Simulation Modeling of Cost Overrun in Construction Project in Ethiopia

Geletaw Taye

Abstract: ***Cost is an essential part of any construction project. It was observed that cost overrun is one of the most frequently occurring issues in construction projects of Ethiopia and it is more severe in different parts of the country. The aim of this research has identified the factors that influence cost overruns of construction projects, quantified the percentage of identified factors, established probability distribution of identified factors and develop simulation modeling of cost overrun. The study was conducted based on the desk study and questionnaire survey. Questionnaire surveys were analyzed by using Relative Important Index (RII) ranking and significance of data checked by using a t-test at a 95% confidence level. Based on the desk study of 19 projects, a simulation model of cost overrun was developed by using the Monte Carlo simulation method. Simulation models showed a higher frequency of cost overrun occurring up to 10%. This indicates that the actual cost of most construction projects runs up to 10 % over the budgeted cost of work performed.***

Authors Keywords; - cost overrun, Monte Carlo simulation modeling, probability distribution

I. INTRODUCTION

Cost is the essential part for any construction project.in recent report (Shanmugapriya & Subramanian, 2013) it has been shown Cost overruns involves unanticipated costs incurred more than the budgeted amounts. And also in another recent report (Saidu & Shakantu, 2016) it has been shown cost overrun as simply an occurrence, where the final or actual cost of a project surpasses the original or initial estimates. (Ubani et al., 2011) outlined that Cost Overruns have also been referred to as the percentage of actual or final costs above the estimated or tender cost of a project. Nega (2008) says that cost overrun as an occurrence, in which the delivery of contracted goods/services is claimed to require more financial resources than was originally agreed upon between a project sponsor and a contractor. (Kaming et al., 1997) outlined that the factors influencing construction cost overrun on high- rise projects in Indonesia, they found that cost overruns occur more frequently and are thus a more severe problem than time overruns on high-rise construction in Indonesia. The predominant factors influencing cost overruns are material cost increases due to inflation, inaccurate materials estimating and degree of project complexity. (Kaming, 1997, Morris et al., 1990) outlined that four factors were identified from the existing research findings. These are; design changes, inadequate planning, unpredictable weather conditions; and fluctuations in the cost of building materials. In a recent report (Stukhart and George, 1997) it has been shown cost overrun is one of the most frequently occurring issues in construction projects worldwide and it is more severe in developing countries. Like many other developing countries, the construction industry in Ethiopia also affected by the cost overrun. Most of the construction projects in Ethiopia are exposed to cost overrun this leading to loss of projects profit, budget shortfall of project owners, falling the project to deliver on time, the company or firms exposed to bad debt or bankruptcy, and it also considered another a big problem, which hinders project's progress since it decreases the contractor profit leading to huge losses leaving the project in a big trouble.

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II. OBJECTIVE OF RESEARCH

The study in this research aimed to identify and analyze construction cost overrun in the Ethiopia construction industry. The specific objectives are as follows:

- To identify the influencing factors of cost overrun in construction projects.
- To quantify the percentage of influencing factors of cost overrun in the construction project.
- To establish the probability distribution of identifying influencing factors of cost overrun in the construction projects.
- To develop a simulation model of cost overrun

III. LITERATURE REVIEW

A. Concepts of Cost overrun

in a recent report (Windapo & Cattell, 2013)it has been shown the concept of cost overrun is a term for a cost increment, or higher spending includes unexpected expenses over a given budget plan for a period. Cost overrun as the adjustment in contract sum partitioned by the first contract grant sum. Be that as it may, cost invades characterized as an overabundance of genuine cost over spending plan. Cost overrun is additionally now and then called cost acceleration, cost increment or spending invades.

B. Cost overruns worldwide

(Memon, 2013) out lined that the history of the construction industry worldwide abounds in projects that were completed with a significant amount of cost overrun, despite the use of modern technologies and software packages. In the recent report (Brunes & Lind, 2014) it has been shown Cost overruns were slightly lower in Europe compared to North America and other geographical areas. In Canada, (Odeck, 2014) outlined that 50 road construction projects were investigated, and the results revealed a cost overrun of up to 82% in 2006.

C, Cause of cost overrun in the construction project

In India, (Subramani, et al., 2014) outlined that the major causes of cost overruns are slow decision-making at the planning stage of a project; poor project schedules and management; increases in the prices of materials and machines; poor contract management; poor design/delay in producing design; rework due to mistakes or wrong work; land-acquisition problems; poor estimation or estimation techniques, and the long-time taken between the design and the time of bidding/tendering.In Egypt, Aziz (2013) outlined that causing cost overruns in waste-water projects and concluded that the major causes of cost overruns are lowest tendering procurement method; additional works that are not included in the original work; bureaucracy in tendering or offering methods; wrong cost-estimation methods, and funding problems by the client.

IV. METHODOLOGY

A. Study Design

This research was conducted using the quantitative approach and was carried out in four stages. The stages involved in the review of literature, data collection, data analysis, and conclusion.

B. Study Variables

Dependent Variable: - cost overrun in construction. Independent Variable: -cost overrun factors; - client factor, contractor factor, consultant factor, project-related factor, and other factors.

C. Population

For this study, the target populations were construction companies, consultants and public and private clients.

D. Sampling Techniques and Sampling Size Determination

Systematic random sampling techniques used for this research. Sample members from the population were selected according to a random starting point and a fixed periodic interval. The interval was calculated by dividing the population size by the desired sample size.

E. Method of data collection

The data gathered approach for the research used both primary and secondary data collection methods. The primary data was collected through questionnaires, interviews and contract document analysis of ongoing construction and secondary data was collected from record data document of previously completed projects. For this study, 96 questionnaires were distributed for three company i.e. client, contractor, and consultant. 16, 60 and 20 questionnaires were distributed for a client, contractor, and consultant respectively. From this distributed questionnaire 81.25% (13 out of 16) returned from the client, 86.66% (52 out of 60) returned from the contractor and 80% (16 out of 20) returned from the Consultant. Totally 84.37% (81 out of 96) returned from three Companies. The data analyzed by relative important index.

V. FINDING

A. Factor of cost overrun

The factor that influencing construction cost overrun from the questionnaire survey was identified based on respondents' responses on each variable of cost overrun factor. The fluctuation of construction material cost was the 1st ranked factor of cost overrun with an RII value of 0.7827. Inadequate project planning and scheduling were the 2nd ranked factor of cost overrun. the top and fatal consequences of inadequate project planning and scheduling in construction project was project failure and also caused for the redundant task this increase the cost and extension of time to complete the project. Poor economic conditions were ranked as the 3rd factor of cost overrun. Poor site management was ranked at 4th level, it also causes of poor productivity of labor due to workers were standing around and waiting, and poor coordination of workers & subcontractors and workers were not properly skilled.

Table 1 Factor of Cost Overrun (source: compiled by author)

Item	RII	Rank	categories
The fluctuation of construction material cost	0.7827	1	Other factors
Inadequate project planning and scheduling	0.7777	2	Client factors
Poor economic condition(currency, inflation rate)	0.7432	3	Other factors
Poor site management	0.7333	4	Contractor factors
Inaccurate time and cost estimation	0.7135	5	Consultant factors
Variation in design	0.6814	6	Consultant Factors
Variation of works	0.6716	7	Contractor factors
Inadequate modern equipment	0.6666	8	Contractor factors
Land acquisition problems	0.6666	8	Project-related factors
Cash flow and financial difficulties faced by contractors	0.6641	9	Contractor factors
Changing of work	0.6593	10	Contractor factors
Low productivity of labor	0.6568	11	Contractor factors
Shortage of materials	0.6543	12	Contractor factors
Inadequate monitoring and controlling of project	0.6519	13	Contractor factors

Frequent design change	0.6494	14	Consultant factors
Unsuitable construction method	0.6444	15	Contractor factors
Inaccurate site investigation	0.642	16	Consultant factors
Long wait time for testing sample approval	0.6296	17	Consultant factors
Corruption	0.6272	18	Other factors
Long waiting time for approval of drawing	0.6222	19	Consultant factors
Shortage of skilled labor	0.6198	20	Contractor factors
Poor estimation techniques	0.6148	21	Consultant factors
Additional work	0.6128	22	Contractor factor
Rework	0.6025	23	Contractor factor
Lack/inadequate experience of a consultant	0.5778	24	Consultant factor
Contractual procedure and type of contract	0.5728	25	Other factors
Increasing tax	0.5556	26	Other factors
A contractual claim	0.5457	27	Other factors
Slow information between parties	0.5259	28	Other factors
Managerial incompetence of client	0.4963	29	Client factors
Financial difficulties faced by owners	0.4864	30	Client factors
Change in scope of the project	0.484	31	Client factors
The poor relationship between labor and management	0.4741	32	Other factors
The complexity of contract size and change size of the project	0.4568	33	Project-related factors
Dispute on site	0.442	34	Other factors

B. Percentage of identified factors

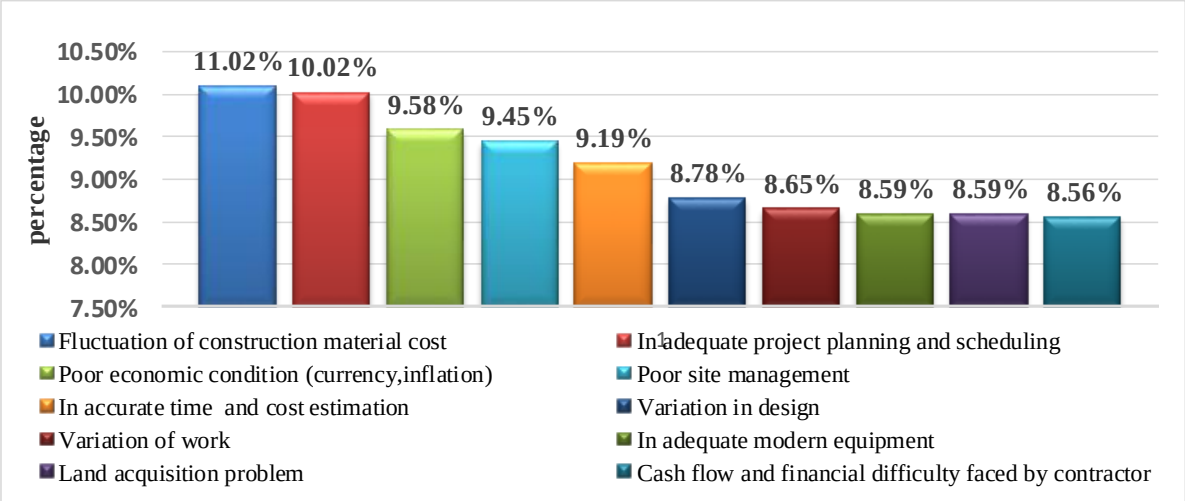
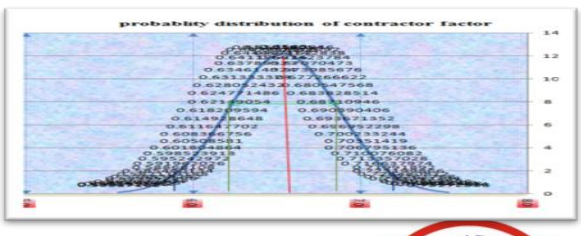


Fig 1 Percentage of top ten factors of cost overrun (source; compiled by author)

C. probability distribution of identified factors

The probability distribution was expressed by using normal probability distribution. (Gordon, 2010) Outlined that the value of the mean fixes the location of the normal curve, where it is centered. In all probability curves, half the scores lie to the left of the mean and half to the right. The value of the standard deviation determines the spread; the higher the standard deviation, the more flat of the curve. In fig 3 and fig 4 according to Gordon says that "scores are most crowded in intervals around the mean and the curve is highest" this tells us the two factors are more significant than others. Towards the ends of the curve, the height is decreased; the scores become less dense from the mean we go. This tells us that observations around the mean are more



likely to occur than observations further from the center.

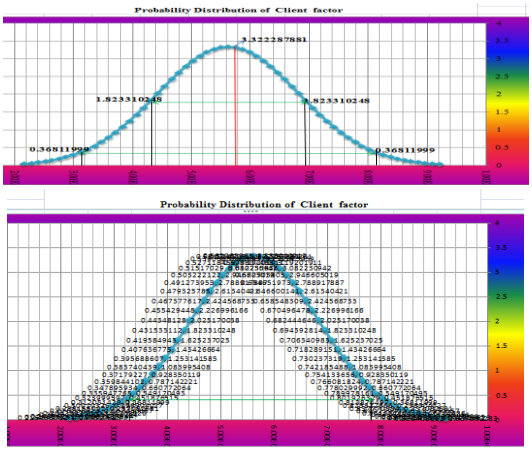


Fig 2 Probability Distribution of Client Factor (mean; 0.5629, standard deviation; 0.119) (source; compiled by author)

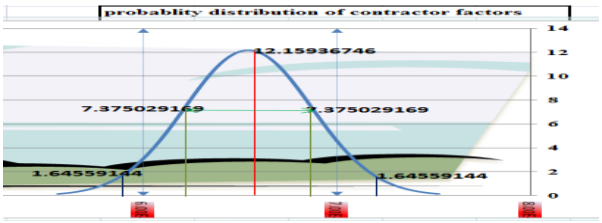


Fig 3 Probability Distribution of Contractor Factor (mean: 0.6543, standard deviation: 0.0328).(source; compiled by author)

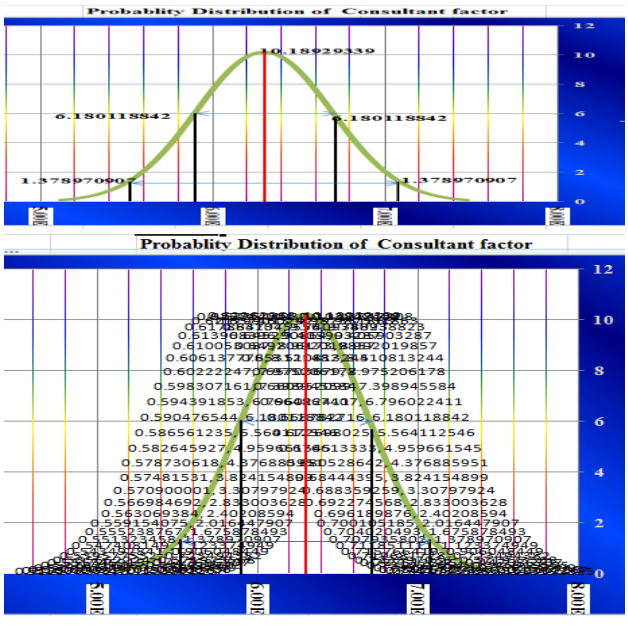
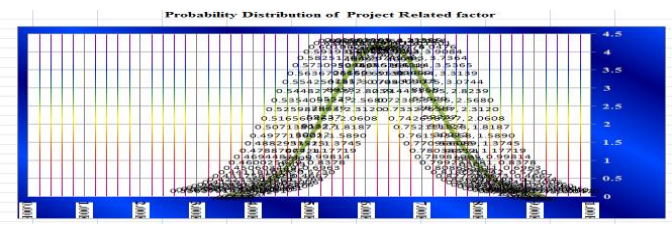


Fig 4 Probability Distribution of Consultant Factor (mean: 0.6296, standard deviation: 0.03915) (source; Compiled by author)



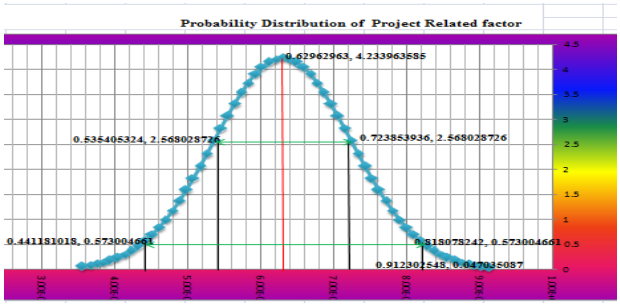


Fig 5 Probability Distribution of Project Related Factor (mean: 0.63, Standard deviation: 0.09422). (Source: compiled by author).

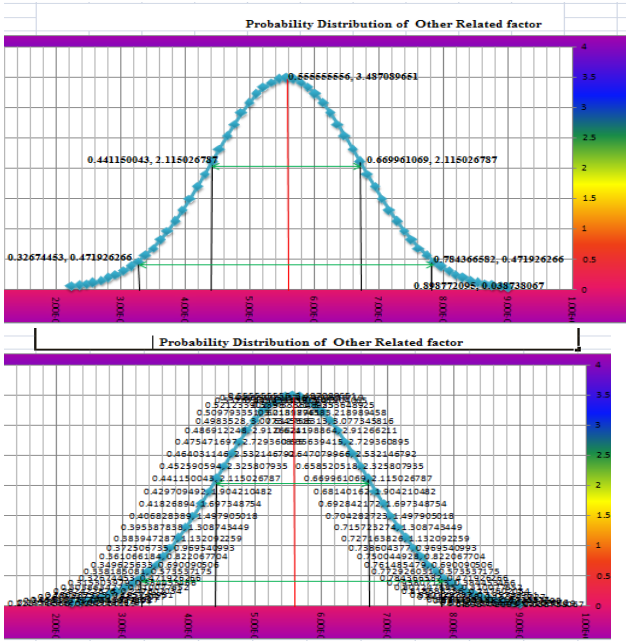


Fig 6 Probability Distribution of other Related Factor (mean: 0.555, Standard deviation: 0.1144). (Source: compiled by author)

The probability distribution of factors indicated that client and other related factors were the most influencing factor of cost overrun than others. In fig 2 and 6, the score is less dense around the mean and the curve is flattest than others" this tells us the two factors are less significant than others. The distribution indicates a major cause of cost overrun were client factors and other related factors (such as price escalation, poor economic condition, corruption).

D. Develop Simulation Model

During the desk study, 19 construction projects were selected. The data was collected by reviewing project documents. Based on data gathered from the desk study, the entire project evaluated in desk study registered cost overrun. The project considered in desk study was 8 ongoing projects and 11 completed projects.Cost overrun for

100% complete = actual cost – planned cost=ACWP-BCWP.

Cost overrun for ongoing project = EV- AC where EV = %of completion *planned cost Percentage of cost overrun for 100% complete project

= ((actual cost – planned cost)/planned cost)*100

Percentage of cost overrun for ongoing project = ((earned value – actual cost)/planned cost)*100

Table 2 desk study of 19 construction project ((Source: compiled by author)

Project	planned cost (PV)	Actual cost (AC)	% of Completion	Earned Value(EV)	Cost variance EV - AC	% of Cost EV - AC / PV
P1	686,511,964.39	420,907,538.76	60%	411,907,178.60	-9,000,360.16	-1.31%
P2	230,785,980.46	301,215,857.82	99%	228,478,120.70	-72,737,737.12	-31.52%
P3	420,085,436.60	492,371,222.61	78.09%	328,044,717.40	164,326,505.21	-39.12%
P4	48,000,000	40,886,990.55	68%	32,640,000	-8,246,990.55	-17.18%
P5	11,000,600	14,000,000	100%	11,000,600	-2,999,400.00	-27.27%
P6	13,000,000	16,258,281.14	100%	13,000,000	-3,258,281.14	-25.06%
P7	2,400,000	3,400,000	100%	2,400,000	-1,000,000.00	-41.67%
P8	2,800,000	3,300,000	100%	2,800,000	-500,000.00	-17.86%
P9	3,395,000	4,100,000	100%	3,395,000	-705,000.00	-20.77%
P10	6,768,393.00	6,768,393.00	25%	1,692,098.25	-5,076,294.75	-75.00%
P11	6,200,000	6,197,645.08	78%	4,836,000	-1,361,645.08	-21.96%
P12	1,883,359.68	847,511.86	35%	659,175.88	-188,335.98	-10.00%
P13	1,894,913.81	1,821,123.38	95%	1,800,168.12	-20,955.26	-1.11%
P14	75,612,137.98	76,612,137.90	100%	75,612,137.98	-999,999.92	-1.32%
P15	95,500,681.97	101,031,539.20	100%	95,500,681.97	-5,530,857.23	-5.79%
P16	75,384,384.99	76,483,940.60	100%	75,384,384.99	-1,099,555.61	-1.46%
P17	120,450,980.30	121,302,420.60	100%	120,450,980.30	-851,440.30	-0.71%
P18	155,384,940.90	156,825,304.90	100%	155,384,940.90	-1,440,364.00	-0.93%
P19	183,970,650.50	184,344,450.90	100%	183,970,650.50	-373,800.40	-0.20%

Table 3 Percentage of cumulative frequency (Source: compiled by author)

cost	frequency	cumulative	percentage of cumulative frequency
0 up to 10	8	8	42.11%
10 up to 20	3	11	57.89%
20 up to 30	4	15	78.95%
30 up to 40	2	17	89.47%
40 up to 50	1	18	94.74%
70 up to 80	1	19	100.00%
Grand Total	19		

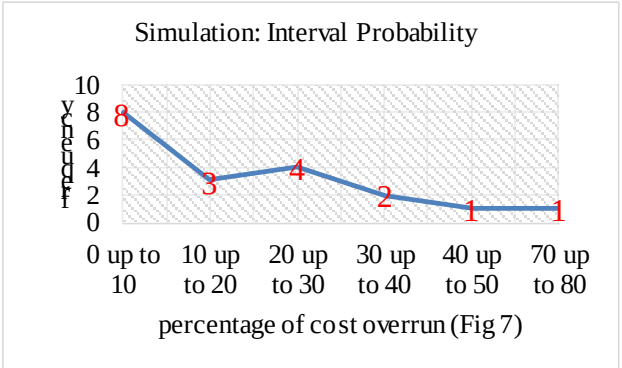


Figure 7 Interval probability model of the percentage of cost overrun and frequency. (Source: compiled by author)

Frequencies of cost overrun from 0- 10 % were 8; -those are Project 12, 13, 14, 15, 16, 17, 18 and 19.

Frequencies of cost overrun from 10-20% were 3; - those were projects 4, 8 and 12.

Frequencies of cost overrun from 20-30%were 4: - those were Project 5, 6, 9 and 11.

Frequencies of cost overrun from 30 – 40 %were 2: - those were Project 2 and 3

The frequency of cost overrun from 40 -50% was 1: - that was Project 7

Frequencies of cost overrun from 70-80% were 1: - that was project 10.

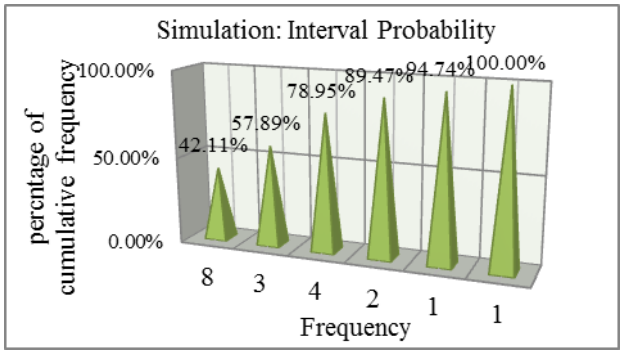
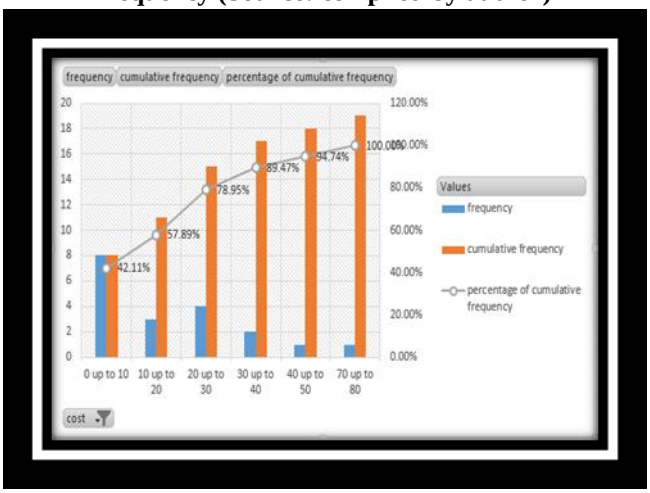


Figure 8 frequency VS percentage of cumulative frequency (Source: compiled by author)



`Figure 9 Frequency, Cumulative frequency, and percentage of cumulative frequency model. (Source: compiled by author)

VI. CONCLUSION AND RECOMMENDATIONS

A. Conclusions

According to the overall view of rank, fluctuation of construction material cost, inadequate project planning & scheduling and poor economic condition (i.e. currency and inflation) were the 1st, 2nd, and 3rdlevel of influencing factor of cost overrun in a construction project with RII value of 0.7827, 0.7777 and 0.7432 respectively. This indicates the fluctuation of material cost was the main cause of cost overrun in most construction projects. e.g., rebar, RHS roof member and other import construction material were increasing their cost highly due to inflation and lack of currency in the current condition of the country.The normal probability distribution client factor, contractor factor, consultant factor, project-related factor, and other factor were distributed with a mean of 0.562962963, 0.6543, 0.62962963, 0.62962963 and 0.555555556 with a SD of 0.119481683, 0.03280946, 0.039153086, 0.094224306 and 0.114405513 respectively. Simulation model of cost overrun as shown on a model in fig 7 the large number frequency occurs 0 up to 10%. This indicates the real cost of most construction projects increases by up to 10% over its budget and some projects exposed to cost overrun up to 80%.

B. Recommendations

- Fluctuations in prices of raw materials and the cost of manufactured materials should be stabilized by breaking the monopoly of few suppliers and controlling the supply chain of the market.
- Appropriate funding levels should always be determined at the planning stage of the project so that regular payment should be paid to contractors for work done.
- Site managerial skills of contractors and subcontractors should be improved by conducting management courses and training to prevent cost overrun.
- To improve contractors' managerial skills, they shall need continuous personal development for personnel in the construction industry to update their knowledge and be familiar with project management techniques and processes, to have effective and efficient performances.
- The project manager should be sure the project spent time to define the project objective, scope, assumption, risk, budget, timeline and overall approach before starting the project.
- Project consultants should develop quality control and quality assurance plans to review and revise Contractor submittals such as material submittals.

REFERENCES

1. Aziz, R.F. (2013). Factors causing cost variation for constructing wastewater projects in Egypt. Alexandria Engineering Journal, 52(1), https://doi.org/10.1016/j.aej.2012.11.004
2. Brunes, F. & Lind, H. (2014). Policies to avoid cost overruns: Critical evaluation and recommendations. Working Paper 2014:06, Section for Building and Real Estate Economics, Department of Real Estate and Construction Management, Centre for Banking and Finance (Cefin), School of Architecture and the Built Environment, Royal Institute of Technology, Sweden, 2014, pp. 1-16.
3. Gordon, S. (2010). Normal Distribution. University of Sydney, UPS.
4. Kaming Peter, O. P. (1997). Factors influencing construction time and cost overruns on high-rise projects in Indonesia. Journal of Construction Management and Economics, Volume 15, pp. No.1, pp. 83-94.
5. Memon, A.H. (2013). The way forward in sustainable construction: Issues and challenges. International Journal of Advances in Applied Sciences, 2(1), pp. 1-8.
6. Morris, S. (1990). 'Cost and Time Overruns in Public Sector Projects', Economic and Political Weekly, Nov. 24, Vol. XXV, No. 47, pp. M154 -168
7. Nega, F. (2008). Causes and effects of cost overrun on public building construction projects in Ethiopia. Unpublished MSc thesis. Addis Ababa University: School of Graduate Studies, Ethiopia
8. Saidu, I. &Shakantu, W.M.W. (2016). A study of the relationship between material waste and cost overrun in the construction industry. In: Windapo, A.O. (Ed.). The 9th Post graduate Conference:
9. "Emerging trends in construction organizational practices and project management knowledge area", 2-4 February, Cape Town, South Africa, pp. 124-134.
10. Shanmugapriya, S. & Subramanian, K. (2013). Investigation of significant factors affecting time and cost overrun in Indian construction projects. International Journal of Emerging Technology and

Advanced Engineering, 3(10), pp. 734-740.
11. Stukhart&George(1997) Estimating the Cost of Escalation‖, In The Engineer's Cost Hand110book Tools for Managing Project Costs, Edited by Richard E. Westney, P.E. Westney Consultants International, Inc. Houston, Texas, ISBN 0-8247-9796-5.
12. Subramani, T., Sruthi, P.S. & Kavitha, M. (2014). Causes of cost overrun in construction. IOSR Journal of Engineering (IOSRJEN), 4(6), pp. 22788719. https://doi.org/10.9790/3021-0464010
13. Ubani, E.C., Okarche, K.A. &Emeribe, S.C. (2011). Analysis of factors influencing time and cost overrun on construction projects in South-Eastern Nigeria. International Journal of Management Sciences and Business Research, 2(2), pp. 73-84.
14. Windapo, A. O., & Cattell, K. (2013). The South African construction industry: Perceptions of key challenges facing its performance, development, and growth. Journal of Construction in Developing Countries, 18(2),

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