TIME AND COST CONTINGENCY ASSESSMENT FOR HIGHWAY PROJECT

A

Thesis

Submitted in partial fulfillment of the requirements for the award the degree

of

MASTER OF TECHNOLOGY

in

CIVIL ENGINEERING

With Specialization in

CONSTRUCTION MANAGEMENT

Under the supervision

of

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MAY- 2021

STUDENT DECLARATION

I hereby declare that the work presented in the Project report entitled **"Time and Cost contingency assessment for Highway project**" submitted for partial fulfillment of the requirements for the degree of Master of Technology in Civil Engineering with specialization in Construction Management at **JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT**, is an authentic record of my work carried out under the supervision of **Assistant Professor Mr. Kaushal Kumar**. This work has not been submitted elsewhere for the reward of any other degree/diploma. I am fully responsible for the contents of my project report.

18th May 2021

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CERTIFICATE

This is to certify that the work which is being presented in the project report titled **"Time and cost contingency assessment for Highway project**" in partial fulfillment of the requirements for the award of the degree of Master of Technology in Civil Engineering with specialization in construction Management submitted to the Department of Civil Engineering**, Jaypee University Information Technology Waknaghat** is an authentic record of work carried out by Pallavi Thakur, 192604 during a period from July 2020 to May 2021. Under the supervision of Assistant Professor Mr. Kaushal Kumar Department of Civil Engineering, Jaypee University Of Information Technology, Waknaghat, Solan, Himachal Pradesh.

The above statement made is correct to the best of our knowledge.

Date: 18th May 2021

Signature of Supervisor	Signature of HOD
Mr. Kaushal Kumar	Prof. Ashok Kumar Gupta
Assistant Professor	Professor and Head
Department of Civil Engineering	Department of Civil Engineering
JUIT, Waknaghat	JUIT, Waknaghat

ACKNOWLEDEGMENT

I would like to express my gratitude to all those who gave me the possibility to complete this Project. I am deeply indebted to my HOD ‘Prof. (Dr.) Ashok Kumar Gupta’. I am very grateful to Assistant Professor Kaushal kumar for all his diligence, guidance, encouragement and help throughout the period of thesis, which has enabled me to complete the thesis work in time. I also thank him for the time that he spared for me, from his extreme busy schedule. His insight and creative ideas are always the inspiration for me during the dissertation work. I would like to thank my parents for always standing by my side in all the difficulties I have faced during this period. I am thankful for all the faculties and lab staff of Civil Engineering Department.

Pallavi Thakur

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ABSTRACT

Contingency plays a very crucial role in the success to manage projects and it acts as a cushion against risk development. Contingency is widely used to prevent uncertainty. The project has three objectives. The first one is to find the factors that lead in delaying of project. Ranking those factors is the second objective and to calculate time and cost contingency of project by a method called Monte Carlo simulation is the third one. These objectives reduce the prospect of any delay until or unless, any risk factor leads to retardation in project activity. A questionnaire is prepared to rank the factors affecting delaying the project. A four lane project is taken i.e. Solan – Kaithlighat, and its time and cost contingency is calculated. @RISK SOFTWARE is used in this project. .This software is used for Monte Carlo simulation. It provides us with different distributions. Triangle distribution is used and minimum, maximum and maximum likely values are determined. . (ATA)Activity time allowance is calculated by difference of target duration and most likely duration. It is also called buffer in the project. Factors are determined which are causing change in project schedule and thus delaying off the project.

LIST OF TABLE

LIST OF FIGURES

TABLE CONTENT

PAGE NO.

CHAPTER -1: INTRODUCTION

GENERAL:

There are many predictable or unpredictable risks which restrict the abilities of workers in showing their skills during a project. Contingency time is used in various projects to avoid project delay and for time estimation of the project. Monte-Carlo simulation is used for calculating uncertainty and time which is permitted in the project.

TIME AND COST CONTINGENCY- Time management is an essential aspect in construction projects. Through time management, we can predict the completion time of the expected projects. Cost contingency is implemented in the projects to counteract with risks which results in increase of cost in the project. A project is called a successful project if it is completed within time without any delay. If the work has been completed in particular time but the project cost increases, then the project is not a successful project. For establishing a new project, the most significant process starts from cost estimation. Detailed and précised information about the project leads to improvement in cost estimation.

Various factors affecting the construction of cost estimation:

1) **Identical construction project:** For construction estimate the best recommendation will be similar construction project. From the past construction project we get an idea for the new construction project expenditure.

2) **Project expenditure:** Project expenditure means the cost of entire project that include material, supplies, labour, supervision etc. It is important to consider all these variations while calculating construction material cost.

3) **Labor earning value:** Labor earning value must be observed in calculations as it vary from place to place. If we have to start a project we need to estimate project cost and variation in wages rate likely to be happen so it has to be considered in the calculation.

4) **Construction site condition**: Project site condition is another aspect that will extend the manufacturing cost site conditions like wet land, waste material, buried pipe, cables, environment sensitive area, archaeological and many morewill cause extension in cost of the project.

5) **Contingency:** This is advised to add 10% contingency for the project cost for unexpected cost or expansion.

RISK IDENTIFICATION : is the main pace in the risk management process. It is very important step. Its main aim is to have simultaneous identification. If the risk occurs, it will adversely affect the project. They may come from within the project or through some external sources.

External project or internal.

External risk : Are produce by non- human source an i.e. beyond human control.

External risk are:

1) Economic risk
2) Natural risk
3) Social risk
    - **Economic risk :** economic risk include changing in market condition. This type of risk occur due to unexpected changes in supplying material labour availability of equipment etc.

- **Natural risk :** Natural risk are naturally occurring in physical phenomena which can be geophysical. Example: earthquake, landslide hydrological avalanches and floods climatologically extreme temperature drat an materialogical , cyclones.

- **Social risk :** Social risk arise from negative perception of an organization and that has adverse effect on community. Risk typically include environment pollution hazards to human health threat to reason of biodiversity.

- **PROJECT RISK** : It is an occurrence that can negatively affect the project.

Types of project risk are :

- **Time risk**: Risk due to delay in project.

- **Technological risk** : Risks due to inefficient machine.

- **Resource risk** : Resource risk is cause due to lack of resource an that leads to meet a goal.

- **INTERNAL RISK** : The risks within company or personal risks are called internal risk . It also include financial and construction risk.

- **Financial risk** : Financial risk on a construction project is an broad topic that an include problems with under funded project contractor default etc.

- **Design :** It refers in defect a failure in the design that fails to satisfy the requirement for a project.

- **Construction risk** : It include working at height moving object slip an falls etc.

- **Operational risk**: It is inability of worker to work with core- team members.

- **Risk analysis** : It shows project outcomes and objectives can differ due to risks.

Four- laning project yet to get extension

Figure - 1

LANDSLIDES

Figure - 2

LANDSLIDES DURING CONSTRUCTION

Figure - 3

Machine Work

Figure - 4

AN UPHILL TASK

Figure - 5

Risk analysis and control

- **Risk analysis**: It involves examining that how project outcome an objectives might change due to impact of risk event.

- **Identification** : The first step is to identify the risk through which the management can suffer. There are different types of risks example : market risk, environmental risk and many more. It is important to identify these risks as soon as possible.

- **Analyze the risk** : As risks are identified, we need to analyze it. It is necessary to analyze relationship between risk and other factors. If we have to find risk effects, we have to study its affect.

- **Evaluate or rank the risk**: Risk should be ranked that cause little inconvenience rated as low risk and the risk that cause high convenience and damage cab be ranked is highest risk. The highest rated risks require immediate obtrusion.

- **Treat the risk** : Every risk need to be abolish as much as possible. This can be easily finished after interacting along expert of field to which the risk belongs.

- **Monitoring and review the risk** : Not all risk can be removed some of them are always present for example : market risk and environmental risk. They need to be monitoring risk allow your work in continuity. Under digital environment the risk management system monitor the entire risk. If there is any change any risk or factors it is easily visible. Computers are much better for monitoring risk then people in continuity.

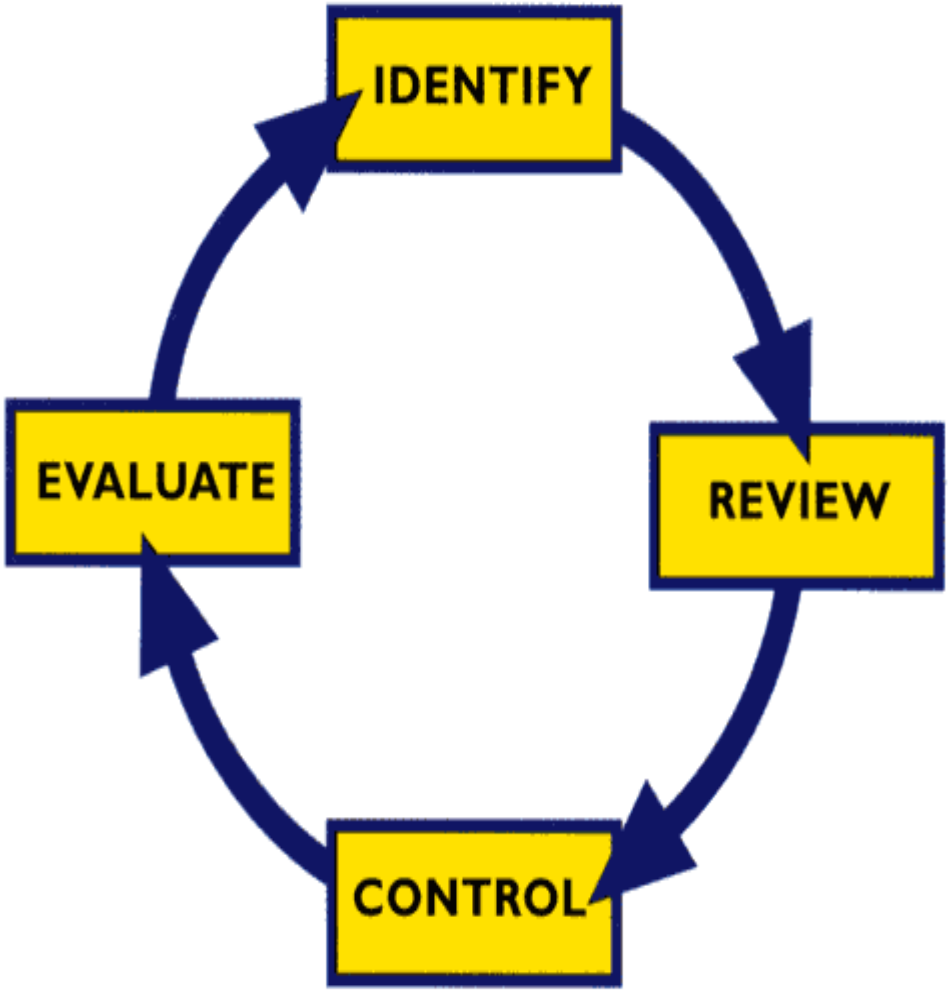
Felling of tree

Figure - 6

- **Risk management** : It is constructed for planning and controlling the measures that can prevents risks. Risk management is a process to find the issues that could have negative

impact on your construction work. Managing risk is a step by which the construction projects become more efficient and practical and we can change the threats into opportunities. The purpose of risk management in construction is to control projects time cost and quality. Risk management categories are classified as:

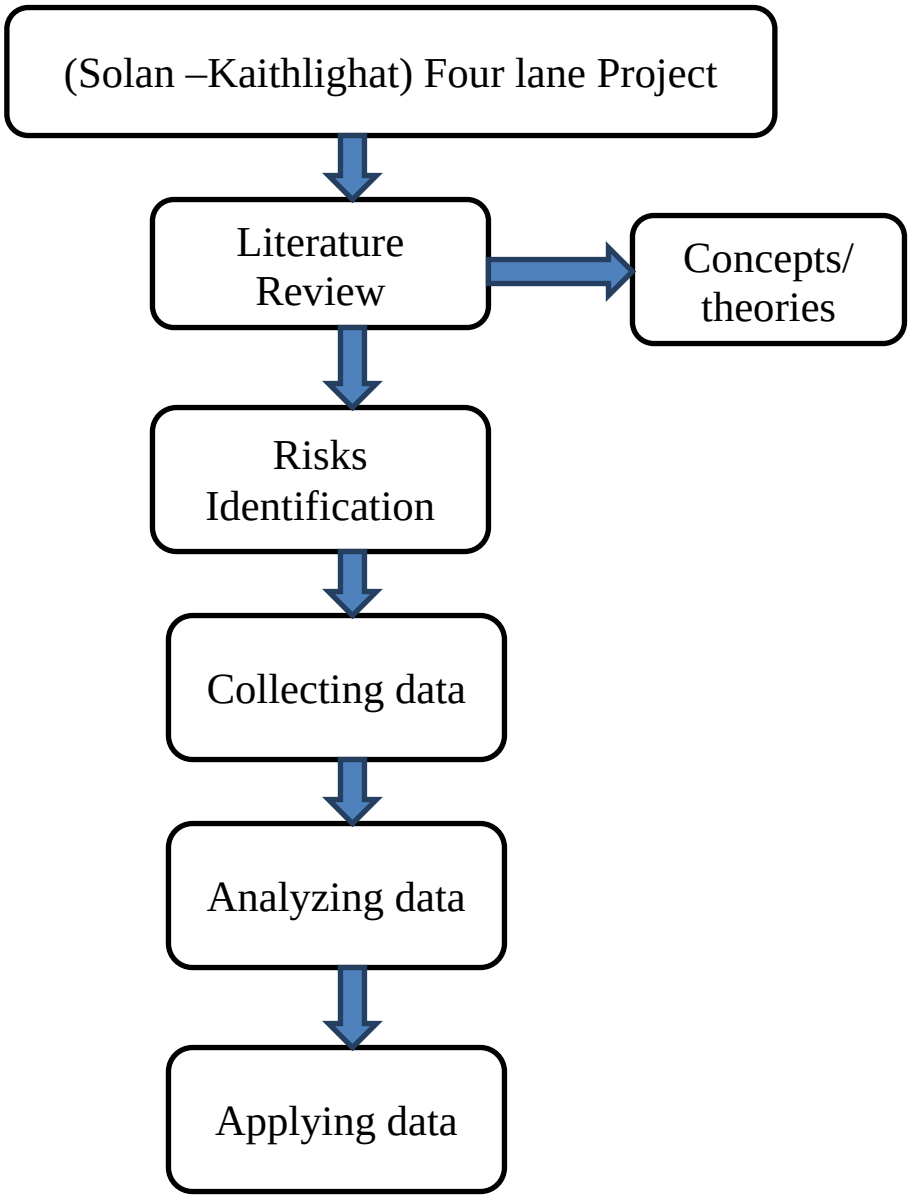
1) Preventing risk e.g. choose to refuse the building project in the area having lane slides, earthquake etc.
2) Transfer the risk.
3) Mitigate the risk.
4) Except the risk



Risk Analysis and control

Figure - 7

WORK METHODOLOGY



CHAPTER-2: LITERATURE REVIEW

EI Touny-et-al (2014) Estimating cost contingency for highway construction projects using Analytic Hierarchy Process - The contractor should consider the risks, find the potential financial impact and determine the uncertainty allowance if the risk was to mitigated through contingencies. The objective of this research paper is to identify financial impact of risk factor. The result shows that the estimated cost contingency matches with (96.31) the average estimated contingency.

Dalia Mohamed-et-al (2009) A prediction model for construction project time contingency- A simple model estimating the expected time contingency of construction project is shown in this paper. The objective is to find the factors that affect scheduling contingency. Also, a survey was conducted on sixteen construction companies in Montreal, Quebac Canada. Analytic Hierarchy process is used. Estimates cost contingency percentage is 87%.The obtained results are acceptable.

Zenonas Turskis-et-al (2010) Risk assessment of construction project- The paper presents risk assessment of construction projects which is based on the multi- attribute decision making methods. TOPSIS grey/ COPRAS-G methods are used in order to rank objects and determine their optimality. A model is proposed and the research results show different risk levels of construction objects.

Mohamed F.Diab-et-at(2017) modeling the construction risk ratings to estimate the contingency in highway projects- The purpose of this paper is to assess perceived ratings of cost and the importance of identified risk drivers on cost contingency amounts. Evaluation of pre identified risk drivers was done using survey from professionals. Insufficient constructability reviews had influence in determining owner contingency and also affects project schedule. Thus model developed will help in finding risks in highway construction projects.

Zenonas Turskis-et-al (2012) Reliability, risk management and contingency of construction process and project- The paper presents the contingency of time and cost, evolution of concepts and main trends in different approaches to risk management. Different local areas in contingency of the project theory are identified. The main trends in different approaches to risk management such as reliability of production and methods of reporting are also presented.

Tiendung Le-et-al (2009) Assessing scope and managing risk in the highway project development process- The project development process is studied and a method is developed to improve this process. Different risk sources are identified. Risk mitigation plans can be developed during high risk elements. Advance planning risk analysis has been examined on limited no. of completed / ongoing projects which gives good results and effective feedback.

-Minsoo baek-et-al (2016) Recommended practice for the cost control of highway project development-

This paper is to find an effective practice for controlling and maintaining the budget and schedule for the project. The aim of this study was categorizing and summarizing various practices that lead to right effect on highway project development in terms of budget, time and quality.

Keith R.Molenaar' (2019) Determining contingency in the management of construction project- This research shows that the construction companies use different types of contingencies to cover risk during the project construction phase. In this project, interviews and surveys were conducted with six additional companies to explore the external validity of the finding. The result shows it can be applied to medium and large sized Spanish general contractor specialized in civil engineering and building construction.

Mohamed Fahmy – et-at(2011) Analysis of highway project construction risk, performance and contingency – Cost and time have been considered as the most important risk according to

the past studies. The main goal of this study is to identify the correlation of risk drivers with project contingency and cost growth. A survey was conducted for this purpose. Thus, main purpose is analyze impact of rating on contingency.

MW Hammad (2016) Allocation and management of cost contingency in projects – Contingency is vital for successfully managing projects. A new methodology is introduced in paper to calculate cost contingency during both i.e planning as well as execution phase. Thus cost contingency allocation technique is used. New measures have been introduced. The results are thus acceptable.

Keith R.Molenaar (2005) Programmatic cost risk Analysis for highway Megaprojects- Highway projects are filled with uncertainty. The paper presents a methodology developed by Washington State Department of transportation for cost estimating validation process. Different case studies are analyzed. Various risks are presented and summarized as economic, environment and other minor risks. It provides for better understanding and communication of risks involved in mega projects.

Kabindra k. Shrestha M.S. CSIT (2016) A contingency costestimation system for Road Maintenance Contracts– During the construction phase, a contingency cost is given to a project mainly to cover change orders. To various reasons can be design errors or scope changes. If cost is estimated correctly then, co cost can be properly managed. A tool was developed in this study to estimate contingency cost by using a mathematical model. It forecasts contingency cost for each activity in contract.

EI-Touny (2014)- Estimating cost contingency for highway construction projects- Many managers set a percentage of cost as contingencies. The main objective is identifying financial impacts of risk factors. A survey was conducted on ninety manufacturing companies in Egypt.

The technique used is (AHP) Analytic Hierarchy process. The result show that estimated cost is similar with 96.31% calculated contingency.

Georgios k. koulinas (2020)-Schedule delay risk analysis in construction projects with a simulation based expert system- A simulation depended approach for effectively estimating delay risks in project schedule with prediction of the possibilities is presented in this paper. The proposed approach helps in predicting the actual project duration with more accuracy. The method was applied to estimate the total project completion time. The promising results show that this process is effective and provide project risk managers with good predictions when calculating budget.

Eugenio PELLICER (2018)- Management of time and cost contingency in construction projects :- A contractor Perspective- The management of risks is the most important task in any construction projects. The study presents important observations that tell how the contractors handle uncertainties. Time and cost contingencies can also be used as a tool for managing opportunities.

Mohamed F. Diab. (2012) – Using Risk Assessment to improve highway construction project performance- The manufacturing industries faces high risks due to the nature of construction process. This paper shows analysis of different risks in US. Thirty one risk drives taken by earlier studies are used in this paper. This paper presents the process of using risk assessment techniques. It also includes project risks and information's. Analysis were taken on the basis of response both public and private sectors. Risk assessment has modified project managing practices.

OBJECTIVE

- First objective is to select those factors which are causing the delaying of the project.
- Ranking of the factors is the second objective.
- Using the method Monte Carlo simulation, calculate time and cost contingency.

CHAPTER – 3: PROJECT STATEMENT AND DATA COLLECTION

ABOUT PROJECT- The project is about four laning of Solan – kaithlighat section of NH-22 (Now NH-5) from 106.139km to 129.05km under NHDP phase –third on EPC Mode in the state of Himachal Pradesh. Project length (km) / Project cost. Design length 22.911km. The reason of considering four laning of Solan- Kaithlighat because we can compare the values by using the particular software.

- **Client / Employer** – National Highway Authority Of India (NHAI).
- **Authority Engineer**- M/S Yooshin Engineering Corporation in Association with Casta Engineering Pvt. Ltd.
- **BID due Date**-: 24 January 2018
- **Appointed Date**-: 9 November 2018
- **Construction Period** -: 910 Days
- **Schedule Completion Date**-: 6 May 2021
- **Contract Price-:** 598 Crore

DATA COLLECTION

This data has been given by engineers working in the four lane project i.e. Solan-Kaithlighat. In order to find factors which will cause delaying of the project, a questionnaire need to be prepared? Company has answered those questions on the basis of which ranking is done and out of 75 factors, 15 factors are selected.

- Shortage of equipment.
- Design errors made by designers.
- Lake of skilled operators for specialized equipment
- Equipment productivity.
- Unclear and inadequate details in drawings.
- Reworks due to defects in construction material.
- Low quality of construction materials.
- Rework due to change of design or deviation order.
- Effects of subsurface condition.
- Poor site layout.
- Wrong or improper design.
- Change orders by owner during construction.
- Change in drawing and specification.
- Delay in material to be supplied by the owner.
- Inadequate experience of designers.
- Conflict between contractor and other parties.
- Un-use of advanced engineering design software.
- Lack of responsibilities.
- Rain effect on construction activities.
- No adherence to contract conditions.
- Traffic control and restriction at job site.

- Accident during construction.
- Unrealistic contract duration and requirement imposed.
- Labor skill.
- Unrealistic contract price.
- Mistakes and discrepancies in contract documents.
- Poor contract management.
- Owner financial problems.
- Payment of completed work.
- Late payment to subcontractor by the main contractor.

- Material and labor wage escalation.

- Financing by contractor during construction.

- Delay of design submittal from consultant.

- Lake of experience of consultant in construction projects.

- Delay in approving major changes in the scope of work by consultant.

- Waiting instruction from consultant.

- Consultant or architect's reluctance for change.

- Inadequate contractor experience causing error.

- Difficulties in financing project by contractor.

- Poor subcontractor performance.

- Poor site management and supervision by contractor.
- Rework because of errors during construction.
- Non-adherence of material specifications provided by client.
- Equipment failure.
- Equipment productivity.
- Lack of high-technology mechanical equipment.
- Shortage in construction materials.
- Materials changes in types and specification during construction.
- Late procurement of materials.
- Slow delivery of materials.
- Mistakes in soil investigation.
- Faulty soil investigation paper.
- Unexpected underground condition.
- No planning before project starts.
- Lake of program of works.

- Improper or wrong cost estimation.
- Poor professional construction management.
- Inefficient capability of contractor staff management.
- Slow land expropriation due to resistance from occupants.
- Design changes by owner or his agent during construction.
- Late in revising and approving design documents by owner.
- Slow payment of completed works.
- Difficulty of coordination between various parties.
- Poor organization of the contractor or consultant.
- Insufficient communication between the owner and designer.
- Foreman incompetence
- Insufficient laborers.
- Low productivity of laborers.
- Shortage of technical staff.
- Personal conflicts among labors.

- Conflict, war, revolution, riot, and public enemy.
- Physical obstructions.
- Bribes and personal interest corruption.
- Poor government judicial system for construction dispute settlement.
- Hot weather effect on construction activities.
- Changes in government regulations and laws.

CHAPTER-4

PROJECT METHODOLOGY:

- MONTE CARLO SIMULATION: - Simulation: simulation means constructing a model of a real system conducting experiment along the model for understanding the behavior for the operation of the system. This method is used by various type of organization for the different uses.

- Monte – Carlo simulation Technique: It is an experiment on probability. In this technique random no. are used and we need to make decisions under uncertainties

- The methodology used in this project is MONTE CARLO SIMULATION. @RISK SOFTWARE is used in this project. .This software is used for Monte Carlo simulation. It provides us with different distributions. Triangle distribution is used and minimum, maximum and maximum likely values are determined. Infinite number of iteration can be entered. Simulations help to explain the impact of risk and uncertainty in forecasting models. Given input data is processed by mathematical formulae which results in analysis of the output. Time and cost contingency is calculated. ATA is calculated by difference of target duration (Td) and most likely duration (Dp). It is also called buffer in the project. *ATA = Td-Dp*

CHAPTER – 5: DATA COLLECTION

FACTORS CAUSING PROJECT SCHEDULE DELAY:

A questionnaire is prepared in which 75 factors are included which can affect a project. Out of those 75 factors, 15 factors are responsible for delaying of project.

S.NO	FACTORS	FREQUENCY
A)	Under Equipment group	
1	Shortage of equipment	0.425
2	Lack of skilled operators for specialized equipment	0.475
3	Equipment productivity	0.460
B)	Under material group	
4	Reworks due to defects in construction material.	0.410
5	Low quality of construction materials.	0.399
C)	Under site group	
6	Effects of subsurface condition.	0.422
7	Poor site layout	0.425
D)	Under owner group	
8	Change orders by owner during construction.	0.462
9	Delay in material to be supplied by the owner.	0.445
E)	Under contractual relationship group.	
10	Conflict between contractor and other parties.	0.345
11	Lack of responsibilities.	0.423
F)	Under External group	
12	Rain effect on construction activities.	0.466

13	Traffic control and restriction at job site.	0.475
14	Accident during construction.	0.476
G)	Under labor group	
15	Labor skill	0.423

Factors affecting cost contingency and their frequencies are calculated as follows:

Total score of frequency

$=\sum$frequency of each factor$=\sum^{n}_{i=1}$

Frequency index=(Fi)

$$= \sum^{n}_{i=1} Fi/ (N*5)$$

Where;

N=5

N = upper scale of measurement

Project schedule gives data before starting of project. Start and end date are also given as shown in table 1.

PROJECT SCHEDULE DATA

S.NO.	TASK NAME	START	FINISH	DURATION
1	Road survey	21-3-18	15-1-19	300
2	Cutting	6-8-2020	20-2-21	200
3	Preparation of base coarse layer	1-3-2021	6-4-2021	37
4	Application of tuck coat	7-4-2021	2-5-2021	25

TABLE 1

CHAPTER – 6

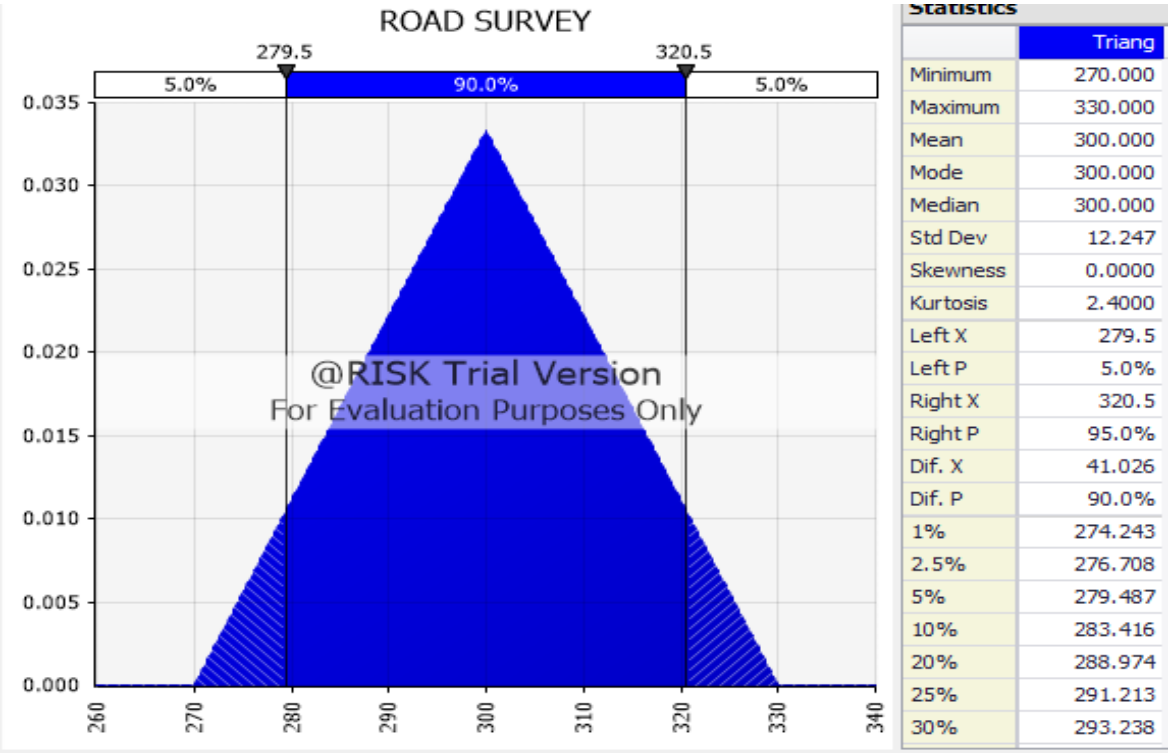
ANALYSIS OF RESULTS

First probabilistic scheduling is done in MS project. @RISK SOFTWARE is used in this project. .This software is used for Monte Carlo simulation. It provides us with different distributions. Triangle distribution is used and minimum, maximum and maximum likely values are determined. Table below shows the minimum, maximum and maximum likely values for each activity.

TABLE 2. Minimum, max likely and maximum value for each activity

S.NO.	TASK NAME	MINIMUM	MAX. LIKELY	MAXIMUM
1	Road survey	270	300	330
2	Cutting	180	200	220
3	Preparation of base coarse layer	33.3	37	40.7
4	Application of tuck coat	22.5	25	27.5

As written above, minimum, maximum and maximum likely values are calculated using @RISK software as shown in TABLE 2.

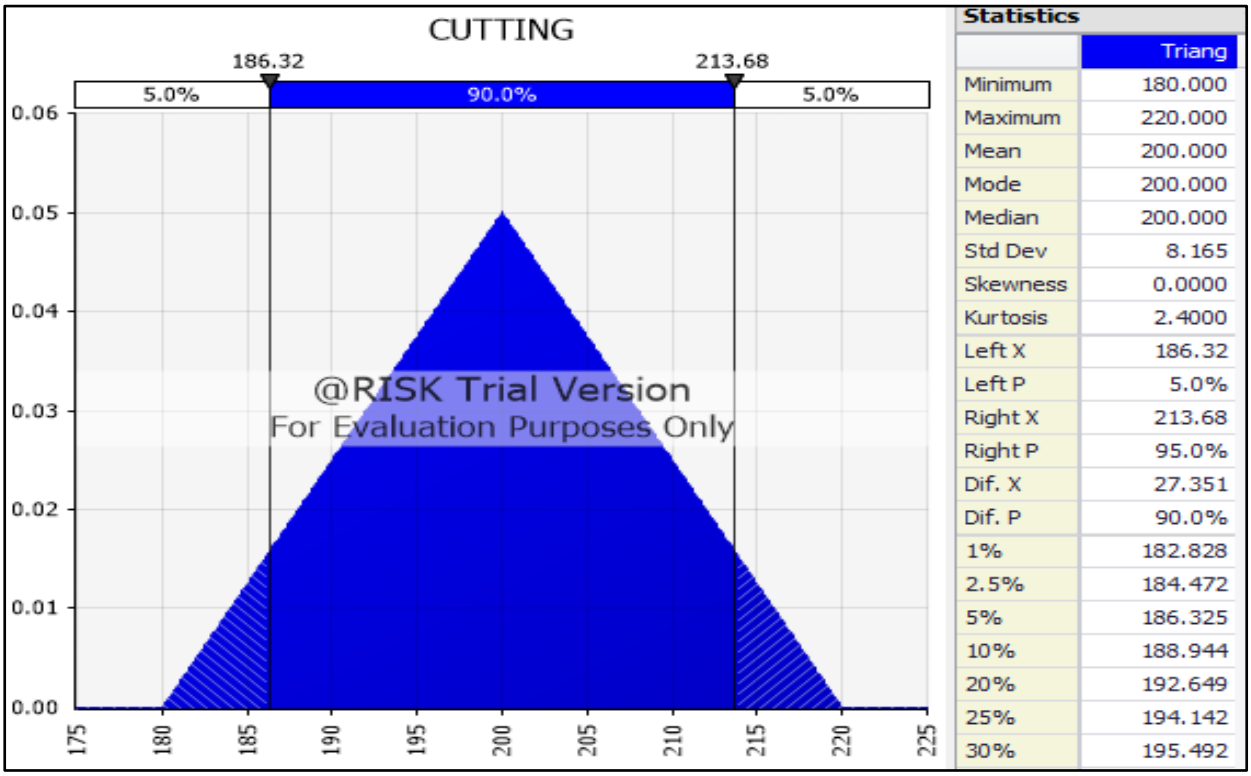


Statistics

	Triang
Minimum	270.000
Maximum	330.000
Mean	300.000
Mode	300.000
Median	300.000
Std Dev	12.247
Skewness	0.0000
Kurtosis	2.4000
Left X	279.5
Left P	5.0%
Right X	320.5
Right P	95.0%
Dif. X	41.026
Dif. P	90.0%
1%	274.243
2.5%	276.708
5%	279.487
10%	283.416
20%	288.974
25%	291.213
30%	293.238

Figure – 8: Graph for road survey

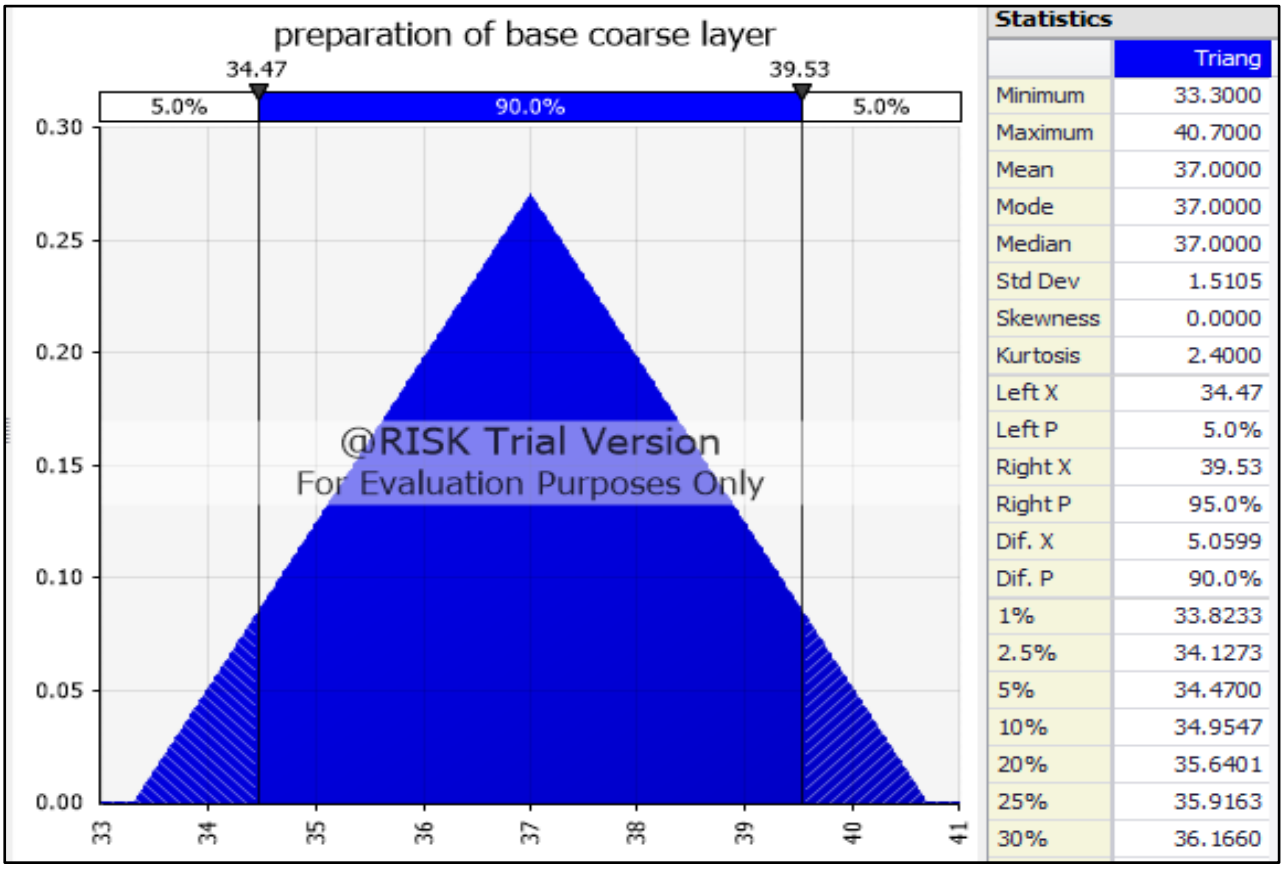
Road survey can complete in 320 days because of 90% chance as shown in the graph and 5% chance of completing in 279 days.



Statistics	Triang
Minimum	180.000
Maximum	220.000
Mean	200.000
Mode	200.000
Median	200.000
Std Dev	8.165
Skewness	0.0000
Kurtosis	2.4000
Left X	186.32
Left P	5.0%
Right X	213.68
Right P	95.0%
Dif. X	27.351
Dif. P	90.0%
1%	182.828
2.5%	184.472
5%	186.325
10%	188.944
20%	192.649
25%	194.142
30%	195.492

Figure – 9: Graph for cutting

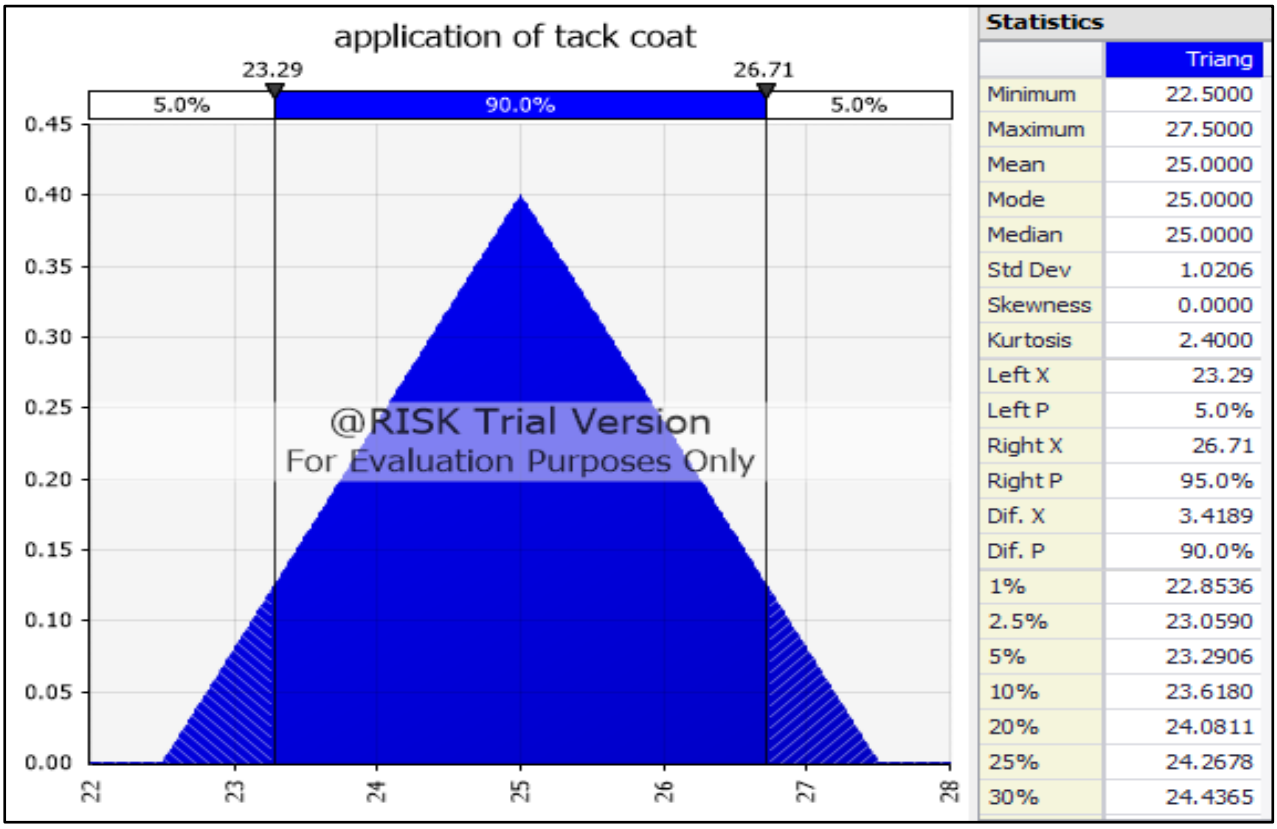
Cutting can complete in 214 days because of its 90% chance as shown in above graph. And for 186 days, it has only 5%chance.



Statistics	Triang
Minimum	33.3000
Maximum	40.7000
Mean	37.0000
Mode	37.0000
Median	37.0000
Std Dev	1.5105
Skewness	0.0000
Kurtosis	2.4000
Left X	34.47
Left P	5.0%
Right X	39.53
Right P	95.0%
Dif. X	5.0599
Dif. P	90.0%
1%	33.8233
2.5%	34.1273
5%	34.4700
10%	34.9547
20%	35.6401
25%	35.9163
30%	36.1660

Figure – 10: Graph for preparation of base coarse layer

Preparation of base course can complete in 39 days as it has 90% chance as shown in graph and 5% chance in 34days.



Statistics	Triang
Minimum	22.5000
Maximum	27.5000
Mean	25.0000
Mode	25.0000
Median	25.0000
Std Dev	1.0206
Skewness	0.0000
Kurtosis	2.4000
Left X	23.29
Left P	5.0%
Right X	26.71
Right P	95.0%
Dif. X	3.4189
Dif. P	90.0%
1%	22.8536
2.5%	23.0590
5%	23.2906
10%	23.6180
20%	24.0811
25%	24.2678
30%	24.4365

Figure – 11: GRAPH FOR APPLICATION OF TUCK COAT

Application of tuck coat can complete in 27 days as it has 90% chance which can be seen from above graph and 5% chance in 23 days.

SIMULATION RESULTS:

Simulation is given in the @Risk software with different iterations i.e. 500 and 1000. This shows number of time data is simulated. It can be seen that after giving iteration, value changes but does not go beyond maximum value.

For 500 iteration:

TABLE 3

S.No.	TASK NAME	DURATION
1	Road survey	310 days
2	Cutting	218 days
3	Preparation of base coarse layer	39 days
4	Application of tuck coat	26 days

For 1000 iteration:

TABLE 4

S.No.	TASK NAME	DURATION
1	Road survey	303 days
2	Cutting	213 days
3	Preparation of base coarse layer	34 days
4	Application of tuck coat	23 days

As mentioned above, values are changing but does not go beyond maximum duration which can be clearly seen from the table3 and 4.

PROJECT DATA FOR CONSTRUCTION ROAD

Activity time allowance (ATA) of each activity is calculated after simulation which is also known as buffer in the project.

$$ATA = Td - Dp$$

Where;

ATA= activity time allowance

Dp= most likely duration

Td=Target duration

TABLE 5

S.NO.	TASK	MIN	MAX LIKELY	MAX	Critical Index	Dp	Td	ATA
1	Road survey	270	300	330	100	300	310	10
2	Cutting	180	200	220	100	200	218	18
3	Preparationof base coarse layer	33.3	37	40.7	0	37	39	2
4	Application of tuck coat	22.5	25	27.5	0	25	26	1

PROJECT DATA

ATA for road survey =10 days

ATA for cutting= 18 days

ATA for preparation of base coarse layer=2 days

ATA for application of tuck coat= 1 days

This is also known as buffer in the project. Cutting has maximum ATA or activity time allowance and application of tuck coat has minimum ATA.

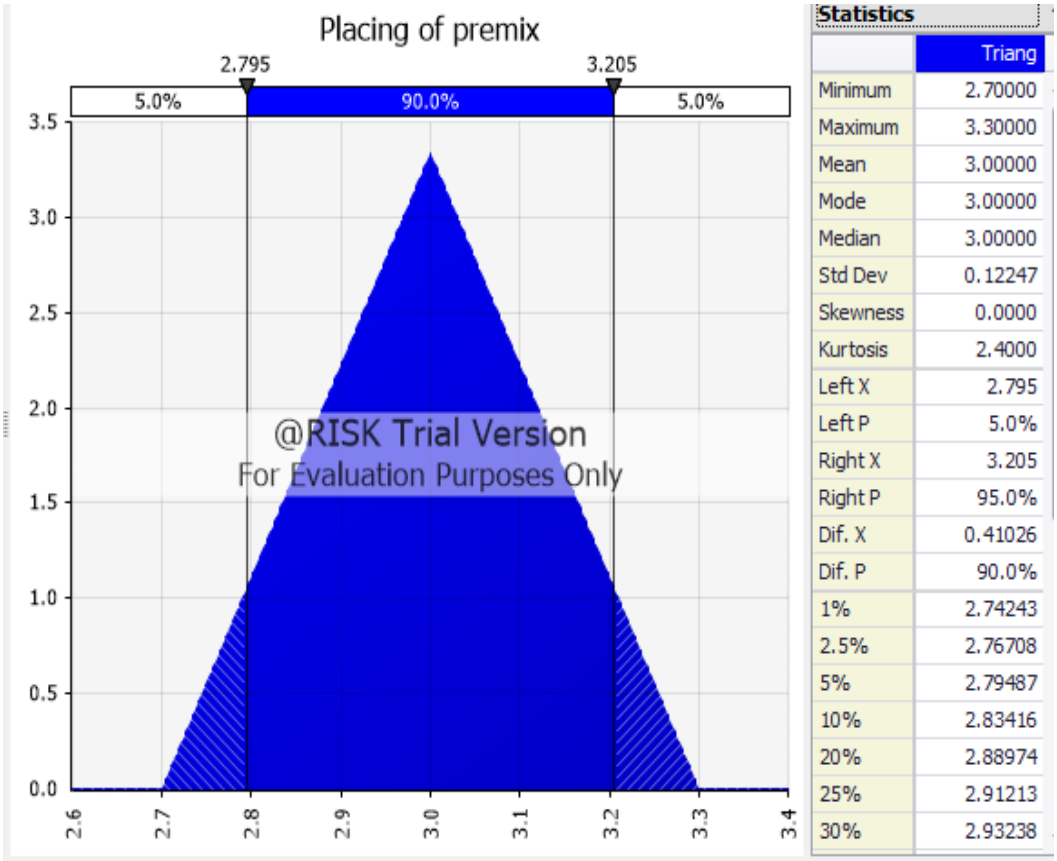
After calculating ATA and critical index; cutting and road survey has 100% chance of remaining in critical path. Others are not causing any change in project schedule.

The four lane project SOLAN-KAITHLIGHAT is not yet completed. The work is still going on.

S.NO.	TASK	DURATION	START	FINISH	MIN	MAX.LIKELY	MAX
1	Placing of premix	3 hrs	9:00 AM	12:00 NOON	2.79	3	3.20
2	Rolling	2hrs	1:00PM	3:00PM	1.86	2	2.83
3	Finished surface	2hrs	3:00PM	5:00PM	1.86	2	2.83

ONGOING WORK

TABLE-6



Statistics	Triang
Minimum	2.70000
Maximum	3.30000
Mean	3.00000
Mode	3.00000
Median	3.00000
Std Dev	0.12247
Skewness	0.0000
Kurtosis	2.4000
Left X	2.795
Left P	5.0%
Right X	3.205
Right P	95.0%
Dif. X	0.41026
Dif. P	90.0%
1%	2.74243
2.5%	2.76708
5%	2.79487
10%	2.83416
20%	2.88974
25%	2.91213
30%	2.93238

Figure - 12

Placing of premix can complete in 3.2 hrs. because of its 90% chance as shown in above graph. For 2.7 hrs. , it has only 5%chance.

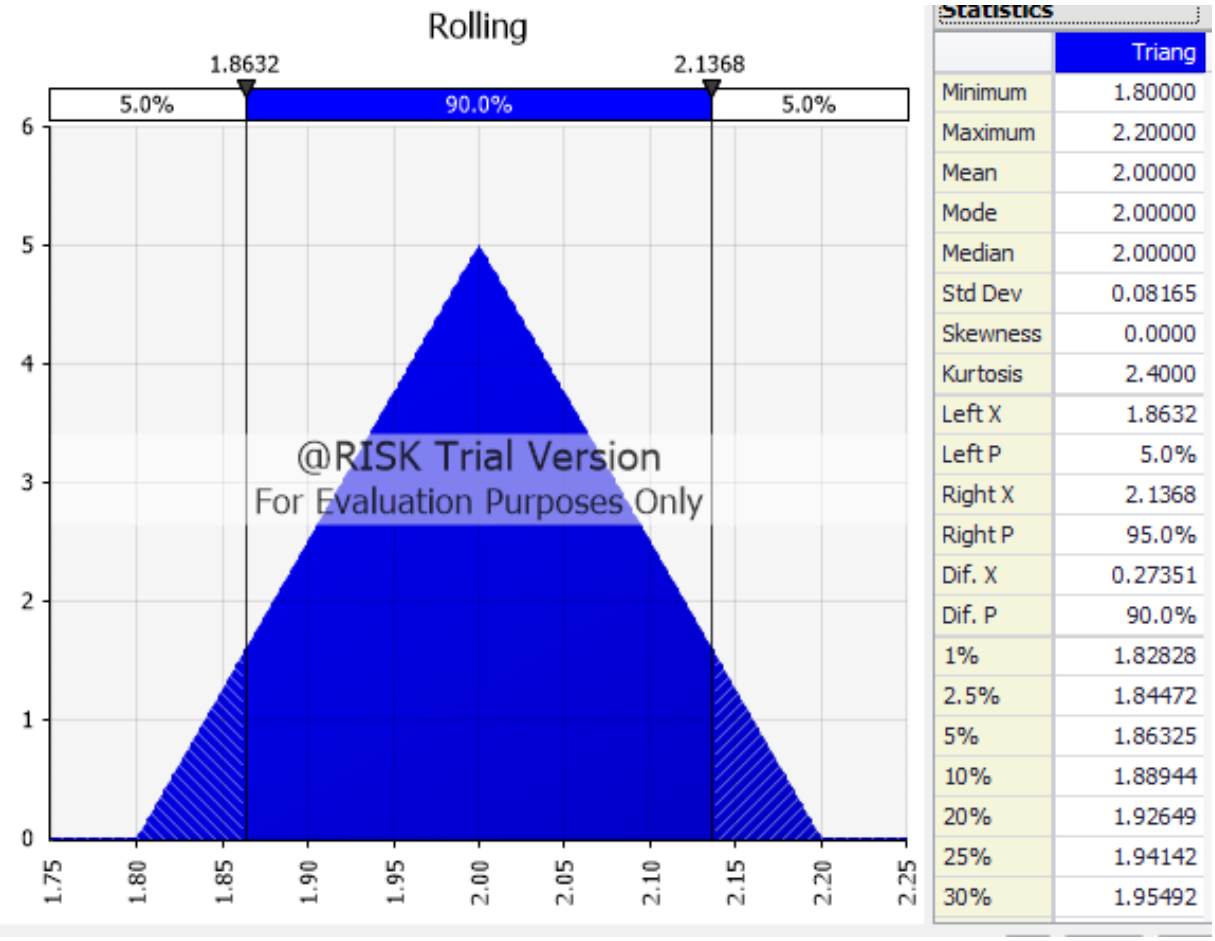


Figure - 13

Rolling can complete in 2.13 hrs. Because of its 90% chance as shown in above graph. For 1.86 hrs. , it has only 5%chance.

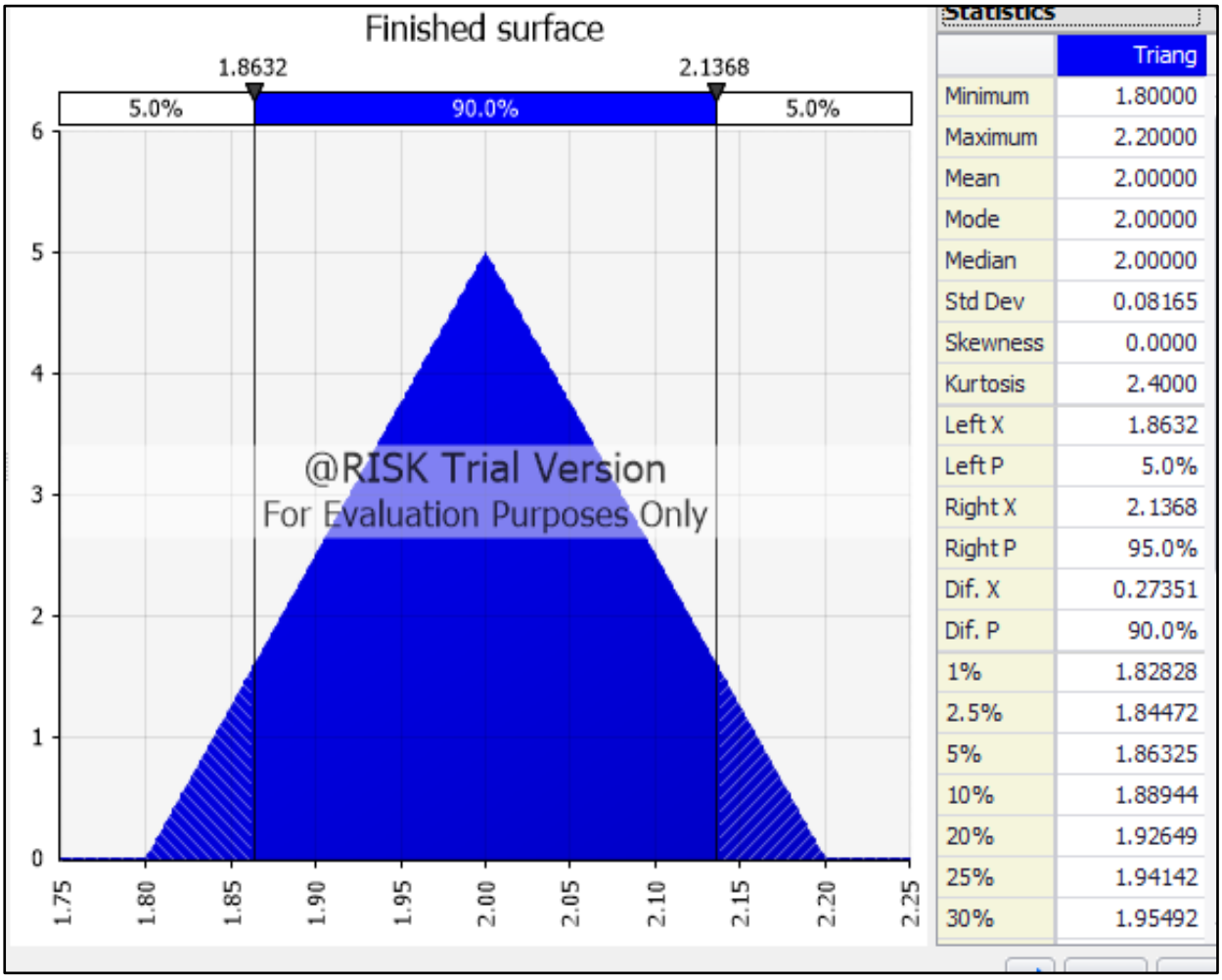


Figure - 14

Finishing surface can complete in 2.13 hrs. Because of its 90% chance as shown in above graph. For 1.86 hrs. , it has only 5%chance.

Again, Simulation is given in the @Risk software with different iterations i.e. 500 and 1000. Duration has been changed but again it does not go beyond maximum. Simulation results for 500 and 1000 iterations has been shown below in table 7 and table 8.

Simulation results are as follows

FOR 500 iteration :

S.No.	TASK NAME	DURATION
1	Placing of premix	2.71
2	Rolling	1.960
3	Finished surface	2.01

Table - 7

S.No.	TASK NAME	DURATION
1	Placing of premix	2.42
2	Rolling	1.86
3	Finished surface	1.963

For 1000 iteration :

Table -8

Project schedule end date is different from actual end date. Planned project duration for road survey is 8 months but in actual there was delay of 2 months. So, contingency has been calculated by dividing delay from planned project duration. At last average is calculated which comes out to be 0.397 as shown in Table- 9.

S.NO.	Task	Start	Schedule end date	Actual end date	Planned project duration	Delay	Contingency
1	Road Survey	21 march 2018	15 Nov. 2018	15 Jan. 2019	8 Months	2 Months	2/8= 0.25
2	Cutting	6 August 2020	21 Dec. 2020	20 Feb. 2021	4Months	2 Months	2/4= 0.5
3	Preparation of base coarse layer	1 March 2021	25 March 2021	6 April 2021	25 Days	12 Days	12/25= 0.48
4	Application of tuck coat	7 April 2021	25 April 2021	2 May 2021	19 Days	7 Days	7/19= 0.36
AVERAGE							0.397

Contingency analysis

TABLE-

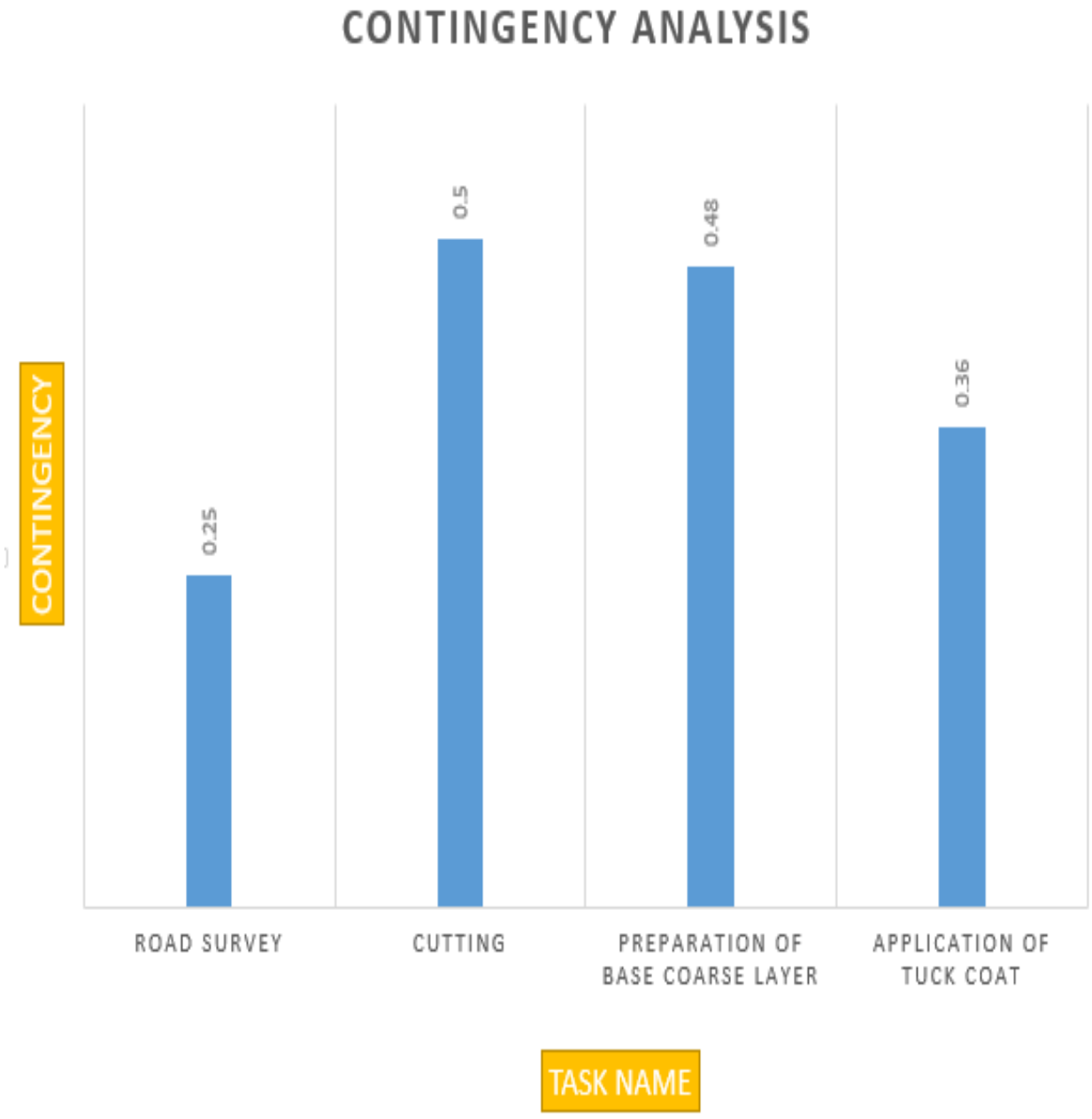

CONTINGENCY ANALYSIS
CONTINGENCY
0.25
0.5
0.48
0.36
ROAD SURVEY
CUTTING
PREPARATION OF BASE COARSE LAYER
APPLICATION OF TUCK COAT
TASK NAME

Figure - 15

CHAPTER – 7: CONCLUSION

Many unpredictable risks are seen in construction industry which affects the performance of the project. For the construction project to be successful, it needs to complete in time with planned budget. Risk identification is the main pace of risk management. Thus we use contingency for managing projects. Proper decision making is the most important task. By using Monte Carlo simulation, contingency time and cost can be calculated. The results will also show risk levels of construction project. Simulations help to explain the impact of risk and uncertainty in forecasting models. Given input data is processed by mathematical formulae which results in analysis of the output. Time and cost contingency is calculated. ATA is calculated by difference of target duration (Td) and most likely duration (Dp). It is also called buffer in the project. ATA =Td-Dp**.**After calculating ATA and critical index; cutting and road survey has 100% chance of remaining in critical path. Others are not causing any change in project schedule.

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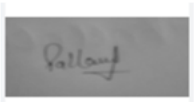

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