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Risk analysis in NEC type B contracts, a case study in Peru

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Abstract– ***The study examines risk management in traditional unit price contracts under the State Contracting Law (LCE) in public works on the northern coast of Peru, impacted by natural phenomena such as the El Niño Phenomenon, contrasting them with NEC Option B contracts. 50 contracts were evaluated through official sources such as SEACE and OSCE, in addition to conducting surveys with 30 professionals and interviews with 22 specialists. The findings indicate that the risks associated with natural phenomena, technical failures and social disputes are mainly attributed to contractors, causing disputes, excessive expenses and de-lays. On the other hand, NEC Option B contracts offer fairer risk management, versatility in scope modifications and better contractual relationships, thus reducing conflicts. The study determines that the application of NEC Option B contracts in public infrastructure projects could significantly enhance risk management in Peru. It is advisable to train experts in the industry and make changes to regulations to simplify their implementation. The implementation of this model has the potential to reduce disputes and enhance the effectiveness of projects, guaranteeing their feasibility and long-term sustainability.***

Keywords-- Risk allocation, NEC contracts, controversies, contracts, state contracting

I. Introduction

Globally, public works are essential for economic and social growth, but they face challenges such as cost overruns, delays, and contract disputes due to inadequate risk management and unforeseen changes. To mitigate these problems, innovative contracts such as NEC (New Engineering Contracts), created in the United Kingdom and widely used in Europe, Asia and Latin America, have been adopted. Their approach is based on collaboration, proactive management and equitable risk sharing, allowing greater flexibility to manage change and prevent conflicts. These contracts have proven effective in flagship projects such as the London 2012 Olympic Games and major reconstruction projects in developing countries. By promoting transparency and cooperation between the parties, NEC contracts have become an internationally recognized contractual model for improving operational efficiency and minimizing controversies in public infrastructure projects [1] [2].

In recent years, additional work, delays and stoppages of construction works on the north coast and in Peru, have been increasingly recurrent, with the risk assignment clause in the contractual field being one of the main causes of all this because there is a misallocation of these risks that mostly have an impact on the contractor. [3] [4] [5] [6].

It is known that success in construction works revolves around a correct administration or management of the clauses of the contract, since the contractual compliance of the projects depends on this, for example, non-compliance with the work schedules has an impact on causes of possible controversies, and a correct administration of the contract and properly managing the risks would avoid the cost overrun of the projects. [7] [8] [9] In the search to solve these problems due to the misallocation of risks or other problems of conventional contracts at unit prices, non-conventional contracts have been implemented for some years such as NEC contracts that seek collaborative work and early intervention of good contractual practices, which has already gained great success in European and English countries. however, this has its origin in the balance and correct distribution of risks to the parties [10] [11] [12] [13].

Currently, the possibility of implementing and standardizing NEC contracts with a more consolidated approach for each region in Peru is being considered, despite the fact that some years ago in Peru NEC contracts were already used under the direction of the Peruvian state belonging to the Presidency of the Council of Ministers through the Authority for Reconstruction with Changes (ARCC) program. today called the National Infrastructure Authority (ANIN) who have signed a State-to-State agreement with the United Kingdom of Great Britain for the construction of infrastructure in various regions of the country; for which NEC contracts were used as a tool [14].

In this scenario, the purpose of this article is to elucidate the perception of the improvements offered by the NEC option B contract, as opposed to traditional contracts under the unit price modality, for the correct allocation of own risks in projects on the northern coast of Peru such as those caused by the El Niño phenomenon and in general recurring and susceptible risks according to the reality of the region [15]. And that in this way they serve as a turning point to postulate their eventual implementation in the search for standardization in public works.

II. Context

A. *Engineering Contracts*

Engineering contracts are agreements between the contractor and the contractor for the execution of a specific project. These contracts establish bases, terms of reference, responsibilities and requirements that determine deadlines, costs and scope. Its application is governed by the procurement laws and regulations of each country, highlighting the relevance of collaborative standard contracts such as FIDIC and NEC, which have proven to be effective in various projects worldwide [16] 17].

B. *NEC Contracts in Latin America*

Recently, NEC contracts have been applied in Latin America, driven by investments from the United Kingdom and agreements between governments for the development of megaprojects, such as the Pan American Games in Lima and other initiatives in Brazil. Its implementation has shown positive results, optimizing the management of projects that, under traditional methods, faced difficulties and controversies during their execution due to inconsistencies in the contractual part [18] [19] [20].

C. *Development of NEC Contracts in Peru*

Since 2017, Peru has begun to implement NEC contracts, starting with the Lima 2019 Pan American Games, where

expectations for improved management were met. Currently, numerous projects are being carried out, such as the Bicentennial Schools and hospitals, thanks to the G2G agreements between Peru and the United Kingdom and ANIN (formerly ARCC) projects. The implementation of these NEC contracts is expected to continue to increase in the coming years, adapting to the needs of each project [21].

D. Contracts under the LCE and its Regulations in Peru

In Peru, under the State Contracting Law (LCE) and its regulations, there are two contracting systems: unit prices and lump sum. The selection of the system depends on the level of detail of the project. Unit price contracts allow you to recognize what is actually executed, while the lump sum establishes a fixed price, which increases the risk for the contractor. Despite the flexibility offered by unit price contracts, the Comptroller's Office has reported controversies and stoppages in a significant percentage of works, which highlights the need to investigate the causes of these problems [22].

E. NEC Option B

NEC Option B contracts are a modality in which payment is made according to the meter executed, using a fixed unit price [4]. This methodology is similar to that of unit price contracts under the LCE; however, the NEC promotes a collaborative approach throughout the project, incentivizing parties to work together to maximize the benefits of the project rather than pursuing individual interests. In addition, the NEC establishes clear mechanisms for change management and risk mitigation, contributing to more efficient implementation and reduced disputes [23].

Based on all of the above, we consider the following problem:

Have the risks and actions of unit price contracts under the State Contracting Law (LCE) in Peru's public works been analyzed, considering the susceptibility of certain regions to specific risks, compared to the effectiveness of the NEC contract, especially Option B, in optimizing risk management, given their similarity as payment options?

This research seeks to close gaps in the implementation of NEC contracts, in particular in Option B, which, despite its affinity with unit price contracts under the State Contracting Law (LCE), has not yet been applied in Peru. The benefits of this model and the reasons for its absence in the country will be presented through research, international experiences and the opinion of specialists, in order to facilitate its future implementation at the national and Latin American level.

III. Objectives

A. General Objective

To analyze the risks and actions of traditional unit price contracts in public works on the northern coast of Peru, comparing their effectiveness with the implementation of the NEC Option B contract, to optimize risk management and ensure project continuity.

B. Specific Objectives

1. Identify the main risk clauses in unit price contracts, focusing on inadequate risk allocation as a critical factor that negatively impacts project management
2. Evaluate the effectiveness of the NEC Option B contract compared to traditional unit price contracts, analyzing its capability in the flexibility of project scope change management.

IV. Literature Review

[24] In a study analysing how NEC contracts, compared to traditional contracts, they are shown to offer significant improvements in risk management, including clear risk allocation in the pre-contract stages, the implementation of an early warning system, and the promotion of mutual trust between the parties involved. The study focuses on Hong Kong's construction industry.

[25] NEC contracts offer multiple options, including secondary option clauses, X clauses, which allow both the entity and the contractor to jointly agree to establish additional clauses on the liabilities resulting from the initial allocation of risks, which could be due to changes in regulations, penalties, limitations of responsibilities, all for a better coping with the risk of arising.

[26] They analyze the great relevance of early warnings in civil engineering works and how their implementation is carried out. On the other hand, they analyze the conditions and benefits for their implementation in the field of construction works and/or projects, seeking to start from a confrontational management of traditional contracts to a collaboratively efficient management and management of risks, through the implementation of NEC contracts.

[27] conducted an analysis of the risks that are the causes of disruptions in the development of construction sites in Palestine, based on a quantitative approach from the perspective of contractors with respect to factors such as the severity index and frequency of these risks. The research highlighted the point that risk management should be implemented throughout the project cycle through collaborative actions between the parties, seeking proposals to eliminate, avoid or adapt to risks and thus carry out the project successfully.

[28] It mentions that traditional contracts have deficiencies in terms of the distribution of risks between the contractor and the contractor. This translates into an imbalance in the responsibilities between the parties, so that in the event of a negative impact on the project, an atmosphere of tension and possible controversies is generated. This situation, assumed in some cases by the contractor, is accepted with the aim of compensating the risk through the increase in the cost of the project for the owner.

[29] He concludes in his research that international standard contract models do not effectively guarantee an efficient execution of works simply by their application. To achieve a full and effective development of these contracts, it is essential to adhere to their work philosophy, prioritizing collaboration between the parties and strengthening the capacities of public officials and control bodies to properly manage these contracts.

[30] The 2019 Pan American and Parapan American Games Special Project used contracting mechanisms such as Government-to-Government Agreements and New Contracts such as the Engineering NEC due to the lack of national experience in mega sporting events. Many public entities consider adopting these methods for their projects, but often do not fully understand their scope. This paper explains the characteristics of these contractual figures and their experience in the Pan American Games, offering recommendations for their use by public entities.

[31] They investigated the compatibility of the ECC's provisions with the laws of the United Arab Emirates, finding that there are no more contradictions with the Czech Civil Code than with the Red Book. Thus, these discrepancies do not explain the lesser adoption of the Czech Civil Code in civil law countries. In construction projects, standard contracts, such as those from FIDIC and NEC, are essential for their time and cost efficiency. The FIDIC "Red Book" and the NEC "ECC" are the most widely used, although the former is more widely used in civil law countries.

[32] They identify the advantages and disadvantages of integrating the good practices of NEC 4 with the Peruvian State Contracting Law. Through a case study in a road project in Arequipa, five deficiencies in procurement processes that affect

contract management are revealed, and opportunities for improvement in the implementation of public infrastructure are proposed. The research seeks to contribute to the understanding and application of NEC4 in the public sector. The study analyzes the need for a collaborative environment in civil engineering and construction in Peru, where a lack of trust and learning among the parties involved currently predominates. Through a literature review, the situation of public works procurement in the country is examined and compared with the New Engineering Contract (NEC), recently implemented in infrastructure projects.

V. Methodology

A. Collection of contracts and details through public project monitoring websites.

A mapping of 50 traditional unit price contracts subject to the State Contracting Law 30225 and its current Regulations was carried out, which specifically belong to 3 regions of the Peruvian North coast: Tumbes, Piura and Lambayeque; to have a more focused focus on the risk area affected by the El Niño Phenomenon and derivatives, likewise, interviews and surveys will be carried out with outstanding professionals who work or have worked to date as contractors and/or managers of construction projects, as well as NEC contracts in order to explore the management of contractual risks and their assignment model in contracts at unit prices [33] [34]. In short, guidelines were drawn based on the data collected and analyzed, which will be supported by the opinion of experts in the field.

Data was collected from the digital platform "SEACE 3.0", in which the 50 traditional contracts were distributed among the 3 regions (Tumbes, Piura and Lambayeque) in an equitable manner, taking as an additional criterion the diversity and complexity of projects. Next, a record matrix is used to compile all the contracts to be analyzed, taking into account points such as location (department), name, contracting modality, risks assigned according to the contractual clause, initial and final cost.

This record served to statistically verify, by means of graphs, that the balance that exists in terms of the designation of risks to each of the parties is not equitable, with the Contractor actor being the most harmed, leading to a series of controversies that are reflected in the fluctuation of the final settled cost.

B. Risk Assessment and Expert Opinion

Based on the literature collected and analysis of contractual data, a series of contractual risks are established that become disputes between the entity and the contractor, thus hindering collaboration between the parties. To this end, the possibility of implementing NEC type B contracts will be evaluated, which resemble traditional unit prices in terms of the form of payment, for this purpose the use of surveys and interviews with professionals on risk management was used as an instrument, from the distribution in the clauses of the contract to the management of the materialization of the same [35] [36].

Within the survey , it was decided to pose closed questions, such as: 1. Years of experience in construction projects, 2. Type of projects in which you frequently participate, 3. Which of these contracts have you used most frequently in your projects?, 4. From your experience, do you consider that the clauses of traditional unit price contracts are effective for risk management?, 5. What risks most generate additional or some type of controversy in projects managed under traditional unit price contracts?, 6. In your experience, what are the contractual clauses of NEC or standardized contracts that avoid the generation of conflict or ambiguity in the allocation of risks?, 7. Do you think that NEC Option B contracts offer a fairer distribution of risks compared to traditional unit price contracts?, 8. In terms of flexibility to manage changes in the scope of the project, how do you rate the capacity of NEC Option B contracts versus unit price contracts?, 9. What has been your experience in resolving disputes under NEC contracts?, 10. What type of clauses in NEC or standardized contracts avoid the generation of conflict or ambiguity in the allocation of risks?, 11. Would you recommend a broader implementation of NEC contracts in Peru for construction projects?

The same that have been applied to 20 professionals in the sector with sufficient experience in the specialty of NEC Option B and Unit Price Contracts - LCE, which were validated by themselves. These results will be evaluated and corrected in statistical reliability by means of Cronbach's alpha parameter, which will be taken as acceptable or good with values greater than 0.6, while the result of the questionnaire resulted in 0.75 [37] [38].

As for the interviews, the selection filters were maintained with respect to the survey, and it was decided to ask open questions through virtual meetings, which made it easier for 18 interviewees to be willing to raise casuistry, experiences, recommendations, etc.

C. Process flowchart

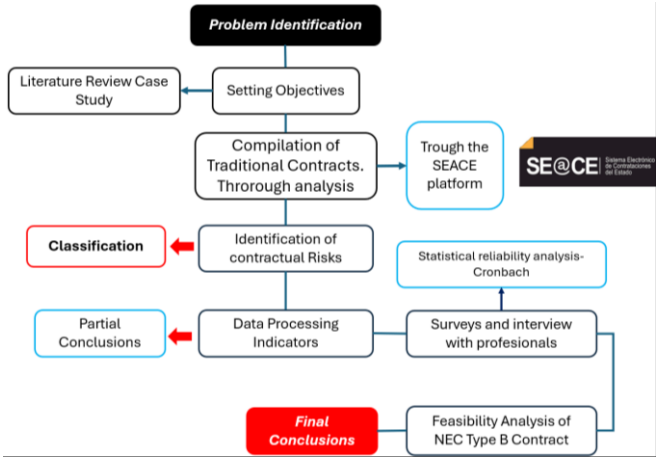

Fig. 1 Process Flowchart

Figure 1 shows the procedure for formulating the problem, extracting data from the SEACE platform, where the public contracts for Peruvian public works are located, its risk analysis in these contracts and its statistical analysis of the risk results.

VI. Results

A. Risk matrix classification incidence (50 contracts)

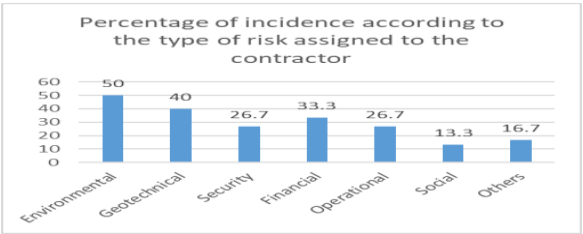

Figure 2. Risk of Contract Incidence

Figure 2 shows the percentage incidence of different types of risks assigned to the contractor in construction projects. Environmental risks are the most significant, representing 50% of the total, followed by geotechnical risks with 40% and financial risks with 33.3%. Security and operational risks have a lower but notable incidence, both with 26.7%, while social and other risks have a lower impact, with 13.3% and 16.7% respectively. This distribution shows that most of the risks fall on external factors, such as environmental and geotechnical conditions, which underscores the need for contractual management that assigns responsibilities more equitably, especially in contexts of high susceptibility such as the Peruvian northern coast.

Environmental risks have gained a lot of strength in recent years because in all projects the care of the environment must be considered, leaving the projects in the same or better conditions, in addition public entities do not easily authorize the use of quarries

and dumps which are typical of these projects, these facts have led to environmental risks taking on a lot of strength.

Geotechnical risks have become an odyssey in recent years, because the reports of the Comptroller General of the Republic have revealed that most works are paralyzed due to deficient geotechnical studies, this is also aligned with Peruvian regulations where there is a small amount of exploration for a certain area. Consequently, the geotechnical risk is imminent in any project, if any value of the bearing capacity of the soil changes, the structural calculations must be updated and this would lead to a variation in prices with respect to the baseline.

Financial risks are subject to the type of contractors we have in the middle, in recent years ordinary people with little capital or without economic solvency have gone into public works tenders, winning in many cases the awards and once the work has started, they have problems with the liquidity and economic solvency of the work. which has led to a reduction in the number of crews or that they end up in longer periods than those agreed in the baseline.

Social risks are manageable and postponable, this is very common because the project stakeholders always have a perception of not being benefited, which generates discomfort in them and can cause excesses or restrictions when construction projects are being executed.

B. Survey

DEMOGRAPHICS

The data collected showed that most of the respondents have more than 15 years of experience. (Figure 3) shows that the rate of respondents with experience between 5 and 10 years is 22.2%. In addition, more than 55.6% of the contractors in the sample have more than 15 years of experience.

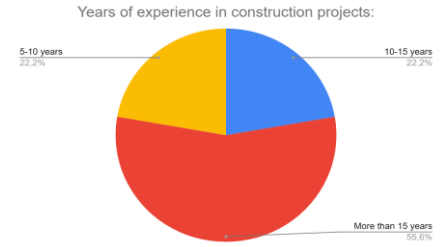

Fig. 3 Respondents' experience

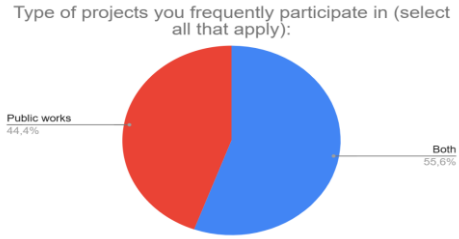

Fig. 4 Type of projects in which he frequently participates

Figure 3 shows the experience in years in the construction industry, more than half of respondents have more than 15 years of experience which represents a high reliability in their answers, the second order is an experience between 10 to 15 years of experience, and with a minority of Nobel engineers that fluctuates from 5 to 10 years of expertise in the construction industry.

In Figure 4 our respondents present a level of participation mostly in public and private projects, and 33.3% only in public projects, this responds to the fact that the state sector promotes the construction of projects throughout the national territory, and also the good practices of the state sector have been transferring it to the state sector. as shown in this figure.

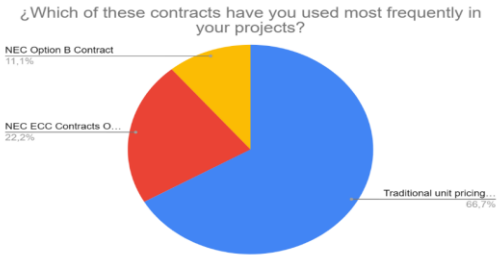

Fig. 5 Which of these contracts have you used most frequently in your projects?

Figure 5 shows the frequency of use of different types of contracts in projects, highlighting a clear preference for traditional unit price contracts reaching up to 66.7% of the cases, this recognizes that although the NEC is well known for promoting the spirit of collaboration and structured risk management, its use is less frequent. this is simply due to the fact that in Peru NEC contracts are not regulated to date, but if they are used through a special framework, when the holder of the specifications of a ministry and the holder of the specifications of economy and finance sign a supreme decree, this has been an alternative in recent years, since it violates the State Contracting Law 30225. On the other hand, traditional contracts at unit prices are regulated in the national territory and it is very common to use this public procurement mechanism in Peru.

C. Risk factors in clauses

SPECIFIC OBJECTIVES 01

Identify the main risk clauses in unit price contracts, focusing on inadequate risk allocation as a critical factor that negatively impacts project management.

TABLE I

IDENTIFICATION OF RISKS IN CONTRACTS AT UNIT PRICES

ITEM	RISKS	SCOPE
1.FORCE MAJEURE CLAUSES:	FLOODS. NATURAL PHENOMENA (EL NIÑO, EARTHQUAKES). FORCE MAJEURE EVENTS OR FORTUITOUS EVENTS. EPIDEMIOLOGICAL RISKS.	**MAIN RISK:** NATURAL PHENOMENA (FLOODS, EARTHQUAKES, EL NIÑO). **DISRUPTION TO THE PROJECT:** IF NOT PROPERLY ASSIGNED, THE CONTRACTOR COULD BE HELD LIABLE FOR EVENTS BEYOND THEIR CONTROL. THIS COULD LEAD TO ADDITIONAL COSTS, CONSTRUCTION DELAYS AND LEGAL DISPUTES, AFFECTING THE CONTINUITY OF THE PROJECT.

2. Contractor Liability Clauses:	Misuse and maintenance of the system (cracks, settlements, cracks). Deficiencies in the contractor's technical expertise. Accidents during the execution of the work. Delays due to delivery of materials or topography failures. Deficiencies in solid waste management. Failure to make monthly construction payments.	**Main risk:** Deficiencies in the technical execution or in the contractor's management. **Impact on the project:** An incorrect assignment of responsibilities could generate structural failures, occupational accidents and deficiencies in the quality of the work. In addition, the entity could incur additional costs to repair contractor errors.
3.Design Clauses and Preliminary Studies:	Deficiencies in the technical file. Deficiencies in the design (inappropriate geological conditions). Errors in the topographical plan. Coverage of unforeseen cost overruns due to technical deficiencies. Problems in the execution of pavements, sidewalks or drainage systems.	**Main risk:** Deficiencies in the technical file or in the design. **Impact on the project:** Without a clear assignment, design errors or deficient studies can lead to cost overruns, scope changes, and delays. The entity may assume costs that should be the responsibility of the contractor or consultant.
4. Third Party Interference Clauses:	Interference by archaeological remains. Interruptions by unions. Lack of coordination with public services (water, electricity, gas). Social conflicts. Nearby basic services that interfere with the work.	**Main risk:** Disruptions by unions, archaeological remains, public services. **Impact on the project:** The lack of clear assignment could generate stoppages of the work due to external factors, increasing the costs and deadlines of the project. In addition, it can generate legal or social conflicts that are difficult to manage.
5.Penalties and Delay Clauses:	Delays in municipal permits. Delays in the delivery of land. Obstruction of access and evacuation routes. Delays due to accidents on site or transport.	**Main risk:** Delays in permits or in the delivery of land. **Impact on the project:** If responsibilities for delays are not correctly assigned, there may be non-compliance with deadlines, economic penalties and impact on the reputation of the contractor or entity. This also impacts project planning and execution.
6. Safety and Environmental Clauses:	Epidemiological risks. Negative impacts on the environment. Damage to nearby properties due to accidents. Environmental risk and pollution.	**Main risk:** Improper management of solid waste or environmental contamination. **Impact on the project:** An incorrect allocation can result in environmental sanctions, stoppage of the work due to legal non-compliance, damage to the community and high remediation costs. In addition, it can affect the public image of the company.

Table 1 details key risks associated with different contractual clauses and their potential impact on construction projects. Force Majeure Clauses highlight the challenge of natural phenomena and fortuitous events, where improper allocation could hold the contractor liable for situations beyond its control, leading to cost overruns and disputes. The Contractor Liability Clauses underline the risk of technical or managerial failures, which can compromise the quality of the work and lead to costly repairs. On the other hand, the Design Clauses and Preliminary Studies show that errors in the technical file or in the design could generate cost overruns and significant delays. Third Party Interference Clauses highlight

external factors such as archaeological remains or social conflicts, which, if not properly managed, can paralyze the works. The Penalties and Delays Clauses reflect the importance of correctly assigning responsibilities for delays, since non-compliance can result in financial penalties and reputational damage. Finally, the Safety and Environment Clauses point out the risks of legal breaches or environmental damage, which could result in severe penalties and affect both the continuity of the project and the public perception of the parties involved. Clear contract management and proper allocation of responsibilities are essential to mitigate these risks.

1. Problems in traditional contracts: In traditional construction contracts in Peru, the allocation of risks is usually rigid, static and with regulatory gaps, based mainly on unit price or lump sum criteria. This creates challenges, because:

- Misassigned risks: External factors such as natural or social phenomena often fall on the contractor, even when they are beyond their control. As architect Natalia Barreda Dominguez was able to confirm in the interview we conducted, "In traditional construction contracts, the incorrect allocation of risks can lead to problems of contract management and increased costs. When the parties do not properly identify and distribute the risks, they fall disproportionately on one of them, usually the contractor, who may not be technically or economically prepared to face them, which harms the execution of the project"
- Conflicts of interest: In some cases, the allocation of risks can be manipulated by self-interest, favoring one of the parties, usually the contracting entity. This generates unfavorable clauses and forces contractors to assume excessive responsibilities.
- Impact: This misdistribution can result in delays, cost overruns, legal disputes, and unfinished projects. In addition, it discourages serious companies from participating in public tenders, affecting competitiveness.

2. Consequences of misallocation of risks for self-interest:

- Cost overruns: The public entity may face cost overruns if the contractor demands higher payments to cover additional unforeseen or misallocated risks.
- Litigation and arbitration: Poor risk allocation practices often lead to disputes, leading to protracted litigation that further delays projects.
- Compromised quality: A contractor who takes excessive risks may seek to reduce costs in other areas, compromising the quality of the work.
- Corruption: Arbitrary allocation of risks can be an indication of corruption or favoritism, affecting the transparency of the sector.

SURVEY RESULTS:

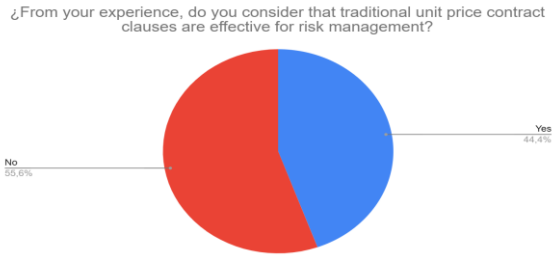

Fig. 6 in Do you consider the clauses of traditional unit price contracts to be effective for risk management?

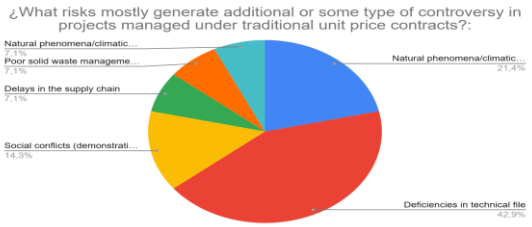

Figure 7. What risks do most additional risks or some type of controversy generate in projects managed under traditional unit price contracts?

Figure 6 supports the results and opinions of our respondents that the clauses of traditional unit price contracts are not effective for risk management. Although traditional contracts with the modality of execution at unit prices tend to generate risk reports at the beginning of the execution of the work, these are only warnings or are simply identified to comply with the contracting law and its regulations, and save liability for the parties, not being able to mitigate the risks in a timely manner. Risk mitigation also commits the entity to use higher costs on behalf of the entity, and this is not good for them, since that monetary resource must be used in other projects. So the entity does not care about the management of the risks that may occur, but on the contrary in these traditional contracts in many cases the risks are unilateral and assigned to the contractor even though they do not correspond to them. And this contractor in the contractual execution is cornered by the entity, not being able to mitigate risks and in many cases the works paralyzed, in arbitration or litigation.

Figure 7 identifies the most common risks that generate additional costs or controversies in projects managed under traditional unit price contracts. The main findings are:

Deficiencies in the technical file (42.9%): Design errors or lack of detail in the designs or preparation of the technical file, technical specifications, calculation reports lead to modifications of the original file during the execution of the works, generating cost overruns and delays.

Natural and climatic phenomena (21.4%): This risk highlights the vulnerability of projects to unpredictable climatic events, which can affect schedules and budgets, more than all this indicator is in the jungle and mountains due to their changing climates and in many cases due to the El Niño or La Niña phenomenon.

Social conflicts (14.3%): These include demonstrations, protests or problems with local communities that can interrupt the works, reflecting the importance of social management in projects. This has become a normality in most public works because the works are always executed on social or third-party land, where each user intends to obtain their own benefits at the cost of generating a conflict with the executing entity, this has been resolved with the persuasion of the contractor's specialists and freeing up work fronts.

Solid waste management and inaccurate measurements (7.1% each): These issues, although less frequent, affect the sustainability and accuracy of execution.

Delays in the supply chain (7.1%): They represent logistical challenges that impact the availability of essential materials, for different reasons, in many cases the inputs are not within reach and in other cases the suppliers do not carry out in adequate times, due to lack of trust with the state sector, this due to its bad reputation in recent years.

D. Effectiveness of the NEC contract - option B

SPECIFIC OBJECTIVES 02

Evaluate the effectiveness of the NEC Option B contract compared to traditional unit price contracts, analyzing its capability in the flexibility of project scope change management.

TABLE II

COMPARISON OF NEC B CONTRACTS VERSUS TRADITIONAL UNIT PRICE CONTRACTS

Comparison Criteria	NEC Option B Contract	Traditional Unit Price Contract
Flexibility in scope changes	High flexibility; The change management process is structured through early warnings and continuous review.	Low flexibility; Changes must be formally negotiated, which can lead to delays.
How to manage changes	Use the Project Manager to evaluate and approve changes quickly, minimizing schedule and cost impact.	It requires formal approval through addenda, which can be a bureaucratic and time-consuming process.
Liability for additional costs	Shared; Risk allocation is more equitable and transparent.	It usually falls on the contractor, even if the changes are due to external or unclear causes.
Documentation and change control	Standardized and collaborative documentation, facilitates traceability.	It requires thorough documentation of each change, which can increase the administrative burden.
Impact on the client-contractor relationship	It fosters a more collaborative relationship, reducing conflicts.	It tends to generate an adversarial approach if changes are not well managed.
Risk of disputes	A collaborative approach and clarity in change management reduces the risk of disputes.	High; Lack of clarity in risk allocation can lead to contract disputes.
Impact on the project timeline	Changes can be implemented more quickly, minimizing delays.	Changes tend to affect the timeline more significantly due to slow approval processes.

Table 2 shows the comparison between the NEC Option B Contract and the Traditional Unit Price Contract shows significant differences in change and risk management. The NEC Option B Contract stands out for its flexibility, collaborative approach and structured processes to handle changes through tools such as early warnings and the active participation of the Project Manager, which allows for agile and transparent implementation. In addition, it encourages an equitable allocation of risks and reduces the risk of disputes by minimizing conflicts between the parties. On the contrary, the Traditional Unit Price Contract presents greater rigidity, with more bureaucratic processes and a risk allocation that tends to disadvantage the contractor, which can lead to delays, additional administrative burdens and an adversarial relationship between client and contractor. In terms of impact on the schedule, the traditional approach is more likely to generate significant delays due to the slow approval of changes.

Flexibility and change management:

NEC Option B offers a more flexible and collaborative approach, which is crucial in dynamic projects where changes in scope are inevitable. The contractual structure facilitates proactive management, whereas traditional unit price contracts can lead to rigidity.

Conflict reduction:

At the NEC, transparency in risk allocation and collaboration between parties minimize disputes. In contrast, traditional contracts can generate an adversarial environment due to ambiguity in change management.

Documentation efficiency:

The NEC reduces the administrative burden through standardized processes, whereas in traditional contracts, each change requires extensive documentation and negotiation.

SURVEY RESULTS:

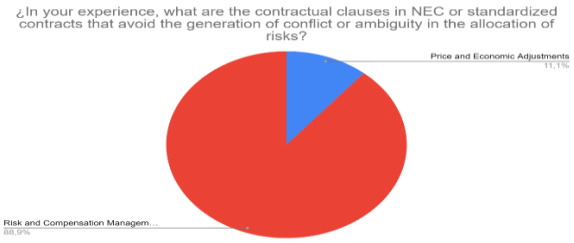

Figure 8. Contractual clauses in standardized contracts that avoid generating conflict or ambiguity in risk allocation.

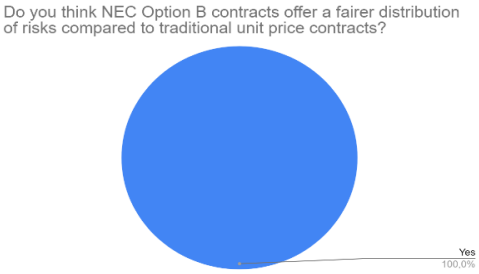

Figure 9. NEC option B contracts versus traditional contracts in terms of fair risk sharing.

In Figure 8, we observe that standardized contracts are more flexible when managing changes in the scope of the project, mainly to the early warning clauses and continuous review, however this figure is not working fully in Peruvian projects, because compensable events must be paid for by the entity in a timely manner. however, the entity is subject to internal budgetary management, which has a limitation in the budget certification, which would lead to losing the collaborative spirit, so the entities must foresee a budgetary contingency or buffer in case projects are executed under the mechanism of collaborative contracts NEC.

In Figure 9, we see unanimity that NEC option B contracts result in a fairer distribution of risks compared to traditional unit price contracts. This responds to the good practice of collaborative contracts in the global construction industry.

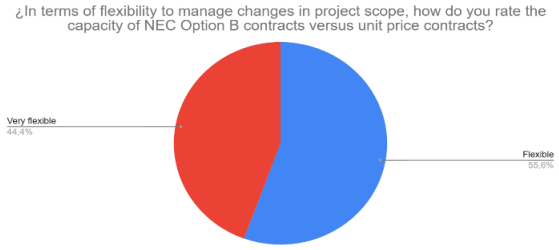

Figure 10. Flexibility to manage changes in project scope of NEC Option B contracts versus unit price contracts

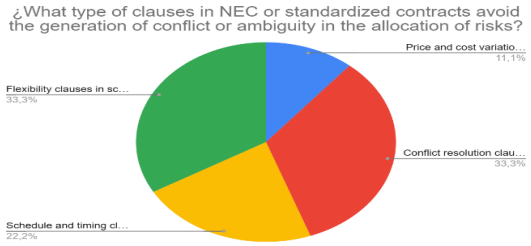

Figure 11. What type of clauses in the NEC contracts do standardized or standardized risk management systems avoid the generation of conflict or ambiguity in risk allocation?

In Figure 10, we see that NEC contracts are more flexible when managing changes in the scope of the project, compared to traditional unit price contracts.

Figure 11 shows the relevance of the contribution of conflict resolution clauses and flexibility of changes in scope to avoid ambiguity in the allocation of risks, with respect to NEC option B contracts.

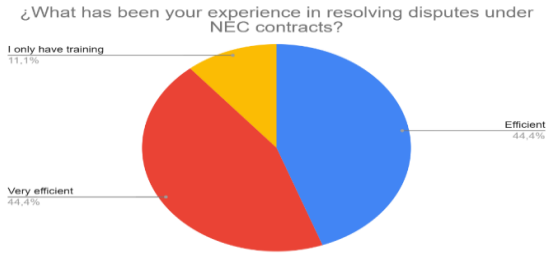

Figure 12. Experience in resolving disputes under NEC Option B contracts

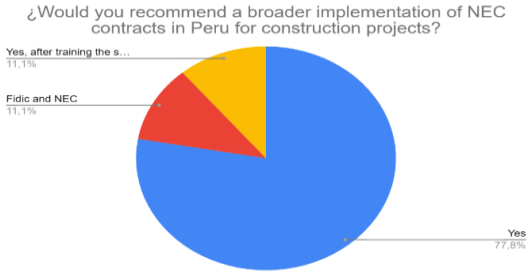

Figure 13. Recommendation for a Wider Implementation of NEC Contracts in Peru

In Figure 12, regarding the efficiency perceived by respondents with NEC option B contracts, the majority believe that it is between very efficient and efficient. This responds to the efficiency of the DAB's that pour all the expertise in controversies that may be generated in the execution of the contract

Figure 13 shows the answers to the question on the recommendation for wider implementation of NEC contracts in construction projects in Peru. 77.8% of respondents are in favor of its implementation without additional conditions, while 11.1% would support it as long as those involved are trained, and another 11.1% suggest strengthening NEC contracts. This reflects a mostly positive perception towards NECs, but highlights the importance of training and the potential complementarity with other international frameworks. Collaborative contracts have a positive history in Peru since 2019, which is why Law 32069 and its regulations propose the application of international collaborative contracts on an optional basis when the amounts are greater than 50 million, however the entities must direct this mechanism, which also entails the expertise of their officials and public servants who could be a weak point in local governments.

E. Interviews

The specialists in unit price contracting under the LCE and NEC international standard contracts, made up of lawyers, engineers and architects, answered the following questions, showing their opinion based on the knowledge and experience in the projects of this sector, giving rise to the following results:

CASES OF UNIT PRICE CONTRACTS UNDER THE LCE

1. From your perspective, within a Contract that is governed by the LCE, what related clauses should be modified for a better resolution of Risk Management problems?

The contracting system under the LCE is rigid, which generates controversies due to the mishandling of risk identification clauses in contracts when they are not clearly defined. Integrated files and bases should be the starting point to manage these risks, so it would be ideal to separate the technical aspects from the strictly contractual ones and establish clear specifications since the user area is responsible for the development of these bases. However, the question arises: how much expertise does the user area have to carry out this management properly?

When the user area lacks expertise in the formulation of terms of reference for the bases, the legal area in charge of drafting the contract respects this approach, limiting the viability of the observations submitted through the OSCE. Which has a period of approximately 8 days, which is insufficient considering the complexity and amounts involved.

Although the file goes through several areas before its approval, a second filter should be implemented to guarantee an adequate distribution of risks. During the acquittal of inquiries and observations, contractors often fail to analyze or question risk management, making both those who do not comment and those who do not clarify the conditions liable. Although contractors can file claims later, working under this framework reflects that the problem originates in the bidding period, where "what is reflected in the contract was accepted."

This problem is aggravated by the fact that the process is mostly in charge of lawyers, relegating the technical part, such as the participation of engineers. This responds, in part, to the roles established in the ROF and MOFs of the organizations, where the legal approach is prioritized over the technical one.

2. Based on your perspective, how should the allocation of the risks identified between the parties to a contract governed by the LCE be managed, and specifically within an area and/or region more susceptible to a type of risk, as in the case of the North Coast with natural phenomena?

Most point out that this type of risk should be assumed by the principal, it is even immoral for the contractor to assume it. Thus, the injured party is the latter by conditioning the sequence of work, such as in items such as excavation or road works or tunnel systems, so FIDIC contracts dedicated a particular book to risks related to geotechnics, identifying them as "standard problems". Another aspect of agreement is that of the need for a mutual agreement between the parties, which ranges from avoiding the cyclical "Accion_Reaccion" that lead to paralysis and/or arbitration and the "abusive" rigidity in the application of clauses, to the approach of a collaborative methodology that extends throughout risk management.

A point to highlight is the foreign vision of avoiding issuing a systematic NO and that instead opts for the Cost-Benefit, depending on the magnitude of the work and the losses that a day of delay would cause.

3. Based on your experience, how have situations been handled in which certain risks were not foreseen in the contract, and these materialized negatively affecting the development of the work, under the framework of LCE? What has been your opinion regarding the effectiveness of the resolution mechanisms applied?

The engineer explains that, in his experience with projects under the State Contracting Law (LCE), when risks not foreseen in the contract materialize, the key has been to identify responsibilities

and apply the corrective mechanisms allowed by the regulations. He points out that, although not all risks can be foreseen in the initial stage, extensions of deadlines and additional work extensions, as long as they are adequately supported, have been useful tools to minimize impacts. In addition, it highlights the importance of maintaining open and collaborative communication with the contracting entity, especially in situations such as unidentified utility interference, where a joint solution can avoid stoppages. It also mentions that the use of insurance, such as all-risk construction insurance, has been decisive in mitigating financial impacts for both the contractor and the entity. However, it recognizes that delay in decision-making by contracting entities often exacerbates problems arising from unforeseen risks.

Regarding the effectiveness of the resolution mechanisms applied, the engineer believes that they are effective in theory, but in practice they face limitations due to bureaucracy, the lack of clarity in the technical files and the resistance of some entities to implement changes. He indicates that extensions of deadlines and additional works are useful mechanisms when they are well documented, although they are not always easily accepted for fear of observations from the control bodies. In addition, it mentions that dispute resolution processes, such as conciliations and arbitrations, have been valuable tools for resolving disputes, although arbitrations, in particular, can be costly and time-consuming. Finally, the engineer highlights that, in comparison, NEC contracts are more effective in risk management due to their collaborative approach and the use of tools such as the "Risk Register", which allows problems to be addressed in advance and reduces impacts on projects. In his view, combining LCE best practices with international contract principles such as NEC could significantly improve risk management in public projects.

NEC CONTRACT CASES

4. Taking into account the time of application of the NEC in Peru, do you think that some aspects of the NEC contract should be adapted to the national scenario so as not to generate controversies? For example, in compensable events

In the NEC contract, the events that may result in compensation must be clearly defined. In the Peruvian context, it would be useful to consider the particularities of the market, such as local regulations, climatic conditions and other factors that are common in the region. This could help reduce ambiguity and minimize the controversies that are often witnessed in traditional contracts.

Reporting events that could result in offsets is crucial. Adapting the process to fit local practices and ensuring that all parties understand specific timelines and requirements can help prevent disputes. The way labor and business relationships are handled in Peru may differ from elsewhere, and this should be reflected in the contract.

It might be useful to establish a specific framework for assessing the impact of events on the project schedule and cost, taking into account the particularities of the construction sector in different parts of the country. This could include creating mechanisms to address the uncertainty and risks associated with project implementation, as well as considering alternative methods of conflict resolution that are more accessible and accepted in the regional context.

Since the NEC is a relatively new approach in Peru, it is critical to provide training and resources to all parties involved in the construction process. Making sure everyone has a clear understanding of the terms of the contract and how they apply in practice can help reduce misunderstandings and conflicts.

5. Taking into account the similarity between the payment option of a Unit Price Contract (LCE) and option B of the NEC. Do you think that the implementation of NEC-type B would lead to better efficiency in terms of flexibility in managing changes in the scope of the project? Comment on experiences

It is contemplated that both contracts share the idea of establishing unit prices for specific items, which allows payments to be adjusted according to the actual quantities of work executed, however, in the NEC Option B, a maximum expenditure limit is set, providing greater budgetary control, which ratifies its greater efficiency compared to traditional contracts. It should be noted that in Peru there is still no experience of execution of a public work where the NEC-type B contract has been applied, a very different case is its application in subcontracts because when it is a work by management many times the subcontracts are managed through unit prices.

In traditional contracts under the LCE, changes in scope typically involve formal contractual modifications, which can delay execution due to rigid administrative processes. For its part, the NEC Option B promotes a more collaborative and flexible approach to managing changes through clear and agreed procedures, such as the development of Compensation Events to evaluate and negotiate modifications in an agile manner.

In short, the idea of improving the perception of risk management managment under the application of NEC-type B contracts is gaining strength, which goes hand in hand with the experiences and knowledge gathered from the interviewees, mainly from Eng. Daniel Coyla, so to successfully implement an NEC Option B contract in Peru, it would be necessary to:

- Train stakeholders (public entities, supervisors, and contractors) on NEC principles.
- Adjust procedures to align with the provisions of the LCE, seeking to reconcile the flexibility of the NEC with local regulatory requirements.
- Establishing a clear framework of roles and responsibilities, especially for the Project Manager, is essential in NEC contracts.

VII. Discussions

DISCUSSION 1:

From the partial conclusions presented by the risk matrix of traditional contracts, we observe that these risks mark the beginning of an unbalanced relationship between the parties. This situation is further aggravated once the risks materialize, since, as can be seen from the development of the bases of the contract, one of the parties (the entity) seeks to avoid responsibilities, attributing them to the other party (the contractor) [28].

We can agree, through our partial conclusions, that three of the most recurrent inappropriately assigned risks in the contract, which are environmental (25%), geotechnical (20%) and financial (15%), are the cause of 59% of some type of controversy. These conflicts are the product of the most susceptible risks, typical of the area and recurrent in traditional contracts. According to surveys carried out on specialists, the most prominent risks are those derived from natural phenomena and weather conditions (21.4%) and deficiencies in the technical file (42.9%).

It is important to highlight the susceptibility of some regions to certain risks [12][36], which is related to and consolidated with research approaches such as that of Mahomemidi Ibrahim in Palestine [6]. This research presents a more detailed classification by external, internal, and contractor- and consultant-related risk factors. It coincides with our research in considering deficiency and changes in the technical file as the most recurrent risk with 70%.

External risk factors that are beyond the reach of the construction parties highlight the fact that, by implementing projects in a region susceptible to the segmentation of Palestinian governorates and political obstacles, which are encompassed as social conflicts, the right of movement and access to the site for the construction parties is restricted. This prevents activities from being carried out as planned [29].

DISCUSSION 2:

The results obtained indicate that NEC Option B contracts tend to offer greater efficiency in risk management compared to unit price contracts. This conclusion aligns with what has been found in previous studies suggesting that NEC contracts promote closer collaboration between parties, allowing potential risks to be identified and mitigated more effectively. For example, [38] research highlights that the inherent flexibility of NEC contracts can facilitate adaptation to unforeseen changes, thereby improving the ability to respond to adverse situations.

In contrast, traditional unit price contracts are often more rigidly structured, which can lead to conflicts during project execution and ultimately increased risk. This finding is consistent with what was stated by [11], who warn about the tendency of these contracts to promote an adversarial approach between contractors and clients, which can result in a lack of communication and, therefore, in the underestimation of risks.

In terms of efficiency in cost control, research shows that NEC Option B contracts allow for more dynamic control tailored to the specific needs of the project. The ability to adjust costs throughout execution, as mentioned in [39] [40] study, offers project managers a valuable tool to keep expenses under control without sacrificing project quality or scope.

However, it is important to note that unit price contracts, while often criticized for their rigidity, have the advantage of clarity in price definition, which can facilitate a priori financial planning. This is corroborated by the expertise of the interviewed specialists, who argue that cost transparency in these contracts can be attractive for certain types of projects where the risks are well known and controllable.

VIII. Conclusions

- Based on interviews, a survey of specialists in the management area of risk management and after a rigorous analysis, of fifty traditional contracts under the modality of unit prices in works on the Peruvian north coast (Tumbes, Piura and Lambayeque), through the web portal of SEACE, OSCE, Infobras and the Investment Monitoring System (SSI); The existence of a misallocation in the risk management clause is confirmed. Specifically, it is about the risk generated by the natural phenomena of the climate of the northern Peruvian coast, which is the El Niño Phenomenon and the intense rains that give rise to other disasters such as floods, the risk mentioned in the vast majority of cases is only attributed to the contractor. This is why controversies arise, which result in additionals, postponements, and even suspension of the construction work.
- Early identification of risks is essential to prevent errors, avoid controversies and manage works effectively. It is crucial to consider the susceptibility of certain regions to specific risks, which allows strategies to be managed, to avoid, mitigate or manage such risks. According to our study, several inappropriate associated risks towards contractors stand out, as presented in our results and discussions.
- The essence of good practices lies in collaborative work and the principle of "win-win". The success of the contract does not depend only on the structure and content of the contract, but also on the people who manage it. Human capital is the most important element for the success of the NEC.
- Distrust of contractors, who seek to take advantage, has led to rigidity in the LCE contract. Although this rigidity can contribute to better management, it limits the flexibility needed to recognize changes or variations that must be accepted by the contractor. This situation exacerbates mistrust and the search for justifications. In contrast, the NEC is more flexible, since in England, where it originated, contractors often work towards the success of the project, which fosters a more collaborative and effective relationship.
- Option B of the NEC, although it is related to the payment option in traditional unit price contracts, and is presented as a better alternative due to its structure, which offers greater flexibility and more appropriate clauses. It is important to consider that NECs, being standard contracts, provide various alternatives that allow combining clauses and options. Therefore, even if Option B is not implemented in a unique way, it is essential to take advantage of the possibility of mixing clauses to adapt to the reality of the projects in Peru.
- From the beginning of the procurement procedure, it is essential to have qualified technical personnel who draw up the bases and clauses of the contract, especially with regard to risk allocation. This is crucial, as poor risk sharing can lead to conflicts, as seen in the risk matrix of OSCE contracts. This will help avoid problems, since, once the contract is signed, what has been agreed is established and claiming about something already agreed can generate controversies. On the other hand, it is essential that the contractor acts in good faith and complies with its obligation to carry out an adequate initial review. A cursory review or deliberate omission of errors could be interpreted as a lack of diligence, which could have a negative impact on the performance of the contract.

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