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PERFORMANCE ANALYSIS OF EFFORT VARIANCE AND COST VARIANCE INVOLVES DIFFERENT STAGES IN SOFTWARE PROJECT BASED ON STATISTICAL METHOD

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ABSTRACT

In this research work focuses an effort variance and cost variance is an important metrics parameter which needs to be more focused an optimization of effort and cost variance is a very significant factor which influences internal organization driven and customer driven goals. Further, predicting the success of software projects based upon information related to Estimation of planned effort and actual effort and planned cost and actual cost is deemed to be one of the vital activities in software engineering research. In this research work focus to apply regression model for analyzing the quality based on estimated value and actual value to achieve better result from the model.

Keywords: Estimation value; Actual value; Effort variance; cost variance; Regression model.

INTRODUCTION

Data of this type is vital to understand the current testing effort and review how it was conducted previously and consider how to make improvements in the future.[7] Various groups and individuals within the organization and clients require this information in support of their own activities and decision making. It enables organizations to improve the quality of

management decision making by ensuring that reliable and secure information and data is available throughout the Software lifecycle.[9, 10] The objective of this metric is to study the distribution of workload by Stage and to reduce the deviation of the actual effort expended as against the estimated effort. The cost measure is in terms of effort which is measure the effort spent on reviews, testing and rework against the production effort.

RELATED WORK

Background information on software project models and software metrics to be used for effort and cost estimation. No model can estimate the cost of software with high degree of accuracy. Estimation is a complex activity that requires knowledge of a number of key attributes. At the initial stage of a project, there is high uncertainty about these project attributes. As we learn that BBNs are especially useful when the information about the past and/or the current situation is vague, incomplete, conflicting, and uncertain. Conventional estimation techniques focus only on the actual development effort furthermore; this paper also described test effort estimation.[1]

Many construction projects suffer from time and cost overruns due to a multiplicity of factors. Earned value management (EVM) is a project performance evaluation which has been adapted for application in project management. This technique helps in comparison of budgeted cost of work to actual cost.[2,3,6] The present study deals with the scheduling and project monitoring process along with it also discusses main parameter's involving in the calculation of earned value analysis in cost and time management of civil construction project. Methodologies and analysis are demonstrated in this paper using an example of real time project. Primavera P6 software can be used for project planning and EVM calculations.

DATA FOR RESEARCH

In this paper the research work focuses the cost variance and effort variance of project using estimated value and actual value parameters which could be calculated based on the equation 1 and 2. Then the variance can be analysing based on statistical method. Also using regression analysis for analyzing the scheduled for a 50 project task of performance and variance of estimated value for planning stage, Designing stage, Building stage, User Acceptance test (UAT) stage, System Integrating Test (SIT) stage, Integration testing and implementation stage. Here the table 1 to 4 represents the sample training data of finding the variance in cost and effort of the project.

$$\text{Effort variance} = \frac{\text{Actual Effort - Estimated Effort}}{\text{Estimated Effort}} * 100 \quad (1)$$

$$\text{Cost variance} = \frac{\text{Actual Cost - Estimated Cost}}{\text{Estimated Cost}} * 100 \quad (2)$$

Table 1. Sample Training Data Set of Effort.

Planning		Designing	
Estimated Effort	**Actual Effort**	**Estimated Effort**	**Actual Effort**
437.71	437.71	603.84	646.84
328.29	328.29	422.69	822.68
1382.964	1382.964	1,382.96	1518.934
1222.1975	1222.1975	1,222	1382.7105
365	365	470.6	495.88
101.4	101.4	111.8	112
169	169	186.33	187
259.995	259.995	365.23	365.23
363.7	363.7	545.55	545.55
363.7	363.7	385.23	395.23
636	636	729	729
173.33	173.33	693	606
244.196	244.196	488.393	488.393
66.1	66.1	99.15	99.15
182	182	273	273
437.71	437.71	86.67	81

Table 2. Sample Training Data Set of Effort Contd.

SIT		UAT	
Estimated Effort	**Actual Effort**	**Estimated Effort**	**Actual Effort**
3,071.37	3211.86	933.14	1010.37
2,233.73	2,374.22	678.65	755.88
1,544.98	1,652.23	595.1808	595.3312
1,892.99	2,064.35	405.396	476.2936
705.71	725.64	235.23	241.88
415.99	415.99	252	252
208	208	189	189
415.99	415.99	653.12	878.49
545.55	545.55	545.55	545.55
732	732	189	189
732	732	724	510.6
953.32	87	252	252
1190.69		189	189
99.15	99.15	99.15	99.15
273	273	273	273
3,071.37	3211.86	933.14	1010.37

Table 3. Sample Training Data Set of Effort Contd.

Integrating Test stage		Implementation Stage	
Estimated Effort	**Actual Effort**	**Estimated Effort**	**Actual Effort**
132.06	135.51	33.02	33.88
99.04	102.49	24.76	25.62
371.99	380	521	530
253.37	260	355	360
58.80	60.47	22.041	22.041
60	60	159.46	160
45	45	119.6	120
60	60	94.2	169.56
181.85	181.85	181.85	196.55
58.80	60.47	181.85	194.55
60	60	102.15	113.53
45	45	102.15	114.32
60	60	43.83	43.83
33.05	33.05	33.05	33.05
91	91	91	91
132.06	135.51	208	208

Table 4. sample training data set of Cost of planning and Designing Stage.

Planning		Designing	
Planned Cost	**Actual Cost**	**Planned Cost**	**Actual Cost**
$20,627.74	$20,627.74	$47,052.84	$47,052.84
$15,470.80	$27,406.20	$34,220.24	$47,955.00
$49,095.22	$50,372.16	$105,644.59	$105,671.29
$43,388.01	$45,536.22	$71,957.79	$84,542.11
$12,967.52	$13,114.60	$52,730.00	$55,101.65
$4,263.53	$4,361.53	$17,995.88	$17,995.88
$7,700.32	$7,777.32	$13,820.82	$13,904.98
$10,220.40	$10,220.40	$93,436.55	$94,225.90
$18,171.38	$18,171.38	$54,514.13	$54,514.13
$18,171.38	$18,171.38	$93,436.55	$94,225.90
$22,896.00	$22,896.00	$59,400.00	$59,526.00
$6,228.00	$6,228.00	$46,800.00	$27,144.00
$10,207.18	$10,207.18	$70,982.41	$70,982.41
$3,335.90	$3,335.90	$10,007.70	$10,007.70
$7,708.57	$7,708.57	$23,125.70	$23,125.70
$883.64	$917.64	$4,860.00	$4,894.08
$1,762.42	$1,830.24	$9,693.31	$9,761.28

Metrics are parameters or measures of quantitative assessment used for measurement, comparison or to track performance or production.[4] The objective of this metric is to study

the distribution of workload by Stage and to reduce the deviation of the actual effort expended as against the estimated effort.

RESEARCH METHODOLOGY

A. *Statistical Analysis*

In statistical analysis, Variance can be measures based on the equation 1 and 2. Effort Variation metric is the difference between Estimated and Actual effort as compared against the Estimated Effort.

Input/Measure	Actual Effort	Estimated Effort
Actual Effort Estimated Effort	(Actual Effort - Estimated Effort)/ (Estimated Effort) *100	Estimated Effort =603.84 Actual Effort= 646.84 = (646.84-603.84)/ (603.84) * 100 = 7.120883
Actual Cost Estimated Cost	(Actual cost - Estimated Cost)/ (Estimated Cost) *100	Estimated cost =$15,470.80 Actual Cost= $27,406.20 =(27,406.20-15,470.80)/ (15,470.80) * 100 = 77.1479

Cost Variance metric is the difference between Estimated and Actual cost as compared against the estimated cost.

Benefits

• To determine the efficiency of effort planning.

• To determine the nature and extend of variances and related impact analysis on cost and schedule.

EXPERIMENT AND RESULT

In good estimation, the actual value and predicted value agree very closely. In most cases a linear regression line captures this close relationship, in which case slope of the regression line is nearly equal to one. The coefficient of determination[8] R^2 indicates estimation capability of the model used for estimation. The R^2 values which express goodness of fit of the calibration curves can also indicate the estimation quality.

The value R^2 is a fraction between 0.0 and 1.0, and has no units. An R^2 value of 0.0 means that knowing X does not help to predict Y. There is no linear relationship between X (Estimated cost / effort) and Y (Actual cost/ effort), and the best-fit line is a horizontal line going through the mean of all Y values.

A. Statistical Analysis of Cost Variance and Effort Variance

From the fig. 1 to fig. 11 illustrates the variance of cost and effort of the project which can be analysed based on the equation 1 and 2.[8] The outlier of the graph represents the more variance from the planned / estimated effort and cost value of the project.

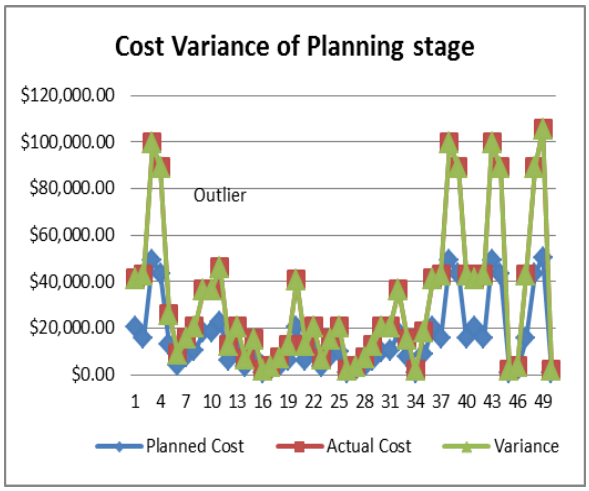

Fig. 1. Cost Variance of planning stage

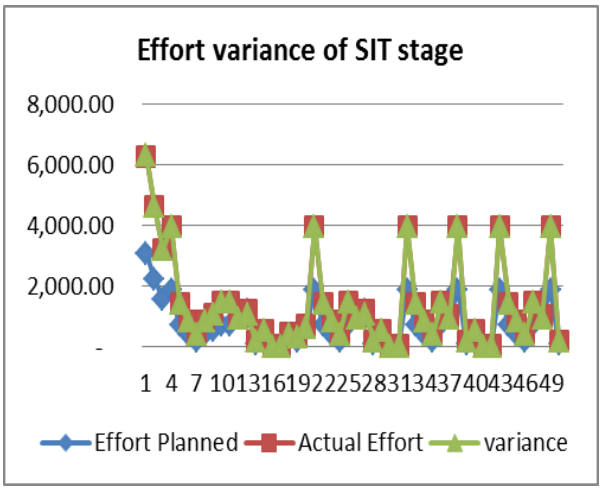

Fig. 4. Effort Variance of SIT stage

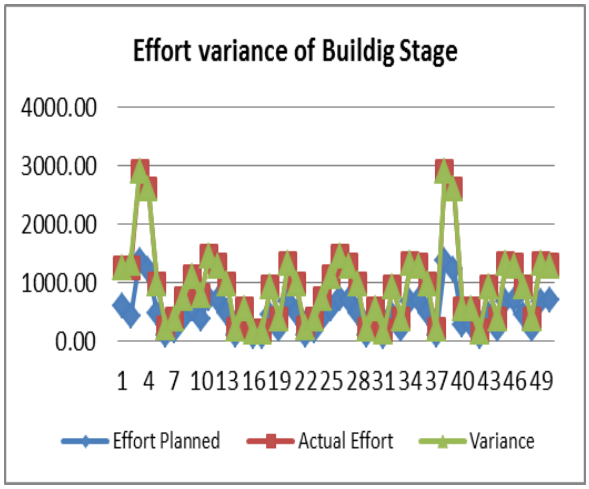

Fig. 2. Effort Variance of Building stage

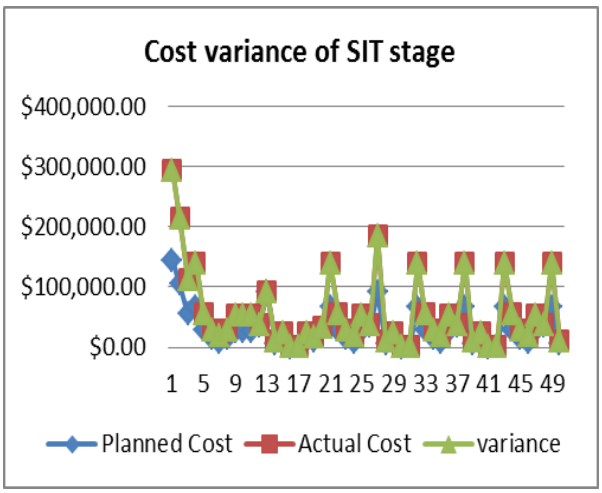

Fig.5. Cost Variance of SIT stage

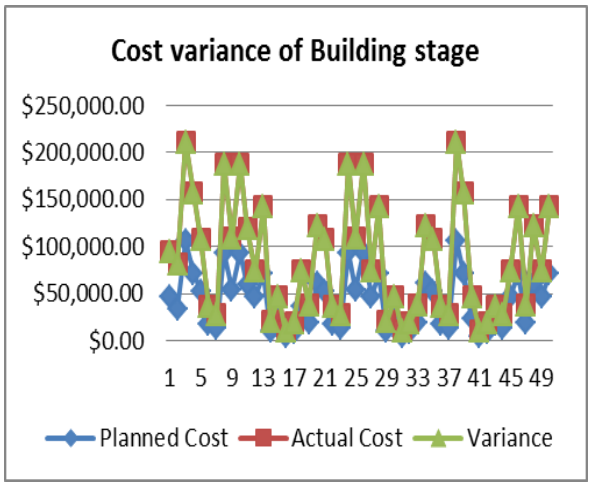

Fig. 3. Cost Variance of Building stage

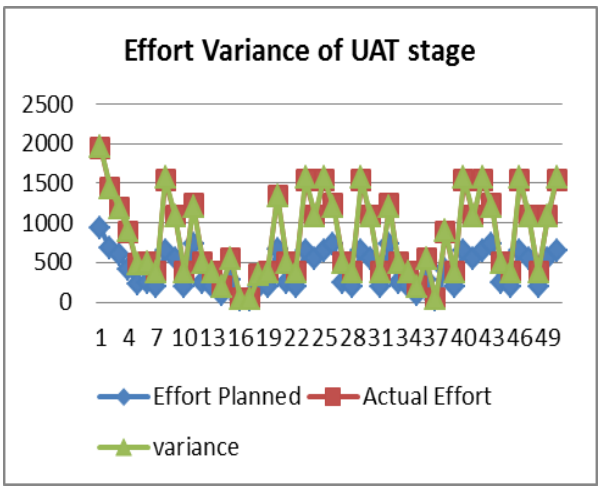

Fig. 6. Effort Variance of UAT stage

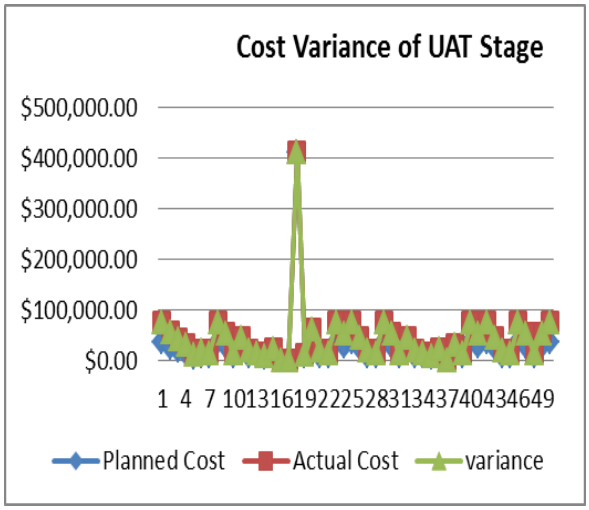

Fig. 7. Cost Variance of UAT stage

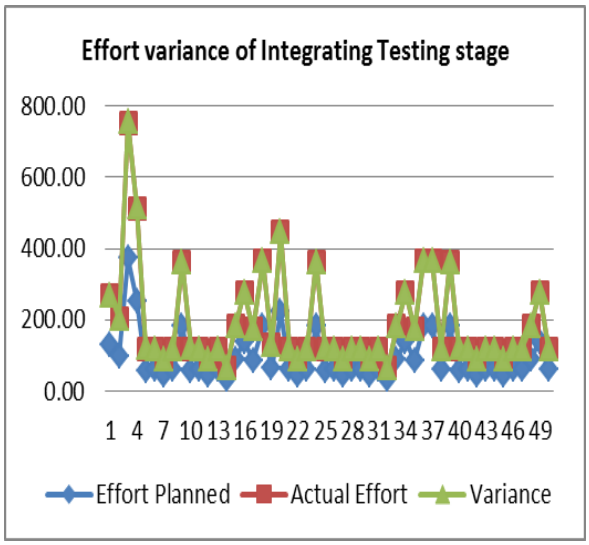

Fig. 6. Effort Variance of Integrating Testing stage.

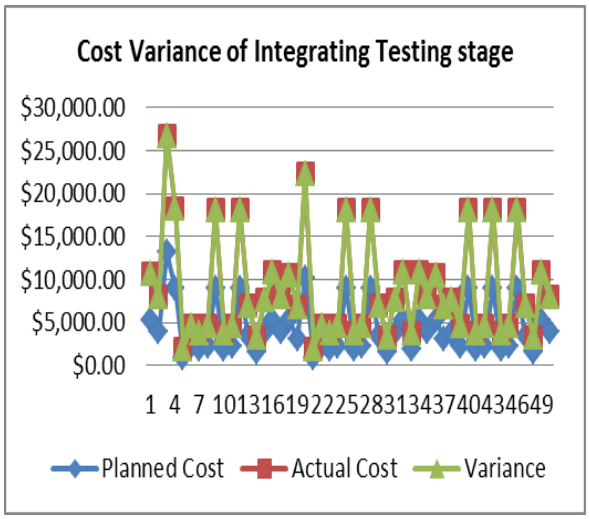

Fig. 9. Cost Variance of Integrating stage

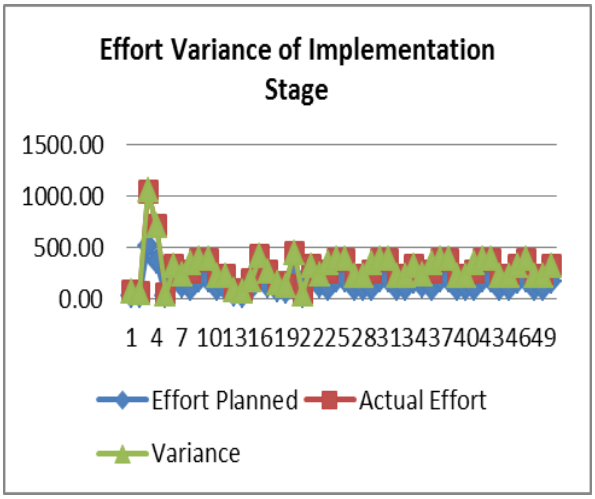

Fig. 10. Effort Variance of Implemetation stage.

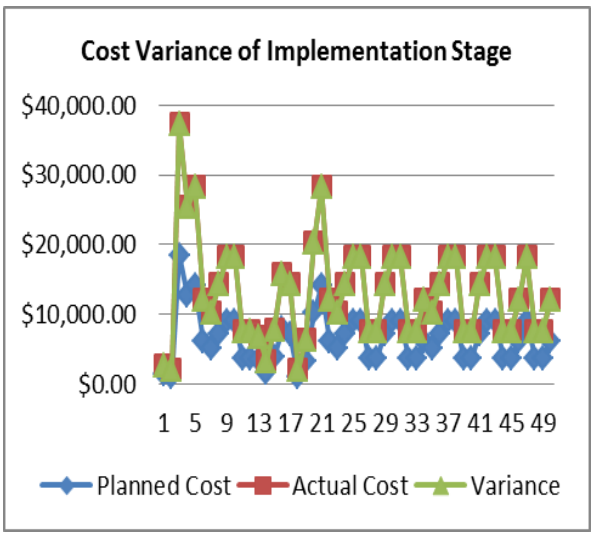

Fig. 11. Cost Variance of Implementation stage.

In the research work, Cost Variance (CV) is a very important factor to measure project performance. CV indicates how much over or under budget.

A. *Regression Analysis of Cost Variance.*

From the fig 12 represents the planned stage of the cost variance shows the linear regression line [5] gives new calibration curve where the actual value is equal to the estimated value. The R^2 values which express goodness of fit of the calibration curves can also indicate the estimation quality. The confidence level is 95.21 %, it's come out with better estimation process in maintenance.

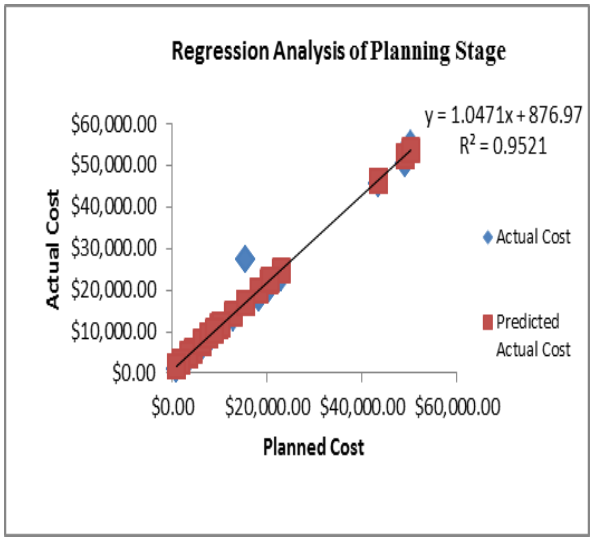

Fig. 12 Regression Analysis of Planning Stage.

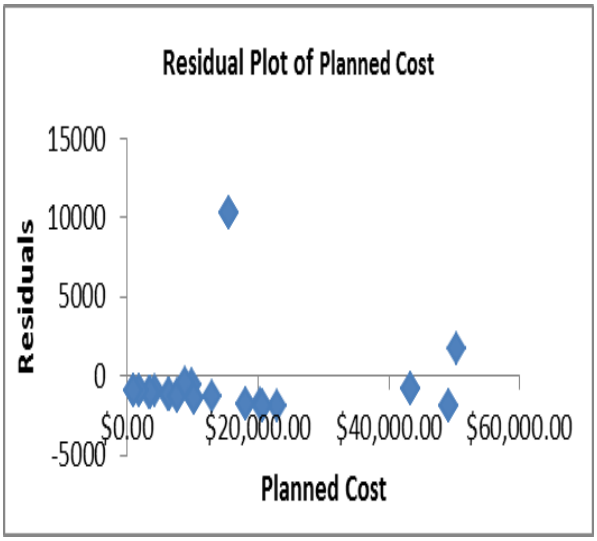

Fig. 13 Residual plot of planning stage.

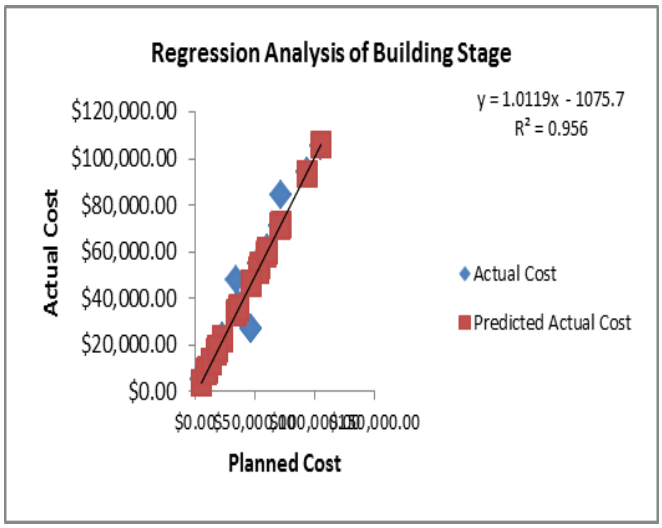

Fig. 14 Regression Analysis of Building Stage

From the fig 14 represents the Building stage of the cost variance shows the linear regression line gives new calibration curve where the actual value is equal to the estimated value. The R^2 values which express goodness of fit of the calibration curves can also indicate the estimation quality. The confidence level is 95.6 %, it's come out with better estimation process in maintenance.

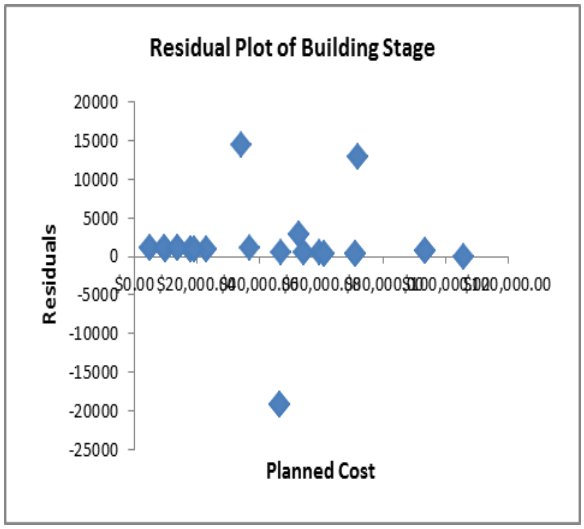

Fig. 15 Residual plot of Building stage.

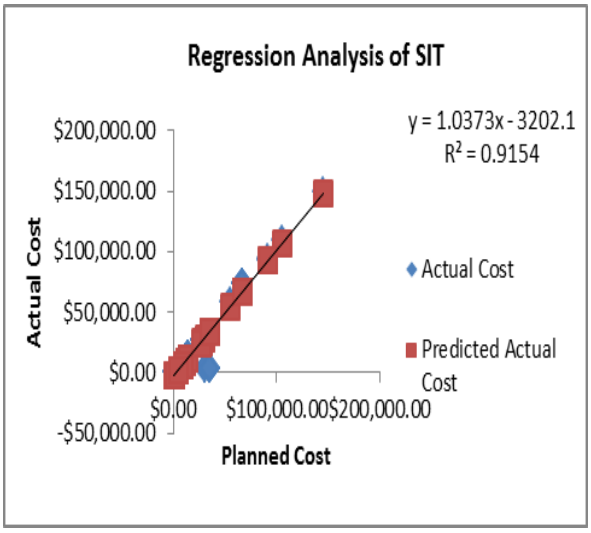

Fig. 16 Regression Analysis of SIT stage.

From the fig 16 represents the SIT stage of the cost variance shows the linear regression line gives new calibration curve where the actual value is equal to the estimated value. The R^2 values which express goodness of fit of the calibration curves can also indicate the estimation quality. The confidence level is 91.54 %, it's come out with better estimation process in maintenance.

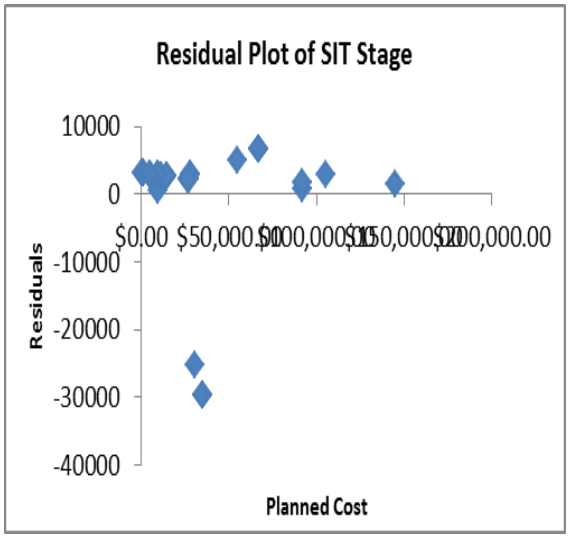

Fig. 17 Residual plot of SIT stage

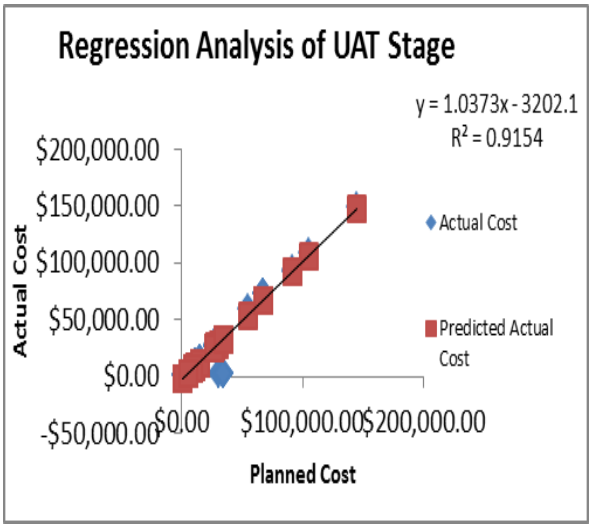

Fig. 18 Regression Analysis of UAT stage

From the fig 18 represents the UAT stage of the cost variance shows the linear regression line gives new calibration curve where the actual value is equal to the estimated value. The R^2 values which express goodness of fit of the calibration curves can also indicate the estimation quality. The confidence level is 91.54 %, it's come out with better estimation process in maintenance.

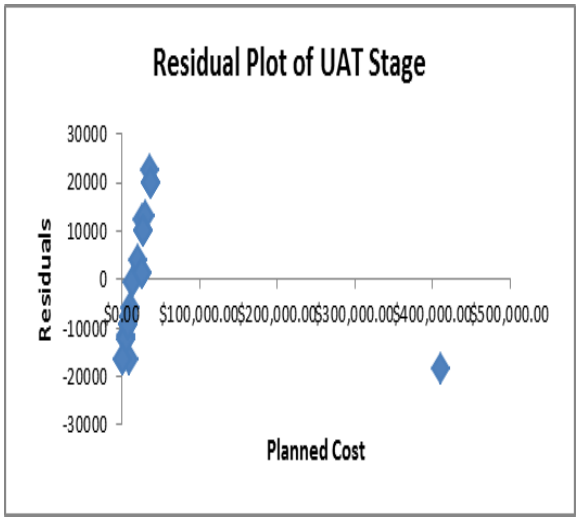

Fig. 19 Residual plot of UAT stage.

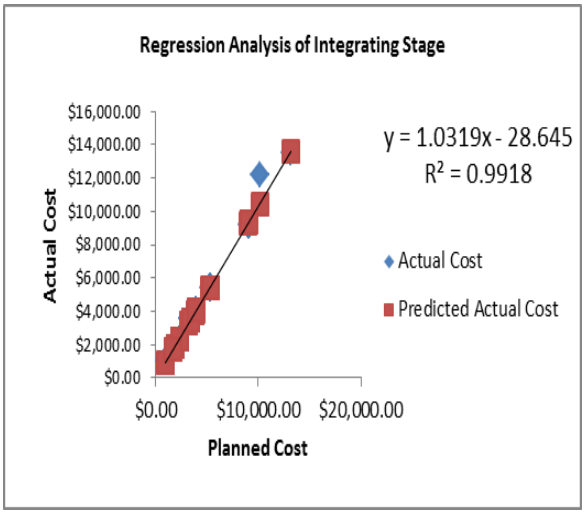

Fig. 20 Regression Analysis of Integrating stage.

From the fig 20 represents the Integrating stage of the cost variance shows the linear regression line gives new calibration curve where the actual value is equal to the estimated value. The R^2 values which express goodness of fit of the calibration curves can also indicate the estimation quality. The confidence level is 99.18 %, it's come out with better estimation process in maintenance.

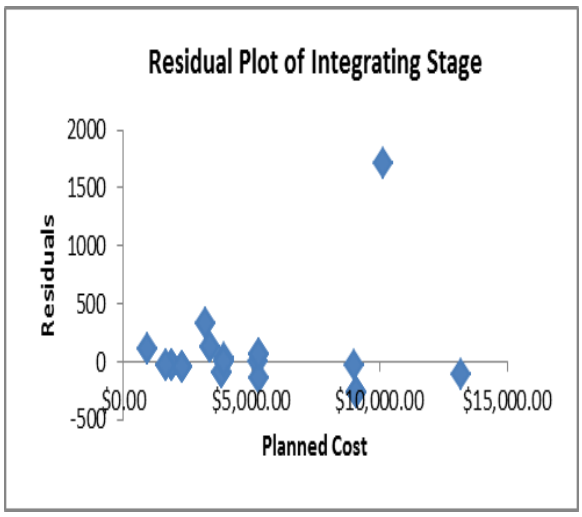

Fig. 21 Residual plot of Integrating stage.

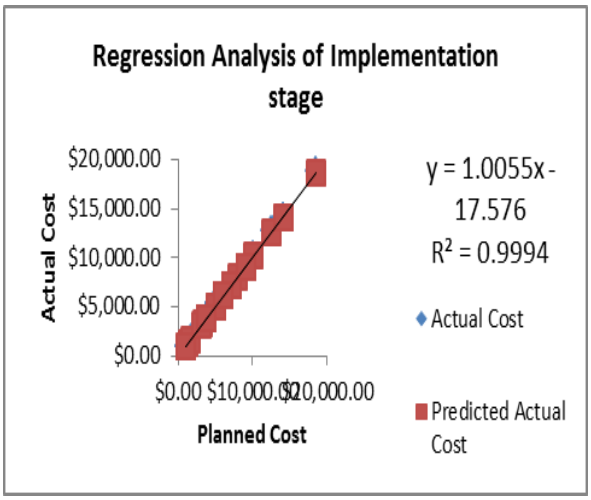

Fig. 22 Regression Analysis of Implementation stage.

From the fig 22 represents the Implementation stage of the cost variance shows the linear regression line gives new calibration curve where the actual value is equal to the estimated value. The R^2 values which express goodness of fit of the calibration curves can also indicate the estimation quality. The confidence level is 99.94 %, it's come out with better estimation process in maintenance.

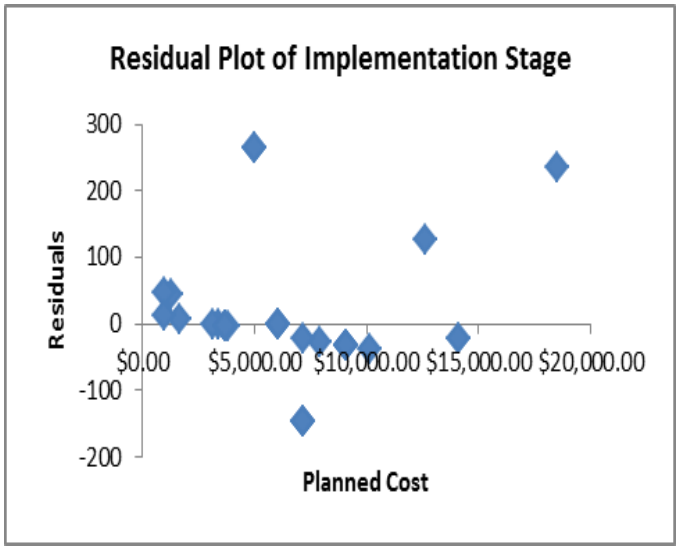

Fig. 23 Residual plot of Implementation stage

Residual plot also analyse the difference between the observed data of the dependent variable *y* and the fitted values $\hat{y}$ as shown in fig.13, fig 15, fig 17, fig 19, fig 21 and fig 23 which is represent the fitted values in different stage of the project work. The residual is positive if the data point is above the graph. The residual is negative if the data point is below the graph.

CONCLUSION

In this research work, it can be concluded that the Effort variance and Cost variance tracking from beginning stage of the project through the end of the project, thereby consider as good based on statistical analysis. The estimated values and actual values are plotted as scatter diagram and regression analysed. R^2 values express goodness fit of the calibration curves which indicated the estimation quality attained higher than above 99% of better estimation, yet the SIT and UAT task of project work estimate 91% of maintenance process. Cost Variation metric is mainly used as an indicator for capability to meet milestones. For these Cost (Budgeting Stage), residual plot also analyse the difference between the observed data of the dependent variable *y* and the fitted values $\hat{y}$. Mostly the values are fitted from the plot analysed as in positive where the data point is above the graph of each stage of the project work.

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