are first ranked by risk degree and, second, their positions in the probability-impact matrix are determined. Finally, some response strategies to prevent them are introduced from the perspective of 20 piping managers with more than 15 years of work experience. The model (Fig. 1) has been presented to identify, prevent, and perform risk analysis of the claims. Each step is described as follows.

2.1. Identification of initial claims (Step 1)

In the first step, potential, probabilistic, and litigable claims in oil and gas piping construction projects were identified through expert judgment. This process involved 20 Project Management Consultants (PMCs), piping managers, and piping experts, all holding at least a bachelor's degree and possessing more than 15 years of professional experience in oil and gas EPC projects. Given the limited availability of published research focused specifically on claims in oil and gas piping construction, expert opinions served as the primary source for identifying claims to address this research gap in a specialized manner. Checklist screening and expert interviews were used to identify frequently occurring, actionable claims affecting piping construction activities. The experts reviewed typical contract conditions, construction practices, and prior project experiences to determine claims with clear spheres of influence on contractor contractual objectives. As a result of this process, a list of 30 initial probabilistic claims was generated, documented, and prepared for further screening and analysis in the subsequent research stages.

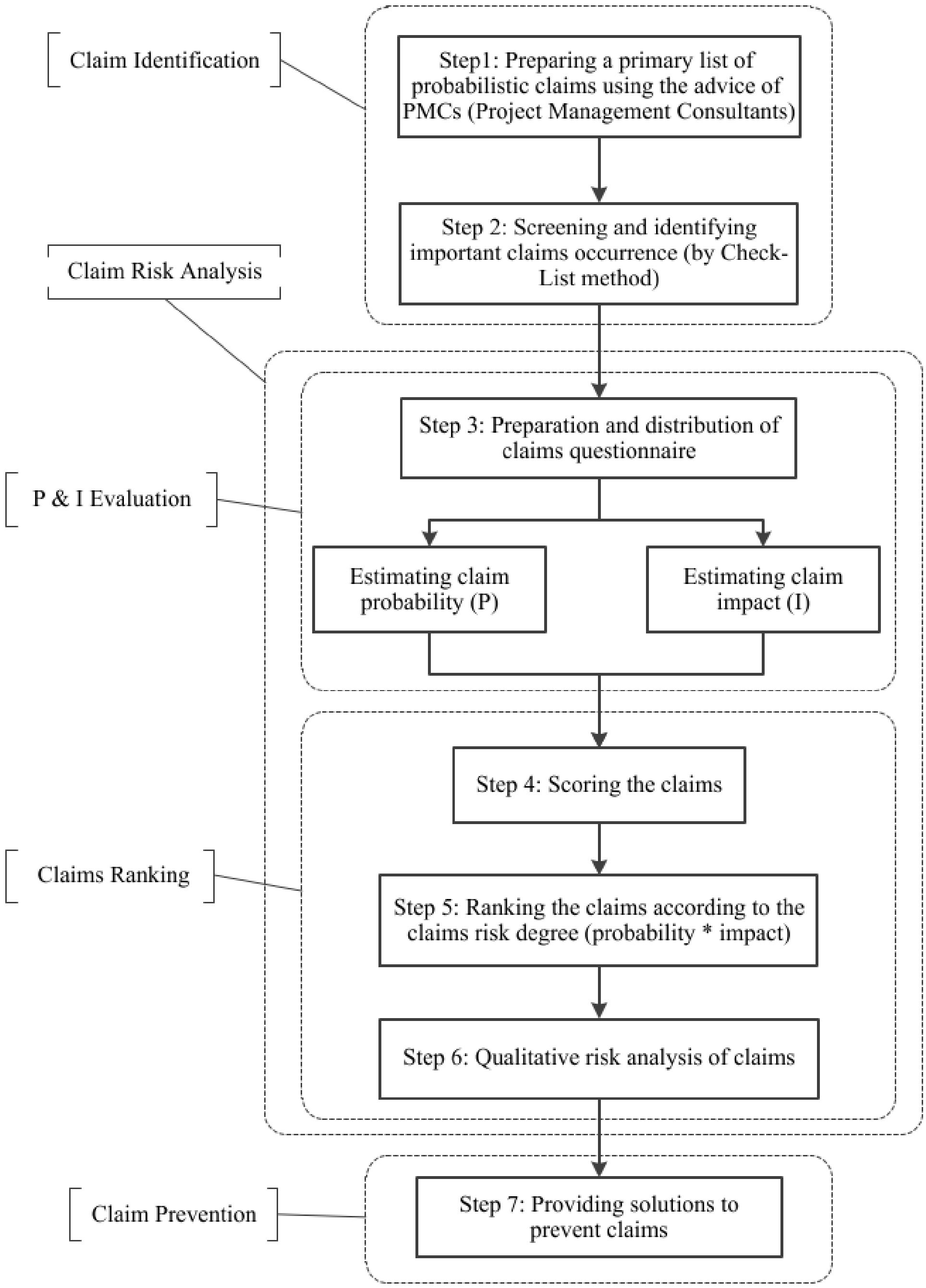

Fig. 1. Claim identification, prevention, and risk analysing model

2.2. Screening and selection of key claims (Step 2)

In the second step, the initial list of 30 claims was refined through face to face and online interviews with 30 experienced pipeline managers and piping experts, each having more than 15 years of professional experience. Since the importance of claims varies across projects and the available project resources to prevent disputes are limited, it is not practical to address all identified claims simultaneously. Therefore, a checklist-based screening approach was applied to evaluate each claim on its relevance, frequency of occurrence, and potential impact on project objectives. Through this systematic screening process, overlapping and low impact claims were removed or integrated, and the list was reduced from 30 to 15 critical and actionable claims. These selected claims received focused attention and were carried forward for quantitative evaluation and prioritization in subsequent stages of the research.

2.3. Questionnaire design and administration (Step 3)

To identify the most important claims, two factors—probability of occurrence and impact (or chance of claim success)—were evaluated using a structured questionnaire. Both factors were measured using a five point Likert scale, with descriptive ratings of very low, low, medium, high, and very high, corresponding to numerical scores of 1, 2, 3, 4, and 5, respectively. The questionnaire comprised 15 questions, each representing an actionable claim, and required respondents to assess both the probability and impact of each claim. The questionnaire was administered via email and paper based formats and distributed to 70 named respondents with substantial experience in oil and gas piping construction projects. The meanings of the probability and impact classifications are presented in Table 3, while the professional positions and work experience of the respondents are summarized in Table 4.

To check the content validity of the questionnaire, the viewpoint of 20 PMCs having more than 15 years' experience in the field of piping construction projects in the oil and gas industry are used. Also, the SPSS software is exploited to measure the reliability coefficient for the questionnaire. The research questionnaire includes questions on the probability and effect of each claim; thus, it yields two Cronbach's alpha coefficients. Researchers use Cronbach's alpha coefficients to show their statistic is relevant [47]. Cronbach's alpha coefficient for questions measuring probability and impact is 0.766 and 0.709, respectively. As can be seen, these values are close to 1, which indicates a high level of internal consistency.

3. Analysis

To clarify the sequence of the research process, it is important to note that Steps 1–3—claim identification, screening, and questionnaire design—were fully described in the Methodology section.

Table 3. Classification of claim probability and impact

Natural language expression	Numeric Score	Probability of the Claims	Claims Impact (Claim Chance of Success)
Very low	1	It has occurred seldom or never occurred in piping projects.	The probability of the claim occurrence is negligible, and their risk can be neglected.
Low	2	It has occurred in a few projects.	The intensity of the claim occurrence is low, and probabilistic claims are easy to resolve.
Medium	3	It has occurred in an average number of piping projects.	The claim's chance of success is Medium and cross-sectional, and the efforts of the parties can resolve claims.
High	4	It has occurred in most projects.	The claim chance of success is high in the project, but it will involve the cost and time.
Very High	5	It has occurred in all projects.	The intensity of the claim occurrence is very high, and it made severe problems in the implementation of the project and affected the claims project strongly.

Table 4. Respondents' profile

Positions	Number of respondents	Percent
Piping manager	20	28.6%
Project manager	8	11.4%
Contract manager	10	14.3%
Piping expert	16	22.9%
Planning and control project manager	10	14.3%
Site manager	6	8.5%
Years of experience		
Less than 15 years	13	18.6%
15 to 20 years	37	52.9%
More than 20 years	20	28.5%

The Analysis section, therefore, continues from this point and presents Steps 4–7, which include scoring the claims, ranking them based on probability–impact values, evaluating their risk levels, and finally proposing preventive strategies derived from expert input.

3.1. Claims scoring method (Step 4)

For each claim, respondents provided two ratings: (i) the probability of claim occurrence and (ii) the impact (or chance of claim success). For each factor, the mean score was calculated as the frequency of responses across each Likert scale category. The scoring approach used in this study is conceptually similar to the Relative Importance Index (RII) method commonly applied in construction management research. However, in this research, the RII concept is adapted to a probability–impact risk assessment framework to transform expert judgments into quantitative measures suitable for claims prioritization. For example, for the claim related to differences and defects in contract terms, the number of responses for the probability of occurrence rated as very low, low, medium, high, and very high were 6, 6, 11, 20, and 27, respectively. To improve clarity, the abbreviations used in Equation 1 are restated here. In this calculation, VL, L, M, H, and VH correspond to the verbal probability ratings *Very Low, Low, Medium, High,* and *Very High* used in the questionnaire. Equation 1 computes the mean probability score for each claim based on the weighted responses:

$$\frac{6\times VL+6\times L+11\times M+20\times H+27\times VH}{70} = \frac{6\times 1+6\times 2+11\times 3+20\times 4+27\times 5}{70}=3.80 \qquad (1)$$

Eq. (1) denotes the mean score computation used for both probability and impact.

The average impact score for each claim was calculated in the same manner. This process was repeated for all identified claims, and the resulting mean probability and impact scores for the 15 selected claims are presented in Table 5.

3.2. Claims ranking (Step 5)

Variables used in scoring include:

- Probability of claim occurrence (P)
- Impact or chance of claim occurrence (I)
- Degree of claim risk (C)

Table 5. Claims of oil and gas piping construction projects and their ranking

Row	Claim Event	Factor	Average Score	Score 100(I*P)	Rank
1	Claims related to differences and defects in contract terms	Probability	3.8	14.277	4
		Impact	3.7571		
2	Not being ready or holding prerequisites of piping	Probability	4.1286	16.809	2
		Impact	4.0714		
3	Claims related to the issuance of different permits	Probability	2.2429	4.9343	12
		Impact	2.2		
4	The contractor claims, in case of issuance of site material request (SMR) and delay in delivering material or non-issues (NIS) of material	Probability	4.3	17.876	1
		Impact	4.1571		
5	The employer delays in delivering isometric drawings	Probability	3.8143	14.222	5
		Impact	3.7286		
6	Changes in plans (isometric & drawing revision) in different sections	Probability	3.7286	14.382	3
		Impact	3.8571		
7	Claims related to the FINs (field inspection notification) of various stages	Probability	2.1286	4.4092	14
		Impact	2.0714		
8	Change in executive standard of the project (inspection and test plan (ITP) and project's specifications)	Probability	2.7714	7.0078	11
		Impact	2.5286		
9	TQ (technical query) due to failure, inadequacy and deficiencies information plan	Probability	3.6	12.446	6
		Impact	3.4571		
10	Interferences with other contractors	Probability	3.3714	11.367	8
		Impact	3.3714		
11	Miscellaneous delay factors of piping project	Probability	2.1714	4.6531	13
		Impact	2.1429		
12	Absence of executive supervisor of employer to receive work from contractor	Probability	2.0714	4.3796	15
		Impact	2.1143		
13	Letter writing and official correspondence regarding general executive affairs	Probability	3.3429	10.458	9
		Impact	3.1286		
14	Delay in piping invoices payment	Probability	3.4143	11.755	7
		Impact	3.4429		
15	Claims related to test package and hydro test operation	Probability	2.8429	7.6351	10
		Impact	2.6857		

After calculating the mean probability and impact score of claims, the degree of claim risk (C) is calculated by multiplying the probability of occurrence (P) by impact (I). Eq. 2 shows this calculation. Now, the identified claims can be ranked and prioritized based on the degree of claims risk.

$$C = P \times I \tag{2}$$

Eq. (2) denotes the overall risk degree.

For example, if the average scores for the probability and impact of claim occurrence are 3.80 and 3.757, respectively, the degree of claim risk will be:

$$C = 3.80 \times 3.757 = 14.27$$

Once the degree of risk for all claims is calculated, ranking is based on that risk. Obviously, the most probable and most impressive claim has a higher degree of claim risk. Accordingly, the most important claims are identified. In summary, the results of the first and second steps of the proposed model consisted of 15 claims in piping construction projects of the oil and gas industry. In the third and fourth steps, the probability and impact of each claim are recognized, and the mean probability and impact scores are calculated. In this step, the 15 known claims are ranked by risk level. For each claim, the average score of impact, the average score of probability, the degree of claim risk, and the claim rank are given in Table 5.

3.3. Qualitative risk analysis of claims (Step 6)

After identifying and ranking the most critical claims in piping projects of the oil and gas industry, we should know the importance of each claim. Since the significance of claims in each project is different, how to deal with them will also be different. The claim with a very low impact on the project or a very low probability of occurrence during the project implementation has less significance than the claim with a high probability or impact. Accordingly, if project participants become aware of the importance of the claim, they can have an effective plan to control and overcome them.

Fig. 2 indicates the risk P-I matrix (Risk Probability and Impact Matrix). This matrix helps the project professionals to improve the quality of data and the process of claims ranking. These matrices can be used in other projects. Once the average probability and impact score of claims have been calculated in step 4, their importance should be determined. Using a risk ranking matrix, the status of each claim is specified in terms of probability and impact. In Fig. 2, the vertical axis shows values of probability, and the horizontal axis shows values of risk effect, and the numbers show the rate of risk factor. This matrix shows the importance of claims and allows project professionals to identify which claim may have more detrimental effects.

Given the average probability and impact score for each claim and comparing them with the values in the claim P-I matrix, it would be transparent where risk is located (Fig. 2). We can determine an appropriate response by identifying the significance area for each claim. Based on the 4x4 risk matrix, the risks are categorized into four levels: very high, high, medium, and low. Level I is low risk (green area), which indicates that the risk of an event is not high enough, the project can be continued with existing control, but the changes should be considered and monitored; level II is medium risk (yellow area), which indicates that strengthened detection and monitoring are required to reduce this risk; level III is high risk (orange area), which shows that any threat obtaining this risk level must be treated in order to reduce the risk level and reach an acceptable level; level IV is very high risk (red area), which represents the critical situation so that measurement that can reduce the risk should be conducted immediately. Fig. 2 shows the probability–impact (P–I) matrix used to classify claims into low, medium, high, and very high risk categories. The matrix is adapted from PMBOK qualitative risk assessment guidelines.

The probability–impact (P–I) matrix used in Step 6 is adapted from the qualitative risk assessment approach presented in the PMI Construction Extension to the PMBOK Guide [43].

3.4. Strategies to prevent claims (Step 7)

Large-scale construction projects are very complicated. These projects are described in some plans and program specifications; they must be executed by the main contractor and some subcontractors, most of whom do not collaborate. This fact can increase the probability of raising claims. Since each project is unique, it has particular circumstances; therefore, it is not possible to anticipate all aspects.

			Probability				
			Very Low	Low	Medium	High	Very High
			1-2	2-3	3-4	4-5	5
Impact	Very High	5	5	10	15	20	25
	High	4-5	4	8	12	16	20
	Medium	3-4	3	6	9	12	15
	Low	2-3	2	4	6	8	10
	Very Low	1-2	1	2	3	4	5

Fig. 2. Probability–Impact (P–I) matrix (adapted from PMBOK qualitative risk assessment)

However, some contradictions occur in contract records, and disputes are very prevalent in the oil and gas industry. In general, according to this study's results, the most important potential claims in oil and gas industry piping projects, along with corresponding response strategies to prevent them, are shown in Table 6.

Several risk response strategies are available, according to PMBOK [48]:

- Avoidance
- Transference
- Mitigation
- Acceptance

In this research, we consider the avoidance and mitigation strategies to prevent claims. Risk avoidance could perhaps change the initial project plan to remove the potential risk or preserve the project goals. Although the project team can never eliminate all risk events, some risks may be avoided. Mitigation efforts decrease the probability and impact of the risk event to an acceptable threshold.

To eliminate or reduce the detrimental effects of known claims, some recommendations by an interview with 20 piping managers having more than 15 years of work experience in the piping construction industry are given in Table 6. Once the most important claims are identified in order of preference, by holding brainstorming sessions with experts and engineers, some solutions are provided to prevent the claims. A list of the most important identified claims, which may occur in piping construction projects of the oil and gas industry, and their preventive solutions are as follows:

- The contractor claims, in case of issuance of site material request (SMR) and delay in delivering material or non-issues (NIS) of material

Preventive solutions are:

- Sending work front to contractors based on inventory.
- Issuing MIV (material issue voucher) based on the executive work front.

- Claim of not being ready or holding prerequisites for piping

Preventive solutions are:

- Applying work breakdown structure (WBS).
- Issuing work orders to contractors based on the construction work front.
- Removing obstacles and prerequisites to prevent the contractor's claim and performing the operation given the schedule.

- Claim of changes in plans (isometric and drawing revision) in different sections

Preventive solutions are:

- Raising Technical Queries (TQ) in ambiguous cases before the executive operation.
- Submitting as-built drawings.

- Claim of differences and defects in contract terms

Preventive solution is:

- Describing the ambiguous details in a private contract so that the least personal interpretation would be possible about the content of the contract.

- Claim related to the delay of the employer in sending the isometric drawings

Preventive solutions are:

- Considering all executive details in drawings as much as possible, sending the last revision promptly, and finally resolving the ambiguities in workshop sessions.
- Releasing work orders and work fronts to contractors based on the issued drawings.

- Claim related to TQ (technical query) due to the insufficiency, defects, and lack of information on the drawings

Preventive solution is:

- TQ or RFI is inevitable, and the design engineers should be meticulous in design and final confirmation of the drawings and plans as much as possible. They should apply all executive details in drawings.

- Claim of delay in payment related to Invoices

Preventive solutions are:

- Reviewing the invoices and documents format before the formal delivery.
- Considering the amount of work done according to the deadline in the invoice based on the micrometre provided.

- Claim related to interference with other contractors

Preventive solutions are:

- Examining the scope of work and dividing it into separate areas.
- Defining golden-joint to prevent interference between contractors.

- Letter writing and official correspondence regarding general executive affairs

Preventive solution is:

- Replying to letters accurately, considering technical and legal issues at the appropriate time.

- Claims related to the test package and the hydro test operation

Preventive solutions are:

- Prioritizing work sequences based on the most important items for hydro testing.
- Having full knowledge of the looping and test package cycle.
- Testing based on project procedures.

- Claim related to a change in the executive standard of the project (inspection and test plan (ITP) and specifications of the project)

Preventive solution is:

- Reviewing the contract documents (such as technical specifications) and preparing a list containing discrepancies, ambiguities, and missing information that are considered inappropriate.

- Claim related to the issuance of different permits

Preventive solution is:

- Issuing work permits in coordination with all disciplines, including Civil, Structure, Piping, Electrical, and Instrument, and so on.

- Claim of miscellaneous delay factors of piping projects
  Preventive solutions are:
- Supplying and delivering materials to the subcontractors concerning the work front
- Reducing the number of variation orders (VO) or change orders (CO).

- Claims related to the FINs (Field Inspection Notification) of various stages
  Preventive solutions are:
- Being punctual to inspect the completed work.
- Develop and implement inspection and test forms for recording inspection and testing for each activity on time.

- Absence of the executive supervisor of the employer to receive work from the contractor
  Preventive solutions are:
- Assigning a formally authorized deputy to receive and approve completed work in the absence of the employer's supervisor
- Implementing standardized digital handover and acceptance forms
- Defining acceptance timelines and delegation procedures within contractual documents

3.5. Significance of the research

Oil and gas projects are inherently high-risk due to their complexity, scale, and financial implications. Piping, as a major component of these projects, accounts for a significant portion of cost and schedule performance. Therefore, understanding and managing claims in this discipline is essential for project success.

This research contributes by:

- Identifying and prioritizing claims specific to oil and gas piping projects, which differ from general construction claims.
- Providing practical preventive strategies that can be implemented by project teams to reduce disputes and associated costs.

The findings offer a structured approach that can be adapted to other large-scale industrial projects, enhancing claims management practices across the sector.

4. Discussion

Recent studies published by Alemu and Thakur [40] and Yıldız et al. [41] demonstrate that delays, coordination issues, and insufficient risk assessment practices continue to have major impacts on construction project performance. The findings of the present study are consistent with Alemu and Thakur's [40] identification of delay driving mechanisms, particularly in how material shortages and late design deliverables intensify schedule pressures. However, our research differs by focusing specifically on piping related claim mechanisms within oil and gas EPC projects, a level of discipline specific detail not examined in their work. Similarly, Yıldız et al. [41] highlight broader communication challenges, and our results show how such gaps escalate into formal claims when drawing releases and contractual obligations are not synchronized.

In addition to these JCEMI studies, the present findings also align with prior research summarized in Table 2. For example, Hasheminasab et al. [1] emphasized the role of external and political risks, whereas our results show that operational and documentation related issues dominate in piping construction. Raeisi and Bagherpour [22] quantified piping claims using simulation, and our probability impact ranking complements their approach by identifying high priority claim categories. Meanwhile, Khanzadi and Yousefi [29] highlighted cost escalation as a major driver, but in our dataset, design changes and material delays were more prominent. These comparisons show that, while aligned with the general claim patterns reported in the literature, this study provides more actionable, discipline specific insights relevant to piping activities in EPC environments.

5. Conclusions

This study identified and ranked fifteen key claims in oil and gas piping construction using a probability–impact approach. The analysis showed that material related delays, lack of work prerequisites, drawing revisions, and contractual ambiguities represent the highest risk claim categories, reflecting the strong dependency of piping work on timely engineering and procurement coordination.

Positioning these claims within a probability–impact matrix highlights which issues are most likely to compromise project cost and schedule performance. High priority claims consistently related to documentation accuracy, timely issuance of drawings, and clarity of contractual responsibilities, while lower priority claims—such as those involving permits or inspection notifications—were found to have more limited project impact.

The preventive strategies proposed by industry experts directly address these analytical results, emphasizing improved workfront readiness, clearer contract wording, better material-tracking practices, and more coordinated communication. Because the examined projects operated within FIDIC based EPC frameworks, these recommendations align with FIDIC's requirements for early notice and robust documentation.

Overall, the study provides a practical and prioritized framework for managing and preventing claims in piping construction. Future research may extend this model to other EPC disciplines or validate these findings with real project performance data.

Declarations

Conflict of Interests

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Author Contributions

S. Raeisi: Investigation, Methodology, Data Collection, Formal Analysis, Visualization, Writing. M. Bagherpour: Supervision, Validation, Writing – Review & Editing.

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Data Availability Statement

All data, models, and code generated or used during the study appear in the submitted article.

Ethics Committee Permission

As part of an interview with humans involved in this research, the construction ethics committee, dated 1 May 2025, reviewed the ethical considerations under number Cons-Eth-25-08.

Use of Generative AI and AI-assisted Technologies

The author(s) used AI partially and ethically to assist with language editing, formatting, improvement and have reviewed and take full responsibility for the final content.

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