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RISK MANAGEMENT OF HIGH VOLTAGE TRANSMISSION LINE PROJECT: A CASE STUDY OF ADB FUNDED PROJECTS IN NEPAL

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Abstract: **The paper analyzes the risk management process of transmission line installation projects. Risk mapping of each project is suggested for better risk management. The methodology suggested is based on the analysis of four major risk factors in the project and division of project into six phases. Then a Questionnaire survey based analysis is done in which risk impact and risk frequency for all 41 risks under six phases identified from Literature review are presented in11 point Juster's probability scale with values ranging between 0 and 1.The risk score is calculated accordingly for each risk by multiplying risk impact and risk frequency. The average risk score is evaluated for all six phases and four major risk factors from the questionnaire survey of Client, Consultant, Contractor and Donor experts. Risk mapping is done based on the standard risk matrix to identify the forty one risk as low, moderate or high risk. Human risk factors and Survey and Background analysis phases are amongst the highest average risk score for deciding the risk mitigation plan for such projects.**

Keywords: **Project risk management, Transmission line installation, Risk mapping, Risk mitigation**

I. INTRODUCTION

1.1 Background

Transmission network is the backbone of any power system as it serves the purpose of transmitting bulk amount of power from the remote power stations to the various load centers or distributing substations. Planned and timely construction of new infrastructure and optimal system operation are the two most significant activities for effective and efficient operation of any power system[1].The development of transmission line systems is unavoidable to develop the hydro power projects in order to address the energy crisis of Nepal [2].Despite the remarkable hydro power potential the nature has gifted, Nepal is still not being able to hitch the benefits. Lack of adequate transmission line across and along the major river basin is amongst the many reason to contribute slow pace of hydropower development. IPPs are unable to evacuate power to national grid due to absence of transmission line infrastructures. As a result, IPPs are unable to generate revenues leading them to bankruptcy due to financial burden due to Take and Pay PPA. Realizing this fact, the Government of Nepal in 2009, through national electricity crisis and its mitigation program came up with the ambitious plan of construction of 2255 km of transmission lines of different voltage levels along the major river basin possessing huge hydro power potential. Although Kalig and aki'A' Hydro power Project (144 MW) is running in full phase, there is bottleneck in transmission of power from Bardaghat to Bharatpur. Similarly, with the completion of Middle Marsyangdi (70MW), there is a bottle neck to transmit combined power of Middle and Lower Marsyangdi (69MW) either to Kathmandu Valley or to augment capacity of prevailing transmission line upto 220 kV. In this backdrop, the Asian Development Bank (ADB) has been providing the financial support for the construction of different high voltage (220 kV or above) transmission line through Project Management Directorate (PMD) of Nepal Electricity Authority(NEA) which is the parent organization for building transmission lines and substations in Nepal.

Project Management Directorate (PMD) in the Nepal Electricity Authority's organogram has a role to execute and facilitate the projects funded by Asian Development Bank (ADB) and European Investment Bank (EIB). PMD is responsible for project preparation, procurement and implementation of all new and existing projects that is or will be funded by ADB. At present, PMD is executing diverse projects in energy sector including transmission line, substation, distribution system, distribution system modernization, smart meters and automation under ADB financed

1. SASEC – Power System Expansion Project (SPSEP)
2. Electricity Transmission Expansion and Supply Improvement Project (ETESIP)
3. Power Transmission and Distribution Efficiency Enhancement Project (PTDEEP)

4. SASEC Power Transmission and Distribution System Strengthening Projects (SASEC PTDSSP)and
5. Electricity Grid Modernization Project (EGMP) (Directorate,2020)

Major ADB financed 220Kv and 400kV high voltage transmission lines under construction are:-

1. Tamakoshi-Kathmandu 220/400 kV Transmission Line Project
2. Marsyangdi Corridor220kVTransmissionLine Project
3. KaligandakiCorridor220kVTransmissionLine Project
4. New Butwal-Bardaghat 220 kV Transmission Line Project
5. Marsyangdi-Kathmandu 220 kV Transmission Line Project

1.2 Problem Statement

Almost all of the transmission line projects are not completing in their original contract completion date. As per NEA, construction of transmission projects such as Kali Gandaki Corridor, Marsyangdi Corridor, Kohalpur-Mahendra nagar and Hetauda-Inaruwa transmission line projects are essential to expand and improve the grid for efficient evacuation of electricity from hydropower plants to the national power system and to ensure increased power supply and reduction of transmission losses. These transmission liens are of strategic importance as they help in evacuating energy generated by key hydropower projects to major load centers [3]. However, the construction work of such transmission lines has been halted in many areas across seven provinces making it difficult to execute such crucial projects on schedule. Proper risk assessment is very important in transmission line projects before their conception. Transmission line projects are complex in nature because they need to consider multidimensional aspects such as land, forest, right of way, terrain, to pography, environment, weather, social factors etc. Thus, risk management is essential right from the planning phase to construction phase.

1.3 Research Objectives

1. To determine average risk score for each phase and for each major risk of transmission line project.
2. To do risk mapping based on standard risk matrix.
3. To suggest risk mitigation plans.

II. LITERATURE REVIEW

2.1 Introduction

Project management for any transmission line installation project is very important which relies mainly upon the extent of use of resources for such project. In Nepal where energy demand is around 30177 MWH currently [4] which will rise exponentially in future with industrialization, relevance of the project management of transmission line projects increases many folds. Project risk management is an essential part of project management in any transmission line installation project and the level of risks involved in such projects is always high. The professional bodies involved in transmission line installation projects always give great attention to the risks involved in commissioning of such projects. In general, the risk management plans consists of risk mitigation plans but for risk mitigation planning, risk assessment is also needed at the first place. In this study, the risk assessment is done for different phases of transmission line installation project. Transmission line installation project are mainly civil work based project in which the overall project is always under one sort of risk or another.

The current study deal with the analysis of risk in transmission line installation projects by measuring or assessing the risk on the basis of fixed scale developed. It normally consists of two sections. The first section deals with the risk assessment or collection of influence factors which determine the value of risk for any transmission lien installation project. The second part of the study deals with division of project in phases and calculating the average risk for each phase in particular. The analysis results in indicating those areas or phase of projects which are more risky and needs special attention while implementing onsite.

The risk management process for transmission line project is studied by authors like [5];[6] but risk mapping is not done on the basis of phases in that particular project. Many studies has stressed on the need for uplift of risk management process in transmission line project. This study is an effort in this direction. In future, more and more such projects are bound to be sanctioned by the Government of Nepal and hence this process will find applicability in most of such projects. As a matter of fact, the whole of the project is needed to be dealt on the basis of a risk profiling of each phases present in transmission line projects.

Transmission line project is one such activity in which we have multiple risk related aspects which are dealt in this study. Although each such project is technically very sensitive and elaborated, but the division in phases canbe applied uniformly to most of such projects. This means that, may be the transmission line can be a short transmission line ranging from a few kilometers or a very long type transmission line extending to hundreds of kilometers, but the processes marked in this study are common for most of the transmission line projects. This feature has increased the applicability of this study. Although technical details may vary to a large extent, so the risk mitigation plans can have a large difference in their applicability in different projects, but the level of risk for each phase can be confirmed to a particular range and hence this study is a step in the direction to bring standardization in the risk analysis process in transmission line projects. This technique of dividing the project in phases and calculating the risk impact at each phase individually increases the overall accuracy in risk

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management by giving a portfolio effect in risk assessment and the division of risks in the phases makes the cumulative risk count of the whole project more accurate. Overall study can be seen as a process of dividing the project according to critical activity and then risk assessment is done for each activity unlike the present methodologies where single project is dealt with common risk assessment process as a whole. It is shown that this process can increase accuracy and allows project managers to have a better and customized risk mitigation plan for each phase of transmission line project.

2.2 Risk and Risk Management

Risk is the consequence of uncertainties. Theoretically, it is defined as a positive or negative deviation of a variable from its expected value. Risk is generalized only as a loss. It is also a chance, indeed. Risk management consists of strategies to accept, avoid, reduce, reject or transfer the losses and use available chances or rather chances potentially a rising from risks. The person taking strategic action shall make precise consideration and assessment of the situations and the scenarios probably occurring in the future. Decisions are made hoping elimination of all risks and used all chances which means recognizing potential risks and avoid threat by averting, evading or reducing their negative effects.

Although risk management in cur increased expenses during planning phase, it is compensated in later stages. Risk management has profound effect at project's conception phase because it helps to identify possible risks and materialize them. However, there shall be lesser chances of rectification during construction phases. As per BRI (Building Research Establishment, UK), 50 percent of errors inbuildings occur during design stages [7]. This also tells the scenario that the risk management in initial stage is very important for the project's success. In the planning phase, possible risks for the subsequent project success canbe identified and reduced through their incorporation into the planning. This has in particular effects on the observance of set dates and deadlines and thus also on the maintenance of the project costs.

Generally risk management consists of following steps:

- Risk register
- Risk analysis
- Risk rating
- Risk mitigation

2.3 Transmission line project risk management

Project risk management is studied by many authors like [8]; [9]; [10] [6] and [5]. Their viewpoints may differ but the core ideology is somewhat similar. Like in most of the studies, the whole process of project risk management is divided into phases like risk identification, risk assessment and risk mitigation. Many studies have suggested methods which include collection of risk factors and then risk impact is calculated form these factors by assessing them through different techniques. The risk management process is mainly based on the collection of risk factors and then these risk factors are treated with different procedures by different authors, like [11]has given a learning based approach in which a database is created through which the risk related information are updated and are used from one project after another.

Project risk management differs as per type of project and industry involved. The power transmission industry is a very unique one in many aspects. It has been found that dedicated studies are present for this sector, the main works in this domain are by authors [5] and [6]. In their studies, they have stressed on the risk management process of projects. Although the studies concentrate on different aspects of operation and installation in transmission line, but the process is dealt with in sight in both the studies. These studies prove the effect of risk on transmission line projects. The effect is seen with the help of graphs that shows risk has direct effect on the project cost and even after the installation during the operation of a transmission line, risks persists and have a consider able effect on the performance. Both of these studies implicate that project risk management is an essential component for transmission line projects. The risk management process as a whole is very well defined and analyzed by[6] in particular with respect to risk management phases like risk identification, assessment and monitoring, the same classification is also given for other types of projects by authors like[8],[9]and[10]and hence that is the reason why it can be conferred that risk management process can be a collection of certain common phases like risk identification, risk assessment and finally the risk mitigation. In our thesis, the same methodology is being followed and risk identification is being done in order to achieve the risk assessment.

The risk identification is another aspect in which the studies are present in abundance over long period of time. Authors have given many aspects of risks and named them differently. In literature survey, many authors have indicated common type of risks. These are risk categories which are predominant and common for various types of project.

Risk Factors/ Authors	Technical Risk	Financial Risk	Environmental Risk	Human Risk
(Erickson & Evaristo, 2006)	S	S	S	S
(Chen, Li, Ren, Xu, & Hong, 2011)	S	S	S	N
(Iyer & Sagheer, 2010)	S	S	S	S
(Regos, 2012)	N	N	S	S
(Aloini, Dulmin, & Mininno, 2012)	N	N	N	N
Wyk et al. (2007)	S	N	N	N
(Thevendran & Mawdesley, 2004)	N	S	S	S
(Fang & Marle, 2012)	S	S	N	N
(Fan, Lin, & Sheu, 2008)	S	S	S	N
(Baccarini & Archer, 2001)	S	S	S	S
(Dey P. , 2001)	S	S	S	S
(Castro, 1995)	S	N	N	N
(Wu, Wang, & Fang, 2008)	S	N	S	S
(Dikmen I. , Birgonul, Anac, Tah, & Aouad, 2008)	S	S	S	N
S- Supported & N-Not Supported				

Figure 1: Risk factors identification by authors

2.4 Risk factor collection

Authors like [12]; [13]; [14]; [5]; [15]; [16]; [17]; [8]; [18]; [19] and[11] have shown consider able importance to the technical factors for assessing the risk level of any project.[9];[13] and[10] have suggested generalized factors related to risk which are technical in nature but[8] has named specific categories of technical risks which are related to equipment, material and engineering related problems. The second most descriptive risk factor present in various literature sources is related to environment factors and[16];[10];[8] and[13] all have shown importance of this factor in project risk management. In our study all such factors under the cap of acts of God or environmental risk factors are given considerable importance and included as one of the primary factors in risk management.[13] has given a dedicated study on environmental risk only and the case taken in his study is also of a construction project and since transmission line project is predominantly a construction based project full of civil based requirement and processes, this study by[13] can be very useful and the amount of emphasis given by the author for environmental risk factor proves that such risk factors is selected as a major risk factor in our study.Human risk factors are also supported by many authors like[12];[14];[20]; cite the vend ran 2004 perception; [17] and [8]. This human risk is usually given the name of clearance related risk or other safety related risks. It can be derived from studies of [8] and [19] that power project managers are especially cautious of such risks. Hence in our study human risk related factors are also included. Another important category is that of financial risk factors since transmission line projects involves a very huge amount of capital investment and organizations from all over the world are jointly handling capital matters in these projects. Authors like[12]; [13]; [14]; [20]; [16]; [17]and [8] have all given importance to financial factors and since it is included in all such project risk management studies, it is found that transmission line projects need financial risk to be included and the same is done in our study. The main risk categories which are formed on the basis of literature survey are:-

Technical risk factors (Rt) 2.Environmental risk factors(Re) 3.Financial risk factors (Rf) 4.Human risk factors(Rh)

2.5 Phases present in transmission line project

Many authors have given view points on phases of transmission line projects. Studies from authors like [18];[21];[22];[23];[24] and[25] have accounted for different sections in a transmission line projects. The complete processes of transmission line in this study are divided into six sub-phases. These phases are the areas of a transmission line installation process in which the studies have been done already. The transmission line installation process is the sum

of these phases. Technical specifications might vary in each phase but the phases are almost same for every transmission line project.
The six main divisions or phases in any transmission line project are:-

1.Survey and background analysis (P1)
2.Tower base construction process (P2)
3. Construction of lattice structure based tower (P3))
4. Hardware installation like Ground wires, electrodes and conductor erection(P4)
5. Stringing and Sagging in conductor(P5)
6. Installation of Vibration Damper, Spacer etc. instruments(P6)

2.6 Risk score

As per Williams ‘suggestion, risk is broken down into two main principles:

1. The probability, which is the possibility of an undesirable occurrence, such as cost overrun, time over run etc.
2. The impact, which is the degree of seriousness and the scale of the impact on the activities if the undesirable thing occurs.

Using a mathematical description, a risk can be described as follows:
R=PXI[26] (1)

Where R is the risk score/value, P is the probability of the risk occurring and I is the impact of risk. In our study we shall take the values of the min [0, 1] which shall give decimal value within 0 and 1 that will represent equivalent percentage on multiplication by
100. Greater the impact value, serious is the effect on project and greater the probability value, more is the chances of occurrence within total project period. In this study questionnaires shall have 11 options of values within [0, 1] for impact and probability of occurrence i.e.0.01,0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9 and 0.99 as per Just er scale. In this method an 11 point scale is advised. In the case of like rt scale, lower values are sometimes assigned to zero probability which is not correct in practical situations. This ambiguity is removed in an 11 point scale.

The Juster’s scale is given as:

2.7 Risk matrix

A standard risk matrix shall be used to determine the risk zone for each identified risk factor. The matrix is 5 X 5 with impact ranging from VL to VH on the horizontal axis and probability (with the same range) on the verticalaxis.

Table 1: Juster’s 11 point probabilty scale

10- Certain, Practically certain (0.99)
9- Almost sure (0.9)
8- VeryProbable(0.8)
7- Probable(0.7)
6- Good Possibility(0.6)
5- Fairly Good Possibility(0.5)
4- Fair Possibility(0.4)
3- Some Possibility(0.3)
2- Slight Possibility(0.2)
1- Very Slight Possibility(0.1)
0- No Chance(0.01)

[27]

Table 2: Scale used to identify factors impact and probability of occurrence

Scale	Impact	Occurrence
¡20 percent	Very low(VL)	Very low(VL)
20-40 percent	Low (L)	Low (L)
40-60 percent	Moderate (M)	Moderate (M)
60-80 percent	High (H)	High (H)
80-100 percent	Very High (VH)	Very High (VH)

Three zones are presented in the matrix: Green, Yellow and Red. The zones have the following characteristics:

1. Greenzone: risks in this zone are low level, and can be ignored.
2. Yellow zone: risks in this zone are of moderate importance; if these things happen, one can cope with them and move on. However, if their probability of occurrence is moderate, it should be reduced and it their impact is moderate, it should be controlled and reduces and a contingency plans should be in place just in case they do.
3. Red zone: risks in this zone are of critical importance. These are the top priorities, and are risks that a close attention should be paid to them.

2.1 Risk mitigation

Risk being materialized either qualitatively or quantitatively shall be now mitigated either by rejecting, reducing, avoiding, accept ingor transferring to those who can bear it and control it. Risk matrix shall assist project managers to classify the risk based
on its likelihood and impact and treat them
accordingly based on their risk zones.

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III. RESEARCH METHODOLOGY

The research includes these sub phases.

- Major 41 risks are identified inherent in all six phases of transmission line project amongst technical, environmental, financial and human risk from literature review.
- Experts of clients, consultants, contractors and donors are provided with questionnaires by means of google form which contains impact and occurrence probability options for all 41 risks in terms of 11scale. i.e.0.01, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9 and 0.99.
- Risk value is calculated for each risk issue for clients, consultants, contractors anddonors.
- Average risk value is calculated for each phase and for each major risk identified from literature review by accumulating data from all respondents.
- ANOVA test shall be conducted to test the significance of difference of means of average risk value for all 41 risk factors amongst respondents.
- On the basis of standard risk matrix, all 41 risks are categorized in low, moderate or high risk zones based on their average risk value.
- Conclusion are drawn based on the risk classification in terms of risk zone for high or mode rate risks.
- Risk mitigation plans are proposed for high and mode rate zone risk as a part of recommendation.

3.1 Data Collection

The primary data for the study was obtained through the distribution of questionnaire among the respondents by means of Google form.

3.1.1 Study area and population

3.1.2 Sample Population

The samples for the research will be purposive sampling method. The professional having a relevant

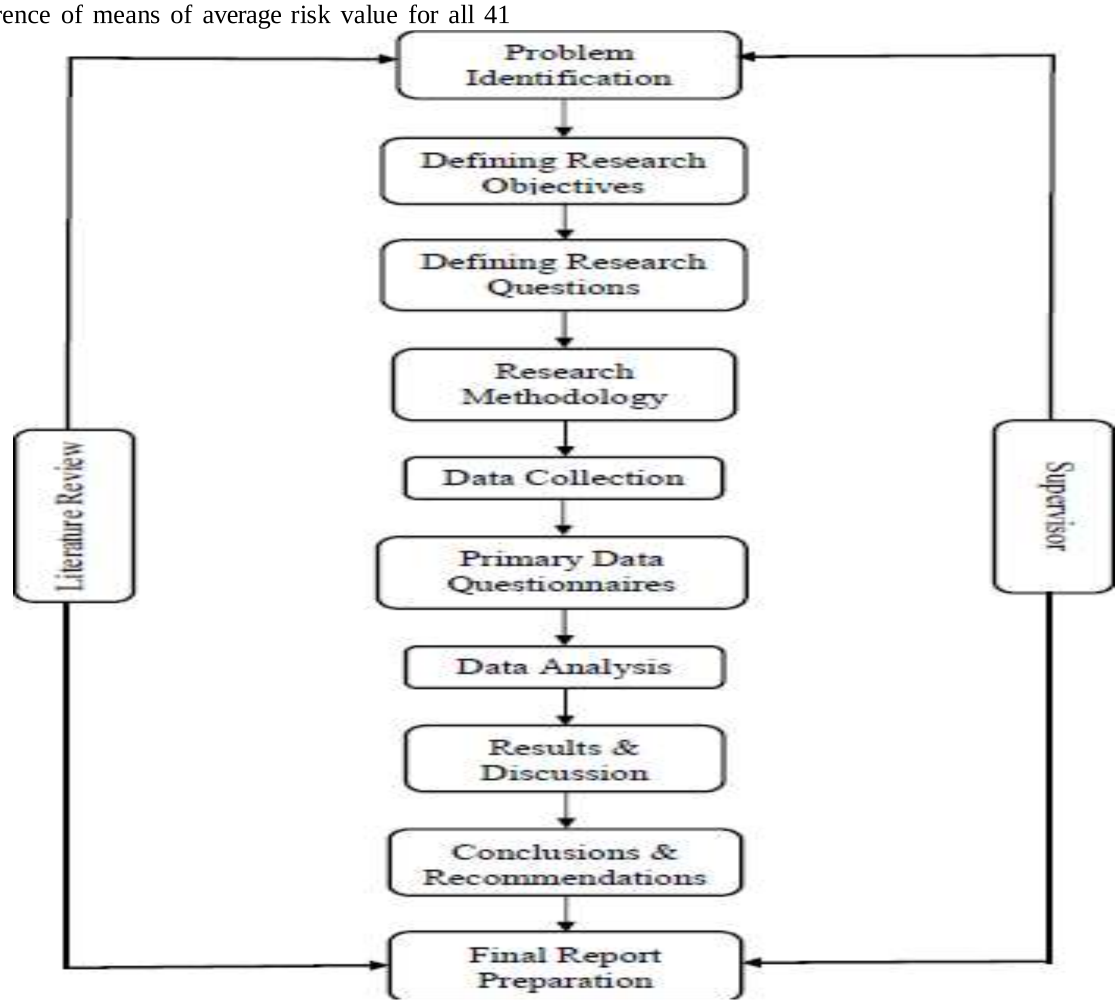

Figure 2: Methodology Research Framework

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<table>
<tr><th>S.N.</th><th>Project Name</th><th>Donor (ADB)</th><th>Clinet (NEA)</th><th>Consultant (PGCIL)</th><th>Contractor</th></tr>
<tr><td>1</td><td>Tamakoshi- Kathmandu 220/400 kV Transmission Line Project</td><td rowspan="4">4</td><td>12</td><td>6</td><td>12</td></tr>
<tr><td>2</td><td>Kaligandaki Corridor 220 kV Transmission Line Project</td><td>9</td><td rowspan="3">1</td><td>6</td></tr>
<tr><td>3</td><td>Marsyangdi Corridor 220 kV Transmission Line Project</td><td>7</td><td>6</td></tr>
<tr><td>4</td><td>New Butwal- Bardaghat 220 kV Transmission Line Project</td><td>3</td><td>5</td></tr>
<tr><td></td><td>Total</td><td>4</td><td>31</td><td>7</td><td>29</td></tr>
</table>

Figure 3: Study Population

Work experience of at least 3 years are only selected for questionnaire survey.

Parameters	Sample Population			
	Donor	Client	Consultant	Contractor
Population Size N	4	31	7	29
Degree of Confidence	95%	95%	95%	95%
Population Proportion (p)	0.5	0.5	0.5	0.5
Error (e)	5%	5%	5%	5%
Sample Size Calculation	70.269	9.747	67.575	6.875
Required Sample Size	**4**	**29**	7	**27**

Figure 4: Sample Population

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3.2 Analysis ofData

Data analysis is done in two basis:

- ANOVA test
- Cronbach's Alphatest

IV. RESULT AND DISCUSSION

4.1 Phase wise average riskscore

Table 3: Phase wise average risk score

SN	Phase	Average risk score
1	P1	0.198
2	P2	0.147
3	P3	0.058
4	P4	0.084
5	P5	0.064
6	P6	0.079

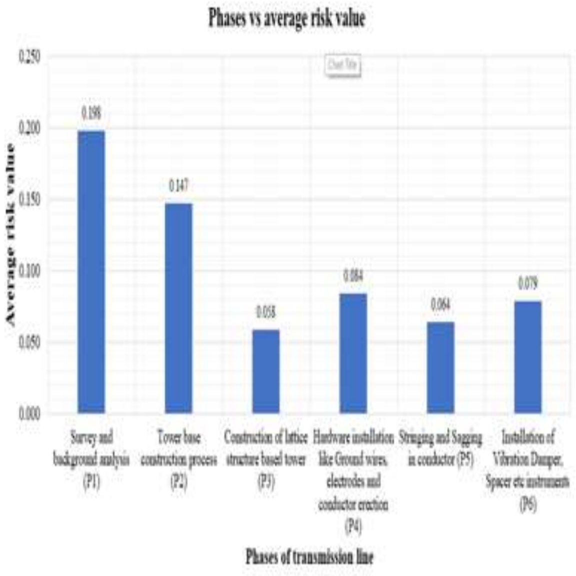


Figure 5: Phase vs average risk value

It is observed from the chart that the average risk score of Phase 1 i.e. Survey and Background analysis is greater than other phases while that of Construction of lattice structure based tower (P3) is the least one. The average risk value of P1, P2, P3, P4, P5 and P6 has been found as 0.198, 0.147, 0.058, 0.084, 0.064 and 0.079 respectively. So, the first phase of the transmission line construction project has been identified as the vulnerable zone regarding risk amongst others.

4.2 Major risk wise average riskscore

In case of Major risks vs average risk value chart, it is observed that Human risks have greatest average risk value of 0.137. Similarly, financial risk, environmental risk bad technical risk has been placed in descending order in terms of average risk value as 0.125, 0.116 and 0.096 respectively.

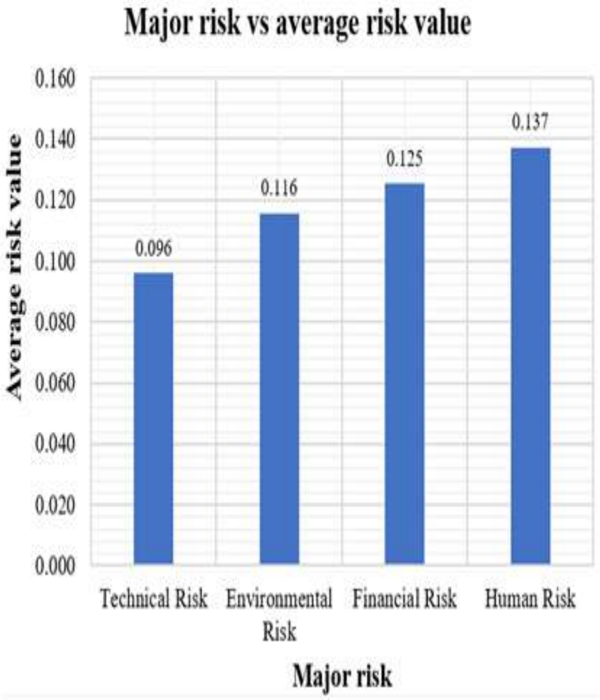
So it can be concluded that human risks are to be mitigated as top priority compared to others. Then financial, environmental and technical comes successively.Technical risks haven't been found as top matter of concern regarding risk.

The table and graphical illustration are as follows:

Table 4: Major risk wise average risk score

SN	Phase	Risk score
1	Technical Risk	0.096
2	Environmental Risk	0.116
3	Financial Risk	0.125
4	Human Risk	0.137

Figure 6: Phase vs average risk value



4.3 ANOVA test

As mentioned in methodology, ANOVA test shall be done amongst two or more independent population samples. In our study, the independent population samples are client, consultant, donor and contractor. ANOVA test is used to test the significance of the difference in the mean value of risk value among stall four population samples for all 41 risk factors. Take alpha = 5 percent such that our confidence interval shall be 95percent.

Null Hypothesis: There is no significant difference in mean value of risk amongst four independent populations and

Alternative Hypothesis: There is significant difference in mean value of risk amongst four independent populations.

Data analysis has been done through MS Excelusing data analysis tab.

The value of Fstatic was found to be lesser than Fcritical for all forty one risks. So, null hypothesis was accepted.

4.4 Cronbach's Alpha test

The average value of Cronbach's alpha is more than 0.7, the questions are acceptable and the overall reliability of the questionnaire is excellent.

SN.	Questionnaire Group	Cronbach's Alpha, $\propto_i$	No. of items, n_i	$\propto_i X n_i$
1	Clinet	0.835	41	34.235
2	Consultant	0.95	41	38.95
3	Contractor	0.917	41	37.597
4	Donor	0.925	41	37.925
			$\sum n_i = 164$	$\sum \propto_i X n_i = 148.707$

Average reliability $= \frac{\sum \alpha_i x n_i}{\sum n_i} = \frac{148.707}{164} = 0.907$

Figure 7: Analysis of reliability of study using Cronbach's Alpha

4.5 Riskrating

As discussed in literature review, risk are generally divided into three zones namely low, moderate and high risk. The table below shall illustrate in graphical way. As per the risk matrix, it is observed that risks namely R7; Country's currency is inflated during initiation of project (Foreign exchange risk, Interest rate risk) and take or pay PPA analysis and R10; Reluctance of Government officials of Malpot, Napi, District Administration to coordinate with project team for expedition of work are marked in red zone. Likewise,risks R13;Differentgeologicalpropertiesin tower legs and R14; Excavated muck for foundation destroying land, vegetation of nearby residents are marked in yellow zone. Remaining 37 risks are marked in greenzone.

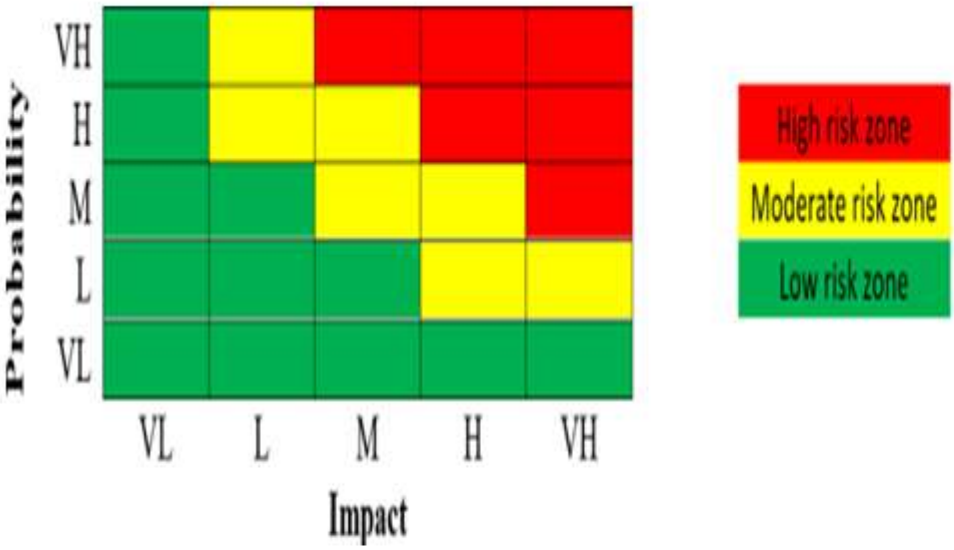


Figure 8: Risk Matrix

V. CONCLUSION

The conclusions obtained from the key findings over the analysis of data are presented below:

- The Survey and background analys is phase and Human risk are amongst the higher average risk value compared to other phases and major risks.
- Amongst forty one identified risks, R7: Country's currency is inflated during initiation of project (Foreign exchange risk, Interest rate risk) and take or pay PPA analysis and R10: Reluctance of Government officials of Malpot, Napi, District Administration etc. to coordinate with project team for expedition of work are mapped as higher zone risks while R13: Different geological properties in tower legs and R14; Excavated muck for foundation destroying land, vegetation of nearby residents are mapped as moderate zone risks. All other remaining risks are mapped as low zone risks.

The major reasons behind above two risks being mapped in high risk zones are:

- Transmission line project are not one dimensional project. It needs contribution of many organizations for successful completion. NEA being the implementing agency and Ministry of Energy, Water Resources and Irrigation (MOEWRI)being the line ministry, Ministry of Finance (MOF), Department of Electricity Development (DOED), National Planning Commission (NPC), Custom offices, Department of Forest, District Administration, Malpot and Naapi Offices of concerned districts are also involved in different phases of transmission line project. It needs the collective effort of all of these organizations for efficient and smooth operation of transmission line project. Unfortunately, there is no coordination amongst these organization. Lots of delay due to stringent, un-contextual, conflicting rules and different interest of individuals has compelled the transmission line project staff to wait for long period even for short approval. Moreover, disputes regarding land acquisition, getting permission to construct in forest areas, lack of timely payment to contractors who have completed their work and security problems are also the major issues.
- Local communities frequently refuse to provide land for erecting towers and stringing power lines. Though the government provides full compensation at determined market prices for land used for towers, it typically only provides 10 percent of the market value of land used for "rights of way"–the area under the power lines, which remains with the owner, but on which they cannot build or plant trees. Developers claim that local people seek unreasonably high rates of compensation for their land, which they say they cannot afford (Niti Foundation,2021).
- Since transmission line project take in average five years for completion in optimistic zone, financial risk always prevail in contract. Foreign exchange risk, interest rate risk is amongst the major financial risk which exists throughout the project period. Predominant transmission line contracts are International Competitive Bidding (ICB) contracts. Tower parts and conductors required for the transmission line needs price adjustment over the project period. This price escalation adds additional financial burden in contract. Further, currency exchange of Nepal and USD also causes contract price to increase with time. These all factors need additional budgeting for the project. Next financial risk factor is take or pay system of power purchase agreement by NEA to the private (IPPs) and subsidiary hydropower developers of NEA. As a result, delay in transmission line project completion shall compel NEA to pay compensation for generation loss to these developers. This shall ultimately result in financial loss of government.

- In Nepal, transmission line tenders are floated based on superficial geological exploration in about dozen locations out of all tower locations. The findings obtained from those locations are generalized for all tower locations which is technically unjustifiable. As transmission line passes through different terrain and runs hundreds of kilometers, geology also differs. Geological properties even differ in four tower legs of a single tower. So, generalization of geological properties and design of towers accordingly is a technical fault. This is the main reason for tower collapse, tower settlement etc. in many regions after construction or commissioning.

- Amongst other environmental issues, this is most vulnerable issues in transmission line projects especially in hilly terrain. Contractors during foundation excavation tend to deposit excavated muck to surrounding landowner's land which is beyond the land acquisition area. As a result, locals demand heavy compensation and even they claim for destruction of vegetation etc. Contractors generally being Indians or Chinese aren't quick enough to solve these issues and locals get enough space to obstruct the work progress. This issue is observed in every tower locations of hilly regions because due to steepter rain, there is no place to dump muck beyond the tower foundation region. Communication gap is also the reason behind the aggravation of problem.

VI. RECOMMENDATION

The major recommendations for the high and moderate risk zone risks as a part of mitigation plan are:

- There shall be good coordination amongst government agencies and expedite the work related to transmission project. Any approvals or other procedures to be followed shall be finished smoothly. Recently the concept of task force is discussed by government to solve transmission line issues. This task force shall be formed at the federal and local level to solve the problems inherent in the construction of transmission lines in future. It was agreed amongst Deputy Prime Minister, Finance Minister, Minister of Home Affairs, Minister for Energy, Water Resources and Irrigation, Minister for Forest and Environment Minister and Minister for Land Management, Cooperatives and Poverty Alleviation, secretaries and officials of Nepal Electricity Authority. Task force at federal level shall be formed representing the Ministry of Energy, Water Resources and Irrigation, Ministry of Forest and Environment, Ministry of Land Management, Cooperatives and Poverty Alleviation and Nepal Electricity Authority. Similarly, local level task force shall be formed under the coordination of the Chief District Officer at the local level with the participation of the concerned bodies and the local level. Both the task forces will make arrangements to solve the problems where ver they are observed. Land Acquisition Act shall be amended to manage land acquisition and compensation because acquisition work for road and transmission line shall not be weighted in same footing. The Ministry of Home Affairs will coordinate and facilitate to solve the problems seen in constructing structures on the land where the land has been acquired and compensation has been distributed. Government would address the genuine Demands rose in various places and if there were any illeg it imate demands, the construction work of the transmission line would be taken forward in the presence of the state (Nepal, 2021).

- Currency exchange risk shall be hedged properly to avoid financial risk. Price adjustment amount shall be reduced to minimum by avoiding any delays in the scheduled work. Compensation based on take or pay tariff shall be minimized by scheduled completion of transmission line projects by the help of task forces especially in the river basins where there are number of developers developing hydropower.
- Rural municipalities, Municipalities and concerned ward offices shall be encouraged to take ownership of transmission line construction project as it is the backbone of our country’s development. Locals shall be consulted in many phases to make them aware during IEE program about pros and cons of transmission line projects.

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