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Implementation of framework for improving Schedule Adherence by Schedule Risk Analysis (SRA)

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ABSTRACT: In this competitive world, where every firm, every company is continuously making incremental improvements and developing new products to sustain in the fast-paced environment, companies tend to operate under pressure to develop the product in lesser timeframe and reduce time to market. While planning and controlling of this kind of projects, schedule management is essential for successful execution. While dealing with the risks in scheduling of projects, schedule risk analysis plays very important role. This research undergoes to proposes schedule risk analysis model to analyse the schedule risks and their impact on the project timeline and to estimate the pessimistic and optimistic values of the duration of the activities. This paper uses Monte Carlo simulation technique to predict the probabilistic results of uncertainties based on the risk criticality and impact of risks on project tasks which helps to obtain realistic timeline of the project closure.

KEYWORDS: Schedule Risk Analysis, SRA, Monte Carlo Analysis, Schedule adherence, Schedule risk management

I. INTRODUCTION

In this Scenario, where every firm is chasing to develop a product in shorter duration reducing time to market to meet the customer demands, Schedule plays very important role in any type of project. Whether it is small or large scale, the chances of successful completion of project depends on the proper planning and scheduling of the project. With the scheduling there always comes uncertainty. Uncertainty is the situation which is not specified, it could be due to lack of information or any organisational problem. Dealing with the uncertainties in the project is most difficult task.

Most of the projects fail because while planning the estimated project duration, uncertainties that can affect and delay the project are not undertaken.

This paper emphasis and analyse the risk involved in the New Product Development project, which helps to accurately determine the project completion. Monte Carlo analysis is a statistical analysis used to obtain probabilistic distribution of the risk. This research studies the existing scheduling timeline of new product development project and optimize the completion time of considering the impact of top 10 risks affecting the schedule of project.

[1]CPM-PERT and Monte-Carlo simulation method. Were used for management of schedule risk in construction project. A questionnaire survey was taken to identify the major risks involved. A system dynamics model was developed.[2]Considering the impact of variance and mean on the probability of project completion times. [3]Performed modified variance and mean assumptions for SRA.[4]explored the impact of the risk factors on the schedule and project milestones . Monte Carlo technique was used.[5]cost and schedule risks were analyzed for design and Used Monte Carlo simulation for analyzing schedule impact. [6] three models were developed to know the forecasted time at completion.

Simulation-based approach was used to estimate the delay happened due to risk and used the output to predict the project completion time.[7]also risk estimations were used which enabled accurate prediction for duration.[8]A framework for SRA was used consisting of personnel, method and time dimension.

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Schedule Risk Analysis

The purpose of risk analysis is toreduce the risk, and also to know what would happen in the future so that required decisions to be taken in advance. Every project has Risks and Uncertainties Therefore,project schedulescontain uncertainty in task. Each project has different perspectives. Andalso, conditions varyfor every project, so sometimes we cannot accurately estimate the schedule of project. We should estimate the risks and its analysis in efficient way. There are many techniquesavailable that can be used. To complete the Project in scheduled time, we have to use proper techniques and tools, which makes planning easier for us. The PERT and Monte CarloSimulationare mostly feasiblefor purpose of planning and scheduling. By using schedule risk analysis, managers or schedulers can identify and predict the risks and have the mitigation actions in advance.

PERT-Program Evaluation and Review Technique

PERT method is used determine the variation in the critical path of project. And look into every task in the schedule. It examines completion time of each task and dependencies. It calculates the minimum time of project closure by calculating time for each activity

For calculating the PERT Estimate, there are 2 major steps to be followed.

Step 1: Determine optimistic time,most likely time and pessimistic time for every activity.
Step 2: Calculating PERT Estimate
Mean, $\mu=(To+4Tm+Tp)/4$
Variance, $\sigma^2=(Tp-To/6)^2$

Critical path is the longest duration of project completion from the start to finish of the project. We can determine the critical activities based on critical path.

Monte Carlo Analysis

The MCA is generally a risk management technique. Project managers use this technique to determine the risk impact on the project as well as on schedule of project.With this method, it is easy to identify the future situations that can happen if the certain risk happens in project The method is used during Project Lifecycleto study the various scenarios and probabilities of risk happen in project.

Microsoft Project or Primavera with the add-ins for Monte Carlo simulation can be used for the purpose of schedule risk analysis. Also, Excel can be used for the same as it is easily available and accessible to everyone. Activities are examined based on different conditions using PERT and normal distribution. Then this data is collected and investigated to find out the probabilities of project completion

II. RESEARCH METHODOLOGY

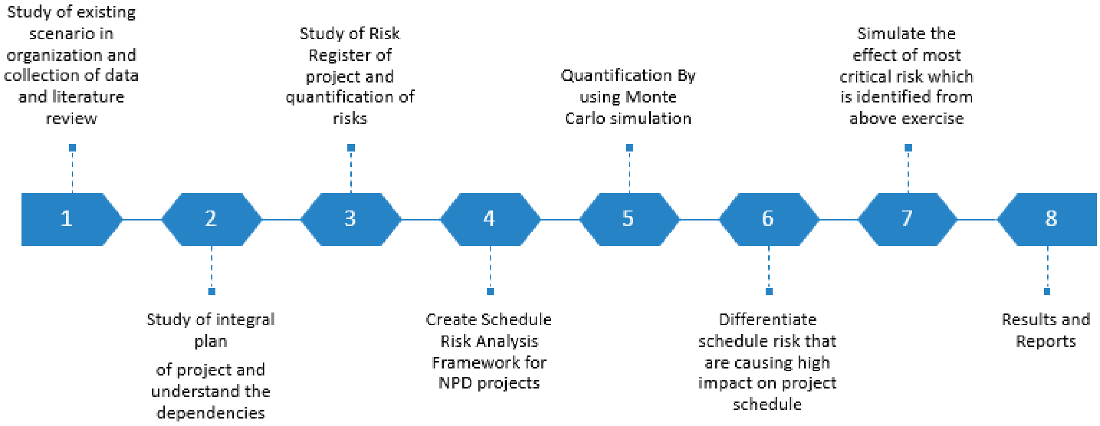

Fig 1 Research Methodology

To survive in this competitive world, firmshave to make improvements to existing products also to develop new products. In the product development different teams are involved having different skillsets and knowledge. The manufactures work under pressure to shorten the duration of project i.e., product development and reduce time to market

The existing project management plan is collected and studied; the plan is considered for new product development project up to 2nd milestone. The start dates and forecasted end dates

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are to be mentioned in the schedule baseline in the planning phase.

The Schedule Risk Analysis is technique which connects risk to the baseline schedule and give the information about every single activity in the schedule about its uncertainty and its impact on the overall project duration.It is very simple and effective. Fig 2 represents the process to be followed for schedule risk analysis. Further for the baseline schedule the optimistic and pessimistic durations are calculated (To) and (Tp) as shown in Fig 4. The mean of activity is calculated by using PERT estimate formula for each activity.

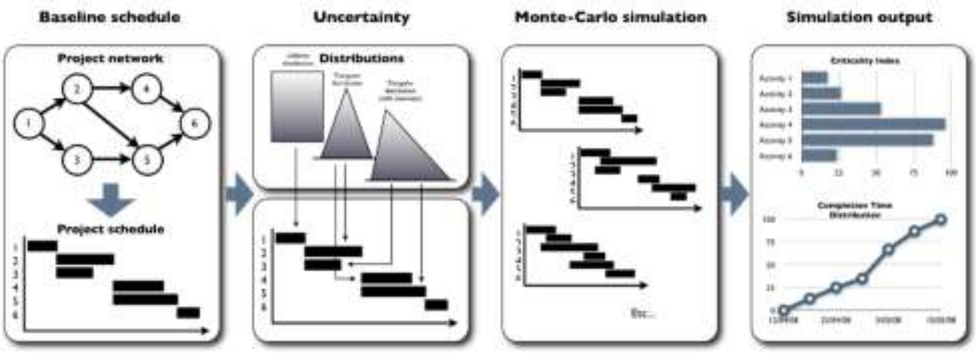
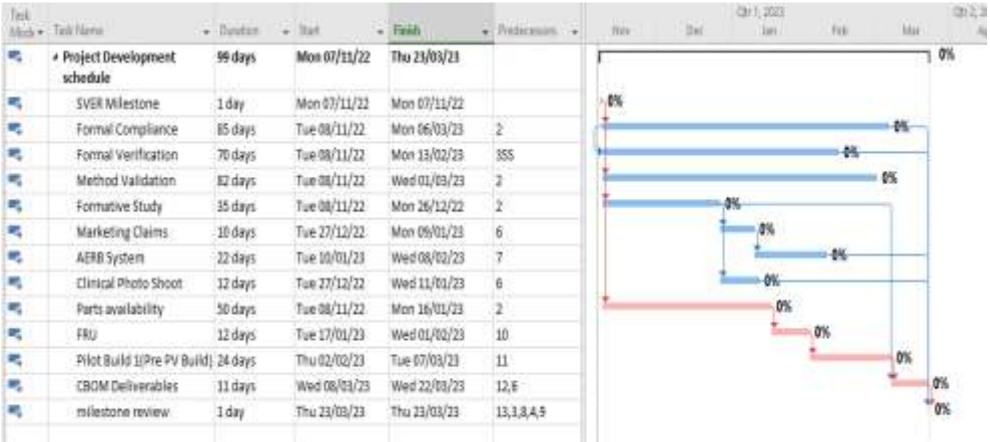


Fig 2 Schedule Risk Analysis



Task Name	Duration	Start	Finish	Predecessors
Project Development schedule	99 days	Mon 07/11/22	Thu 23/03/23	
SVER Milestone	1 day	Mon 07/11/22	Mon 07/11/22	
Formal Compliance	85 days	Tue 08/11/22	Mon 06/03/23	2
Formal Verification	70 days	Tue 08/11/22	Mon 13/02/23	3SS
Method Validation	82 days	Tue 08/11/22	Wed 01/03/23	2
Formative Study	35 days	Tue 08/11/22	Mon 26/12/22	2
Marketing Claims	10 days	Tue 27/12/22	Mon 09/01/23	6
AERB System	22 days	Tue 10/01/23	Wed 08/02/23	7
Clinical Photo Shoot	12 days	Tue 27/12/22	Wed 11/01/23	6
Parts availability	50 days	Tue 08/11/22	Mon 16/01/23	2
FRU	12 days	Tue 17/01/23	Wed 01/02/23	10
Pilot Build 1(Pre PV Build)	24 days	Thu 02/02/23	Tue 07/03/23	11
CBOM Deliverables	11 days	Wed 08/03/23	Wed 22/03/23	12,6
milestone review	1 day	Thu 23/03/23	Thu 23/03/23	13,3,8,4,9

Fig 3 MPP plan of Project

Task no	Task Name	Duration	Predecessors	T0	Tm	Tp	Te Te=(To+4Tm+Tp)/6	variance σ2=((Tp-T0)/6)^2
1	SVER Milestone	1 d		1	1	2	1.17	0.03
2	Formal Compliance	85 d	1	81	85	102	87.17	12.25
3	Formal Verification	70 d	2SS	64	70	85	71.50	12.25
4	Method Validation	82 d	1	75	82	110	85.50	34.03
5	Formative Study	35 d	1	31	35	40	35.17	2.25
6	Marketing Claims	10 d	5	8	10	13	10.17	0.69
7	AERB System	22 d	6	19	22	25	22.00	1.00
8	Clinical Photo Shoot	12 d	5	11	12	15	12.33	0.44
9	Parts availability	50 d	1	46	50	70	52.67	16.00
10	FRU	12 d	9	10	12	18	12.67	1.78
11	Pilot Build 1(Pre PV Build)	24 d	10	22	24	32	25.00	2.78
12	CBOM Deliverables	11 d	11,5	10	11	13	11.17	0.25
14	milestone review	1 d	12,2,7,3	1	1	2	1.17	0.03

Fig 4 Pessimistic and optimistic time

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Item Number	Description	Most Likely Duration	% Complete	Working Hours	Start	Finish	Free Float	Work Amount Uncertainty
0	MPP plan of...	99 day(s)	0	8	11/07/2022	03/23/2023		
1	Project...	99 day(s)	0	8	11/07/2022	03/23/2023		
2	SVER Milestone	1 day(s)	0	8	11/07/2022	11/07/2022		Min:1, Most likely:1, Max:1
3	Formal Compliance	85 day(s)	0	8	11/08/2022	03/06/2023		Min:81, Most likely:85, Max:102
4	Formal Verification	70 day(s)	0	8	11/08/2022	02/13/2023	27	Min:64, Most likely:70, Max:85
5	Method Validation	82 day(s)	0	8	11/08/2022	03/01/2023	16	Min:75, Most likely:82, Max:110
6	Formative Study	35 day(s)	0	8	11/08/2022	12/26/2022		Min:31, Most likely:35, Max:40
7	Parts availability	50 day(s)	0	8	11/08/2022	01/16/2023		Min:46, Most likely:50, Max:70
8	Marketing Claims	10 day(s)	0	8	12/27/2022	01/09/2023		Min:8, Most likely:10, Max:13
9	Clinical Photo...	12 day(s)	0	8	12/27/2022	01/11/2023	51	Min:11, Most likely:12, Max:15
10	AERB System	22 day(s)	0	8	01/10/2023	02/08/2023	30	Min:19, Most likely:22, Max:25
11	FRU	12 day(s)	0	8	01/17/2023	02/01/2023		Min:10, Most likely:12, Max:18
12	Pilot Build 1(Pre ...	24 day(s)	0	8	02/02/2023	03/07/2023		Min:22, Most likely:24, Max:32
13	CBOM Deliverables	11 day(s)	0	8	03/08/2023	03/22/2023		Min:10, Most likely:11, Max:13
14	milestone review	1 day(s)	0	8	03/23/2023	03/23/2023		Min:1, Most likely:1, Max:2

Fig 5Adding Optimistic and Pessimistic time to all Activities

Risk Driver Method

While conducting the Monte Carlo simulation, a risk occurrence is depended on this probability. The probability of risk which will occur can be calculated as the iterations % in which that risk has occurred. If the risk is occurring then it will affect overall activities in the schedule and cause the delay.

If there is risk occurrence, it can affect the individual activities schedule. The impact of the risk on activity schedule can be computed in 3 estimates – for low 95%, most likely 105% and high of 125%.

These 3-point estimates define probability of risk impacton each activity. By considering this, 3-point estimates are calculated for each risk identified in the risk register. Then, activities are assigned by the risks. They are assigned on the basis on whom they affect. as shown in Fig 7.One risk can affect many activities in the schedule and one activity can have many risks assigned to it.

Local Risks | Pelican Risks

					Delay Impact Distribution (Days)			Cost Impact Distribution ($)			Status
ID	Risk Description	Expected Frequency	Independent	Single Event	Min	Most Likely	High (P90)	Min	Most Likely	High (P90)	Include?
TSL4	Risk-1	0.8	✓		3	5	11				✓
TSL5	Risk-2	0.7	✓		4	6	7				✓
TSL6	Risk-3	0.5	✓		2	5	7				✓
TSL7	Risk-4	0.8	✓		3	4	5				✓
TSL8	Risk-5	0.5	✓		5	8	10				✓
TSL9	Risk-6	0.5	✓		1	1	2				✓
TSL10	Risk-7	0.4	✓		1	1	2				✓
TSL11	Risk-8	0.28	✓		0.5	1	1				✓
TSL12	Risk-9	0.28	✓		0	1	1				✓
TSL13	Risk-10	0.28	✓		0.5	1	1				✓

Fig 6 Adding Risks and Risk Estimates

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Item Number		Description	Most Likely Duration	% Com...	Working...	Start	Finish	Free Float	Work Amount Uncertainty	Task - Specific
0		MPP plan of...	99 day(s)	0	8	11/07/2022	03/23/2023			
	1	Project...	99 day(s)	0	8	11/07/2022	03/23/2023			
	2	SVER Milestone	1 day(s)	0	8	11/07/2022	11/07/2022		Min:1, Most likely:1, Max:1	
	3	Formal...	85 day(s)	0	8	11/08/2022	03/06/2023		Min:81, Most likely:85, Max:102	TSL9
	4	Formal...	70 day(s)	0	8	11/08/2022	02/13/2023	27	Min:64, Most likely:70, Max:85	TSL10,TSL11
	5	Method Validation	82 day(s)	0	8	11/08/2022	03/01/2023	16	Min:75, Most likely:82, Max:110	TSL12,TSL5
	6	Formative Study	35 day(s)	0	8	11/08/2022	12/26/2022		Min:31, Most likely:35, Max:40	TSL13
	7	Parts availability	50 day(s)	0	8	11/08/2022	01/16/2023		Min:46, Most likely:50, Max:70	TSL4,TSL6
	8	Marketing Claims	10 day(s)	0	8	12/27/2022	01/09/2023		Min:8, Most likely:10, Max:13	
	9	Clinical Photo...	12 day(s)	0	8	12/27/2022	01/11/2023	51	Min:11, Most likely:12, Max:15	
	10	AERB System	22 day(s)	0	8	01/10/2023	02/08/2023	30	Min:19, Most likely:22, Max:25	
	11	FRU	12 day(s)	0	8	01/17/2023	02/01/2023		Min:10, Most likely:12, Max:18	

Fig 7 Linked Risks to Activities

III. RESULT AND ANALYSIS

PERT analysis

The PERT Simulation results is shown in histogram in Fig 8 and Fig 9.

This is obtained after running Monte Carlo simulation on PERT schedule.

For the baseline plan, having the PERT estimates, it shows that the deterministic date of 23 March 2023, less than 10% chance is there that the project will be completed on scheduled date without considering any action for risk mitigation. There is 80% probability that project can be finished on 7 APR 2023 or about 109 days considering all the pessimistic estimates and risk impacts on the projects.

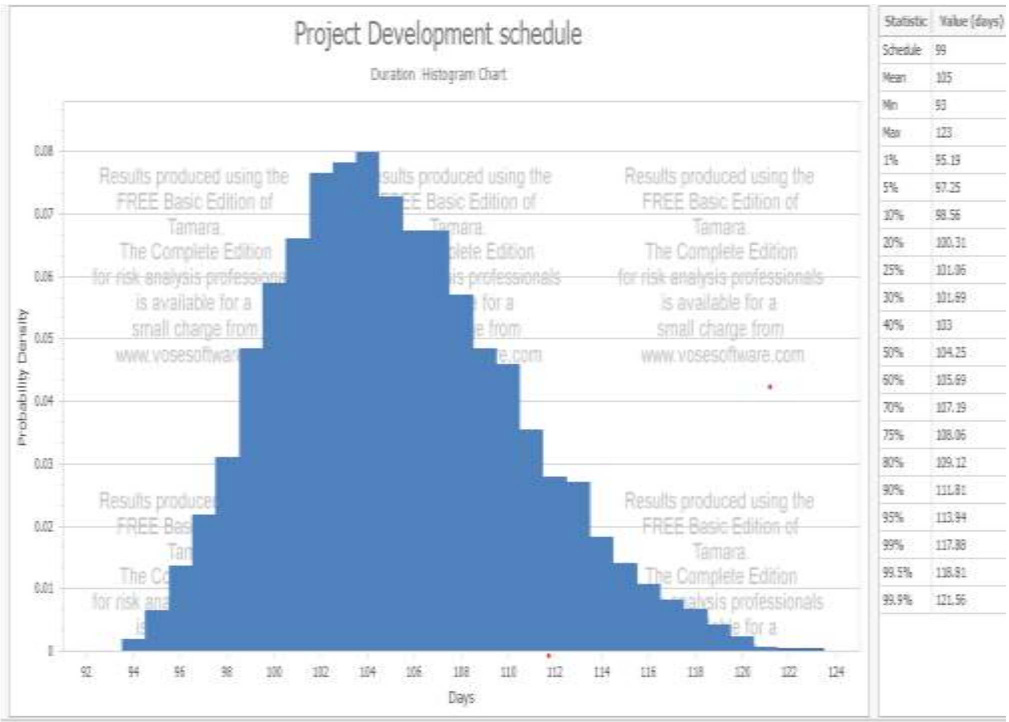

Fig 8 Histogram for PERT Simulation (Days)

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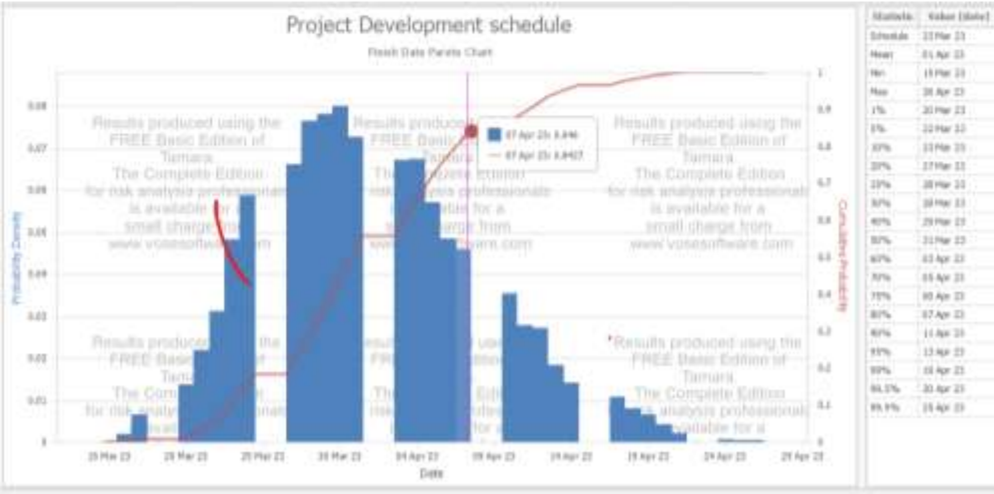

Fig 9 Histogram for PERT Simulation (Date)

SRA analysis

The schedule risk results are shown in the form of histogram as in Fig10 and Fig11. Monte Carlo Analysis is used for the analysis. After considering the 3-point estimates of the risks and connecting them to the schedule, it shows that 23 March 2023 which is original planned date is less than 10% that the project end date is achieved. It is 80% likely that the closure of the projects falls on or earlier than 4 May 2023 or about 136 days with the consideration of the risk impacts on the activities. Fig 12 expresses the tornado for the most critical and most impacting risk and activity in the project schedule, so that the manager can prioritize them for the mitigation actions.

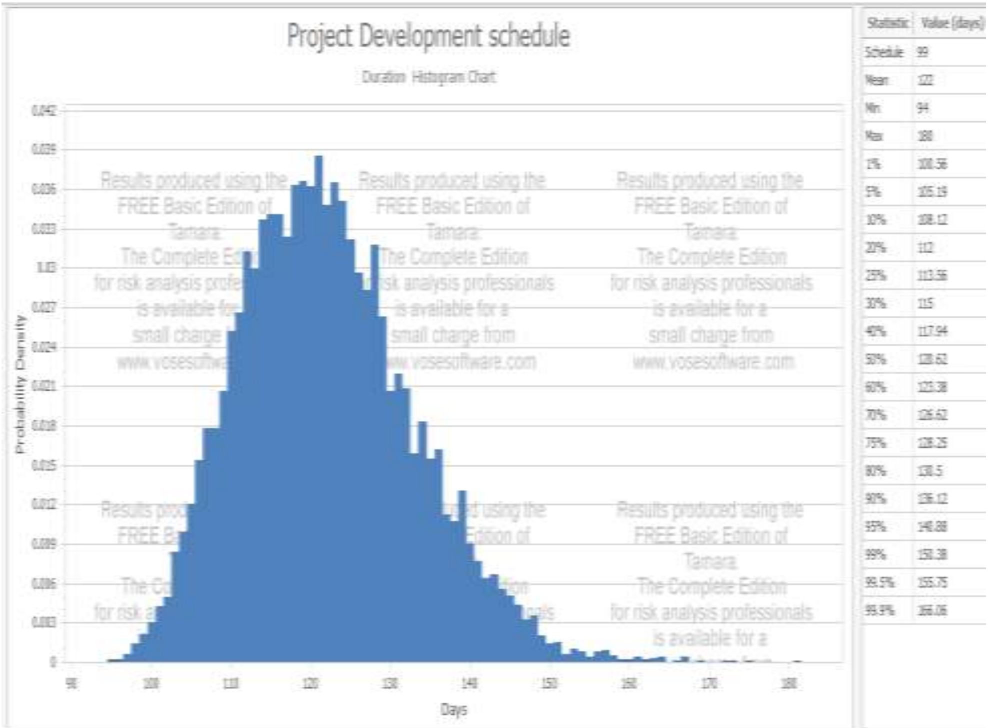

Fig 10 Histogram for SRA Simulation (Days)

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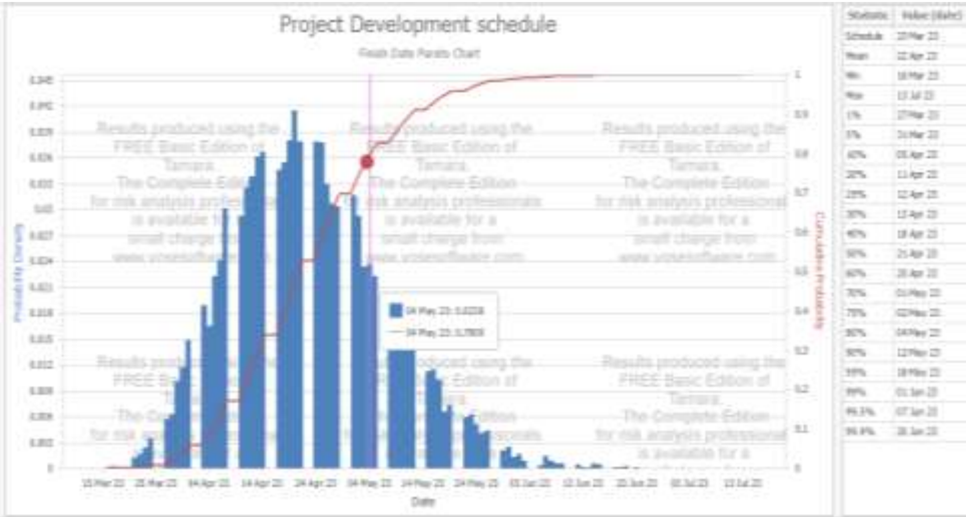

Fig 11 Histogram for SRA Simulation (Date)

Fig 12 Tornado for Most critical activity and Risk

SRA analysis

From above analysis it is shown that the Project End date sifts after thePERT analysis is 25-Apr-22(Project completion time-121 days) and shifts to 20-Jun-23 after Monte Carlo schedule risk simulation.(Project completion time-166 days).

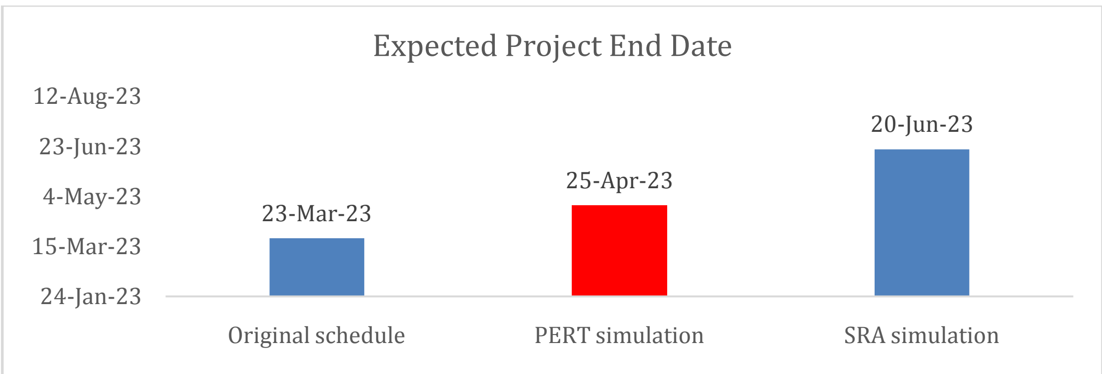

Fig 13Schedule Contingency

IV. CONCLUSION

Monte Carlo Simulation identifies the critical path of project. Also, we can analyse the criticality distribution of the risk impact with the help of Monte Carlo histogram we can generate probability curve. Due to MCA, we get the information about the risk analysis, its impact on schedule in the early stage so identifying and analysing risk becomes easier. We can also have look on the active risks and can plan corrective mitigation actions. From the graph, we get the pictorial data output which can be easily studied and can be used for the decision-making purpose. So that project manager can predict the completion date. This paper discussed the model for estimating low and high (optimistic and pessimistic) estimates, which are used in the PERT simulation. Also 3-point estimates for risks are considered which makes the simulation more accurate.

Risks had to be predicted clearly and in advance. And can predict more accurate data regarding to risks impact of delay. But if we considered too many uncertainties while analysis, which can adversely impact on project by other perspectives. It can increase the mitigation cost.

Though, the results from simulation are feasible and promising, this study can be further extended for identifying and risk factors, consisting of the risk collection methods like questionnaire, brainstorming with a higher level of customization Also while considering the risk, we should also consider the mitigation actions required, cost and resource requirement needed for that. A future study should extend current proposed model.

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