FORECASTING INACCURACIES IN TRANSPORTATION PROJECTS IN SELECTED SOUTH EAST ASIAN COUNTRIES

Nicanor R. ROXAS Jr.
Part-time Lecturer, Department of Civil Engineering, De La Salle University, Manila, Philippines
E-mail: roxasn@dlsu.edu.ph

Saksith CHALERMPONG
Assistant Professor, Department of Civil Engineering, Chulalongkorn University, Bangkok, Thailand
E-mail: saksith.c@chula.ac.th

Abstract: Past studies show that transportation infrastructure projects often perform poorly as compared to the forecasts made before they were constructed in that projected costs are underestimated while forecasted demand are overestimated. In this research, a database of transportation projects from Thailand and Philippines was assembled to verify whether inaccuracies in cost forecasts exist in the region. From the analysis, it has been verified that there are no significant differences in cost forecast errors between road and bridge projects. However, the errors found in transportation projects in Thailand are significantly different in magnitude from those in the Philippines. The level and frequency of cost forecast errors in the two countries were examined as well. Although findings from this study can contribute in improving the method of cost forecasting in South East Asia, they should be used and interpreted with caution due to the small sample size and limited types of projects considered in the study.

KEYWORDS: project feasibility studies, cost underestimation, ex-post evaluation

1. INTRODUCTION

The Second Stage Expressway in Thailand and the MRT3 in the Philippines are some of the transportation projects that are enormous in size and costly to construct. Past studies show that projects of this magnitude often perform poorly as compared to the forecasts made before they were constructed in that projected costs are underestimated while forecasted demand are overestimated (Anguera, 2006; Gómez-Ibáñez, 2000; Flyvbjerg, 2003; Wachs, 1987). Such inaccuracies have been persistent over the years despite the advancements in forecasting methods and techniques (Flyvbjerg B. *et al.*, 2003).

This research followed the approach adopted by Flyvbjerg (2007). The researcher focused on the forecast inaccuracies in transportation projects found in Thailand and the Philippines. Specifically, the researcher examined completed transportation infrastructure projects in selected countries and performed analyses on cost data, both projected and actual, of these projects.

2. PROBLEM STATEMENT

Do systematic cost underestimation and demand overestimation exist in transportation projects in selected South East Asian countries? In this study, a database of cost and demand,

both projected and actual, of transportation infrastructure projects in Thailand and the Philippines was constructed and analyzed in order to verify whether forecast inaccuracies in such projects exist in the region. The database generated was then used as the basis for the application of the *Reference Class Forecasting Technique, (RCF)*, proposed by Flyvbjerg. Using this method, the forecaster looks to the distribution of forecasting inaccuracies in the set of projects that are deemed similar to the project in question; i.e. in the same "*reference class*", and use that as a basis on which the forecasted figures of demand and costs are adjusted in order to allow for the probable inaccuracies that will occur (Flyvbjerg, 2007). This method has shown potential in improving forecasting results over those of conventional forecasting techniques (Flyvbjerg B. *et al.*, 2003*)*. However, the applicability of the method depends largely on data sufficiency. *RCF* can only be performed when adequate data has been gathered about the actual and estimated demand and cost of projects.

In addition to this, the researcher answered some underlying subproblems such as the size and frequency of the forecast inaccuracies in Thailand and the Philippines, the differences in the magnitude and frequency of forecast inaccuracies across different project types and location, the probable causes of inaccuracy in forecasts, and the measures that can be employed to alleviate such problems.

3. OBJECTIVE

The objectives of this research are:

- To verify whether systematic forecast inaccuracies in transportation projects exist in selected countries of the South East Asian region.

- To address the missing key information regarding project evaluations in order to allow systematic comparisons of projects in the case where RCF is not applicable.

4. RESEARCH SCOPE

The transportation projects, such as roads and bridges, dealt with in this research are from Thailand and the Philippines. The data of transportation projects included in the database of this study are all gathered from government agencies such as the DOH in Thailand, DPWH and DOTC in the Philippines, and other foreign institutions such as JBIC, ADB, and JICA. This study focuses on the inaccuracies in cost forecasts only.

The database included in this research is limited to those projects with forecasted and post-opening data. Transportation projects with this kind of data are hard to find so the sample size is small thus, the sample may not be representative of the population. Also, since the data are obtained from agencies mentioned earlier, projects with poor performance may not be disclosed to the researcher. Lastly, due to confidentiality reasons, projects such as PPP may not be well represented in the database.

5. METHODOLOGY

5.1. Research Design

The authors of this research constructed a transportation infrastructure projects database for Thailand and the Philippines which verified whether underestimation of costs of such projects exist in the two countries. Reference Class Forecasting (RCF) technique was also performed.

The greater part of this research replicated the study, *Megaproject Policy and Planning: Problems, Causes, Cures*. The same methodology was applied to the selected transportation infrastructure projects from the selected developing countries in the South East Asian region. The first step carried out in this research was to enumerate completed transportation infrastructure projects such as roads, expressways, bridges, and rail from selected countries in South East Asia. These projects are candidates for the data gathering phase of this study. However, these projects are subject to the availability of data required.

5.2. Data Considerations

Annual reports, ex-post evaluations, and materials from other similar studies were assembled in order to acquire more knowledge in the field of study. The websites of international organizations such as JICA, JBIC, ADB, World Bank, and the archives of government agencies for transportation and public works were also checked in order to obtain the necessary information on prospected projects in the region. There was also a research trip conducted in the Philippines in order to visit the different agencies and obtain project documents to be included in the database. Statistical analyses were performed on the data from the transportation projects in South East Asia. The magnitude and frequency of demand and cost forecast inaccuracies were determined. Comparisons across project types, project size, source of funding, and location were also performed. Lastly, the results from the statistical analyses of this study were compared with the results of Professor Bent Flyvbjerg in his paper, *Megaproject Policy and Planning: Problems, Causes, Cures*.

Establishing a database of transportation infrastructure projects for South East Asia proved to be difficult due to scarcity of data, time constraints, and limited resources; thus, the sample points were incorporated based on data availability.

5.3. Data Analysis

The statistical analyses were performed by using the *Statistical Package for the Social Sciences* or SPSS. Among the analysis tools included in the study are descriptive statistics, correlation analysis, comparison of means by the use of t-test, and analysis of variance (ANOVA). The level of significance or the *p-value* used in this study is 0.05.

6. RESEARCH FINDINGS

6.1. Descriptive Statistics of the Transportation Projects Database

After months of data gathering, a total of 129 road and bridge projects complete with projected and actual cost data were compiled. There were 44 from Thailand, and 85 from the Philippines. Of the 129 transportation projects, 89 were roads while 40 were bridges. Though it may seem that there were a lot of transportation projects included in the database of this study, there could have been more. Many transportation projects were dropped because the plans and completion documents did not match. Also, more projects could have been added to the database had the different transportation agencies and funding institutions assisted the researcher. Despite these shortcomings, the number of transportation projects in the database still permits the application of RCF.

Table 1 shows the descriptive statistics for cost overrun in the two countries. It can be seen that the Philippines has a positive average cost overrun while Thailand has a negative average cost overrun.

Table 1. Descriptive Statistics for Transportation Project
in Selected ASEAN Countries with respect to Country

COST OVERRUN (%)			
COUNTRY	**N**	**Mean**	**Std. Deviation**
Philippines	85	5.4084	35.90187
Thailand	44	-10.8175	30.49495

6.2. Case of Thailand

6.2.1 Overview of Transportation Projects from Thailand

For the transportation projects in Thailand, the information regarding costs were gathered from JICA, JBIC and the Department of Highways (DOH). There are a total of 44 transportation projects gathered from Thailand, 15 of which are bridges while 29 are road projects.

6.2.2 Classification of Cost Overrun in Thailand

Since there is a considerable number of transportation projects gathered from Thailand, it is important to find out whether the groups of projects should be joined into one big class or not. Flyvbjerg and COWI (Flyvbjerg and COWI, 2004) suggested that if there are at least 10 projects in each of the two groups, then they should be tested whether they can be considered equal or not. The t-test is performed in order to identify the relevant reference class of transportation projects. The test for difference in sample variances is performed first since the test for the difference in sample means requires the assumption regarding the equality in variances. The null hypothesis for this test states that the two sample variances are equal while the alternative hypothesis states just the opposite. It can be verified from Table 2 that

the F value is very small and definitely less than the critical value which is also confirmed by the significance value of 0.690 which is greater than the 0.05 level of significance. Thus, it can be said that there is no statistical difference between the sample variances. Also, by looking at the columns for the test for equality of means associated with the assumption of equal variances, it can be verified that the 2-tailed significance value is far too big to satisfy a 95% level of confidence. Thus, from the results of the analysis using the SPSS software, there is no reason for the two sample groups to be considered separately. Thus, the reference class of projects for Thailand includes both road and bridge projects.

Table 2. Independent Samples Test for Transportation Projects in Thailand

COSTOVERRUN	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2-tailed)
Equal variances assumed	.161	.690	-.121	42	.904
Equal variances not assumed			-.120	28.084	.905

Now that the 2 groups of samples can be joined together, Table 3 shows the descriptive statistics for all of the transportation projects considered in Thailand. A negative value for the average cost overrun indicates that, in real terms, the actual cost is less than the projected cost in real terms. This is actually good since most of the projects are completed within the budget. Even if one looks at the cost overrun, in nominal terms, the average underestimation is only 0.6193, which is not even 1% of the projected cost.

Table 3. Descriptive Statistics for Transportation Projects in Thailand

	N	Min	Max	Mean	Std. Deviation
COST OVERRUN IN REAL TERM (%)	44	-58.83	106.64	-10.8175	30.49495
COST OVERRUN IN NOMINAL TERM (%)	44	-53.93	120.89	.6193	32.90510

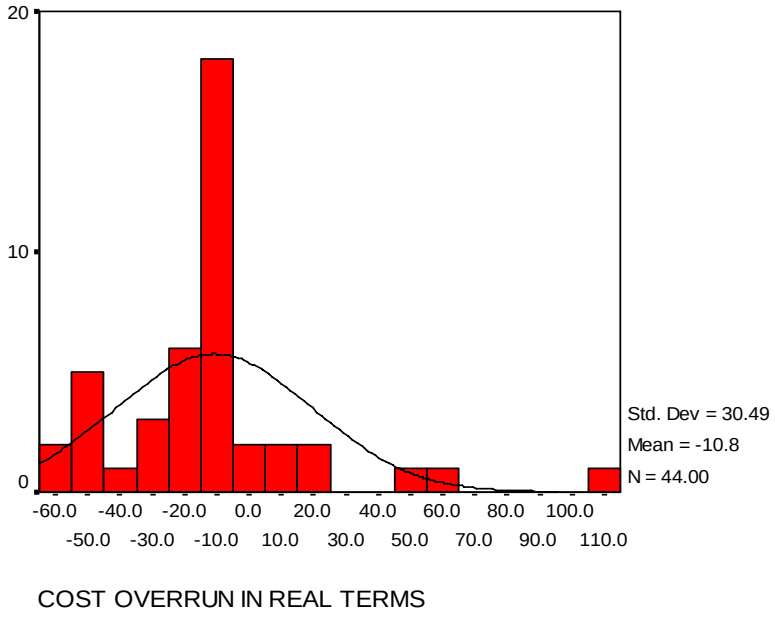

Figure 1. Histogram of Cost Overrun in Real Terms
for Transportation Projects in Thailand

The following figure shows the required bias uplifts for a certain acceptable chance that cost overrun might happen. It is clear that the chances of cost underestimation included in the following graph are limited, as also illustrated by Figure 1. The largest chance of cost underestimation happening, with a positive bias uplift is at about 13% with a required uplift of almost 13%; a 5% chance that cost overrun may happen, needs about 49% of uplift in its budget. Again, the limited levels in the figure is caused by the fact that a lot of projects included in the database experienced small or even no cost overrun. This may actually change if there were more sample points included in the database. The true scenario can be shown more clearly and accurately if there are more projects in the database.

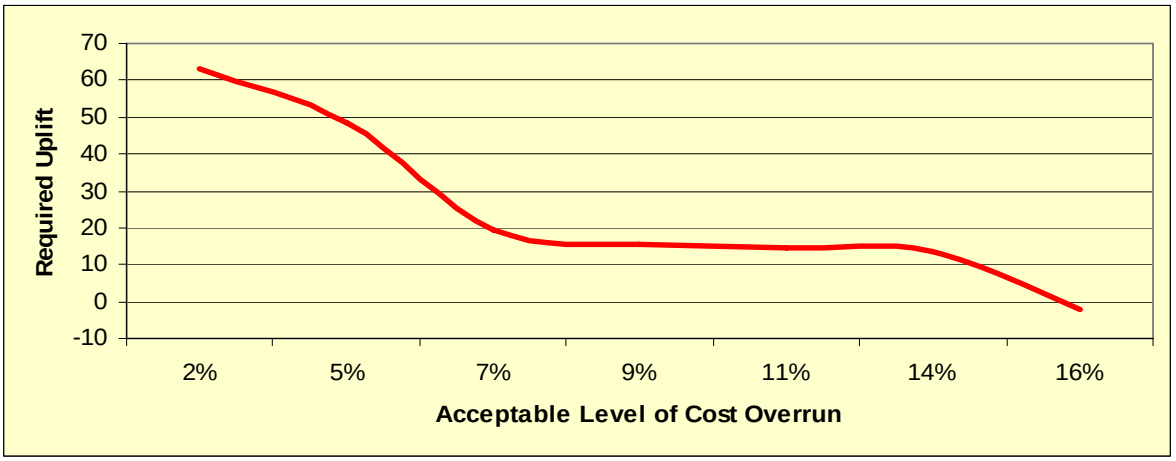

Figure 2. Required Uplift for a Certain Acceptable Probability
of Cost Overrun for Transportation Projects in Thailand

After performing the analyses, it has been determined that there is no significant difference between road and bridge projects in Thailand, in terms of the cost overruns experienced. However, there may be some other factors that bring about differences in the cost overruns in transportation projects. Factors such as the project size, source of funding, and location *(urban or rural)* of transportation projects are also tested in order to verify whether these factors have influence on the amount of cost overruns incurred.

Road and bridge projects from Thailand are divided into groups of projects with comparable costs. The analysis by means of the t-test shows that, when the group of transportation projects with costs less than one billion baht are compared to the other group of transportation projects includes with costs of one billion baht and more, the size of the project significantly influences the amount of cost overrun incurred. Moreover, the average cost overrun and standard deviation of the second group are less than those of the transportation projects with smaller costs.

After looking into the size of the projects, the 44 transportation projects are divided into two groups according to their respective location. Projects located in urban areas are assigned to group 1 while those projects in the rural areas are assigned to group 2. Results from t-test shows that there are no significant differences in the cost overruns experienced in

transportation projects from both the urban and rural areas. This suggests that projects are planned, evaluated, and implemented consistently, despite the different area classifications.

The third and last factor tested is the source of funding for all the transportation projects in Thailand. The researcher's hypothesis states that if a project is funded by a foreign institution, then it is expected that the inaccuracies are less pronounced due to the fact that there are less incentives or no incentives at all, for the foreign agencies to manipulate the figures in the project proposals. For the case of Thailand, there is a significantly small number of foreign funded projects in the database due to the fact that most of the transportation projects recently planned and completed are all locally funded. Results of t-test indicated that the source of funding has a significant when considering the cost overruns in transportation projects in Thailand. Moreover, the average cost inaccuracy of foreign funded projects is smaller than those of locally funded projects, supporting the hypothesis of the researcher.

In summary, transportation projects in Thailand in terms of project type and location *(urban or rural)* are indifferent from each other, in terms of cost overrun. However, there are differences in the cost overruns experienced brought about by the source of funding and the size of the projects. Looking into the source of funding of the projects, the average inaccuracy for foreign funded projects is smaller probably because of their evaluation methods, policies, and conditions. As for the size of the projects, it is surprising to find out that bigger projects have smaller cost overruns. It should be noted that there is a small number of big projects in the database and may not represent the population. Nevertheless, the difference may be brought about by the fact that bigger projects are handled by contractors from higher categories, thus ensuring the quality of work, and smooth implementation.

From the previous results, two-way analysis of variance (ANOVA) is performed in order to verify whether more specific reference classes of projects can be made. The projects are classified in terms of their size, type, source of funding, and location. All possible combinations of these 4 factors were tested for two-way ANOVA. In performing two-way ANOVA, it should be noted that, the other variables not included in the individual analysis do not influence the outcome or are not correlated to the variables being tested. Analyses show that no two factors are significant at the same time for each time the two-way ANOVA was performed. This simply means that no further or more specific reference classes can be made for this dataset which are statistically significant. Three-Way ANOVA was also performed; however, there are a lot of groups that are empty due to small sample size. Therefore, such tests were no longer undertaken.

6.3. Case of the Philippines

6.3.1 Overview of Transportation Projects from the Philippines

A total of 85 transportation projects from the Philippines were included in the transportation database of this study. Project information for the Philippine transportation projects were gathered from different government agencies such as the DPWH and DOTC, and other

institutions such as the ADB and JBIC. From the 85 transportation projects, 60 were roads, while 25 were bridges.

6.3.2 Classification of Cost Overrun in the Philippines

The following table shows the results from SPSS. It can be verified that there is no statistical difference between the sample variances due to the small F-value which is also confirmed by the significance value of 0.965 which is greater than the 0.05 level of significance. Also, by looking at the columns for the test for equality of means associated with the assumption of equal variances, it can be verified that the 2-tailed significance value is greater than the 0.05 level of significance to achieve a 95% level of confidence. Thus, the reference class of projects for the Philippines includes both road and bridge projects.

Table 4. Independent Samples Test for Transportation Projects in the Philippines

	Levene's Test for Equality of Variances		**t-test for Equality of Means**		
	F	Sig.	t	df	Sig. (2-tailed)
Equal variances assumed	.002	.965	-1.079	83	.284
Equal variances not assumed			-1.095	46.397	.279

Combining the two groups of samples will yield a total of 85 sample points and the descriptive statistics are shown in Table 5. Negative values for cost overrun means that the project was completed with money to spare or that the budget for the project was not fully spent.

Table 5. Descriptive Statistics for Transportation Projects in the Philippines

	N	**Min**	**Max**	**Mean**	**Std. Deviation**
COST OVERRUN IN REAL TERM (%)	85	-66.68	166.57	5.4084	35.90183
COST OVERRUN IN NOMINAL TERM (%)	85	-15.89	234.18	42.8996	44.01933

The following figure shows the histogram for the amount of cost overrun experienced by the transportation projects in the Philippines. It can be seen that the histogram approximates the normal curve and thus can be considered normally distributed. It is important to establish normality since it is required as an assumption in the establishment of the required uplifts for the budget to avoid cost overrun.

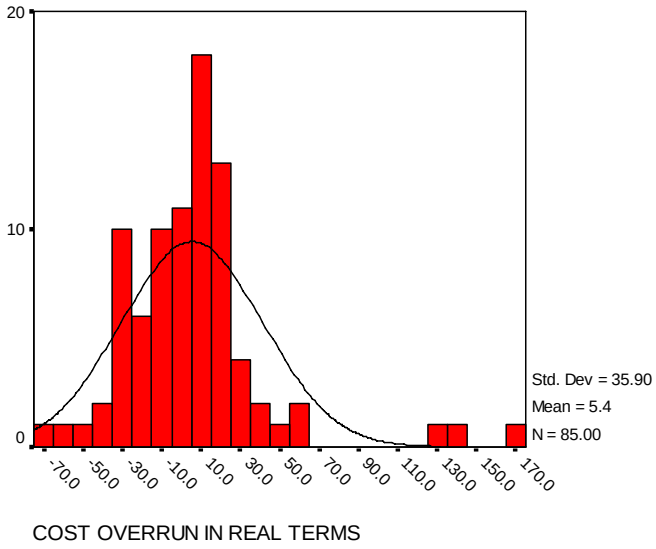

Figure 3. Histogram of Cost Overrun in Philippine Transportation Projects

The following figure is derived from Figure 3. This figure illustrates the amount of budget uplift needed for a given acceptable chance of cost overrun. It simply means that if the transportation agency responsible for the project wants to be 95% certain that cost overrun will not happen, *conversely a 5% chance of cost overrun*, then it must at least increase its budget by 58%. But if say, the transportation agency only decides to increase its budget by about 5%, then there is a 50% chance that cost overrun will or will not happen.

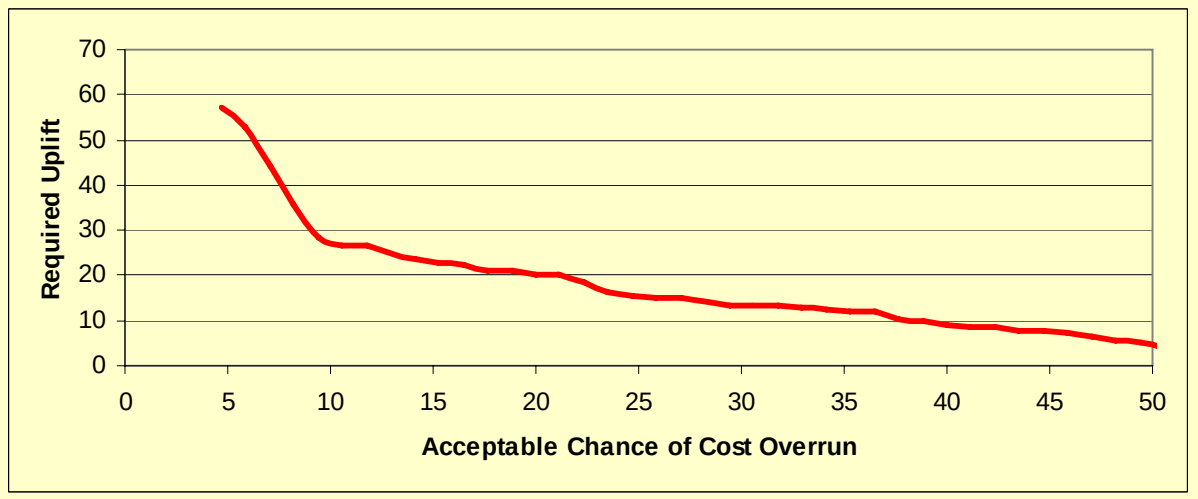

Figure 4. Required Uplift for a Certain Acceptable Probability
of Cost Overrun in Philippine Transportation Projects

Aside from considering the reference class of roads and bridges in the Philippines, there are other relevant factors that may influence the difference in cost overruns experienced in the country. It is important to find out whether the difference in size of the projects, the location, i.e. rural or urban, and the funding agencies involved in the transportation projects all have effects on the difference in the amount of cost overruns experienced. Results of the analyses by using t-test show that factors such as the location *(urban or rural)*, project size *(projected*

cost less than 1 billion pesos or more), and the source of funding, all have significant effects on the amount of cost overrun experienced. Projects from the urban areas have less cost overruns probably because of better project monitoring, known site conditions, quality of contractors, and many other factors that affect the cost of the projects. Bigger or more expensive projects also experience less cost overruns when compared to less expensive projects probably because bigger projects often have international consultants and longer planning and evaluations. Lastly, projects funded by JBIC/PJHL have less cost overruns when compared to other funding agencies. This may be attributed to the different JBIC consultants and numerous evaluations such as feasibility studies and ex-post evaluations.

From the results of t-tests, two-way analysis of variance (ANOVA) is performed in order to verify whether more specific reference classes of projects can be made. The projects are classified in terms of their size, type, source of funding, and location. All possible combinations of these 4 factors were again tested for two-way ANOVA. Analyses show that no two factors are significant, with $\alpha = 0.05$, at the same time for each time the two-way ANOVA was performed. However, when the level of significance is increased to at least 0.07, the source of funding and location can be used as a more specific class of transportation projects in the Philippines and that both these factors affect the amount of cost overrun experienced.

7. CONCLUSION AND POLICY IMPLICATIONS

After completing the analysis for the transportation projects in Thailand and the Philippines, it has been found that there are no significant differences, in term of cost overrun, between road and bridge projects in both Thailand and the Philippines, respectively. However, further analyses show that cost overrun in transportation projects in Thailand and Philippines are significantly different from each other.

A previous study of Flyvbjerg also showed that nine out of ten transportation projects in his database experienced cost overrun, with an average of 33.8% cost overrun for bridges and tunnels, and 20.4% overrun for roads. He also added that 84% of these projects have cost forecasts that are wrong by more than ±20% (Flyvbjerg, 2005). These figures can be compared with what has been found in the selected countries in the region. Considering all the 129 transportation projects included in the database, 42% experience cost overruns, with an average of 2.3% for bridges and -1.2 for roads, much lower than the result of the previous study which is 90%.

It has been shown that the forecast inaccuracies found in Thailand and the Philippines are much smaller in magnitude and less frequent as compared to those found from previous studies. However, due to the small sample size of the database in this study, it may not be a representative of the population used and thus the results should be interpreted with caution. Also, most of the projects considered in this research are funded by international agencies such as the ADB, World Bank, and JBIC. Thus, locally funded projects and PPP projects are not well represented in the database. It is recommended that a bigger and more diverse

database of transportation projects be assembled for South East Asia in order to establish more credible budget uplifts for transportation projects and to better assess the condition of forecast inaccuracies in the region.

It can be verified that Flyvbjerg's database (Flyvbjerg, 2007) is bigger and more diverse when compared to the current study. There are more projects included in his database, there are more project types considered, and that the project size in terms of the project cost is much bigger when compared to the database of the current study. Thus, the results of this research should be used and interpreted with caution. The budget uplifts established in this study is only applicable to specific project types and size. No further reference classes were established due to the restrictions caused by the sample size.

Despite the seemingly good results of this study, a number of things need careful consideration. First of all, the cost overrun experienced in the region should be monitored continuously. From the results of the analysis presented, it appears that trend is increasing and thus requires attention. Also, the general public should be cautious of what happens with the transportation projects planned and constructed. A system of checks and balances should be employed in order to determine whether resources were used efficiently or not. The government should also promote transparency in order to get the public more involved, and to gain their trust and respect. The government should also advocate the practice of ex-post evaluation in transportation projects. But since most transportation projects encountered in this study do not have demand forecasts, this should be included in the reform of the transportation planning process in the South East Asian region. Though traffic surveys and interviews are a bit costly, it is only through these comparisons of the actual and forecasted values can all the costs and benefits be weighed. Ex-post evaluations show how the investments perform as compared to the forecasts. Thus, such evaluations can aid government agencies on how to allocate resources more efficiently. It may seem that the suggestions offered to the government are demanding but such revisions are simply for the betterment of society.

ACKNOWLEDGEMENT

The researchers would like to thank the ASEAN University Network / Southeast Asia Engineering Education Development Network (AUN/SEED-Net), Chulalongkorn University, and De La Salle University for the much needed support. Thanks also to the staff at the DPWH Manila and Department of Highways Bangkok for their help in data gathering. And the researchers would like to extend their gratitude to Professor Bent Flyvbjerg for his help regarding the methodology of this research.

REFERENCES

Anguera, R. *The Channel Tunnel – An Ex-Post Economic Evaluation*. Transportation Research Part A, 2006, pp. 291-315.

Gómez-Ibáñez, J. A. *Bangkok's Skytrain (A): Opening the System*. Kennedy School of Government Case Program, Harvard College, 2000.

Flyvbjerg B. *Delusions of Success. Harvard Business Review*, December 2003.

Flyvbjerg B. et al. *Megaprojects and Risk, An Anatomy of Ambition*. Cambridge University Press, United Kingdom, 2003.

Flyvbjerg, B. *Megaproject Policy and Planning: Problems, Causes, Cures*. Aalborg University, February 2007.

Flyvbjerg, B. *From Nobel Prize to Project Management: Getting Risks Right*. Project Management Institute Research Conference, Montreal, July 16-19, 2006.

Flyvbjerg, B. and COWI. *Procedures for Dealing with Optimism Bias in Transport Planning – Guidance Document*. The British Department for Transport, June 2004.

Flyvbjerg, B. *Measuring Inaccuracy in Travel Demand Forecasting: Methodological Considerations Regarding Ramp up and Sampling.* Transportation Research Part A 39, pp. 522-530, 2005.

Wachs, M. *Forecasts in Urban Transportation Planning: Uses, Methods, and Dilemmas*. Graduate School of Architecture and Urban Planning, UCLA, 1987.