Time-Cost Relationship for Residential Construction in Texas

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SUMMARY

- Studies indicate that there is a relationship between project cost and construction time for different construction markets. The purpose of this study is to validate the time-cost relationship model developed by Brolmilow et al. in context with residential construction projects in Texas. The data for the study was obtained from about 55 completed residential projects. The results indicate that Bromilow et al.'s model holds good for the Texas Construction Industry at the level of significance (*p*-value) of < 0.0001.

INTRODUCTION

- Objectives of the Study
  - The characteristics of the residential construction industry in Texas has been reviewed in this study; a time-cost relationship model developed by Bromilow, et al. and validated by few other researchers has been use to verify whether such a relationship holds good for the residential construction industry in Texas. It is hypothesized that the total construction time of a residential project in Texas is positively correlated with the total construction cost of the project.

INTRODUCTION

- Review of the literature
  - A relationship between completed construction cost and the time taken to complete a construction project was first mathematically established by Bromilow (1974) and subsequently updated by Bromilow, et al. (1980). For the updated model, the authors analyzed the time-cost data for a total of 419 building projects in Australia. The equation describing the mean construction time as a function of project cost was found to be:
    - $T = K*C^B$
    - where T = duration of construction period in wording days, C = completed cost of project in millions of Australian dollars, K = a constant indicating the general level of time performance per million Australian dollar, and B = a constant describing how the time performance is affected by the size of the construction project measured by its cost.

INTRODUCTION

- Review of the literature
  - The model indicates that the duration of project time of a construction project is basically a function of its total cost. It provided a basis for all parties concerned with the construction process to establish a fairly accurate probable duration of a project in days, given the estimated cost of the project. The authors also analyzed the overruns on cost and time that provided a measure on the accuracy of the industry's time and cost prediction.
  - Taking a cue from Bromilow et al., some other studies have been performed to make similar predictions for either a specific sector of construction or construction industries, in general, around the world.
    - Ireland (1986) replicated the study to predict construction time for high-rise buildings in Australia
    - Kaka & Price (1991) conducted a similar survey both for buildings and road works in the United Kingdom
    - Kumaraswamy & Chan (1995) investigated the effect of construction cost on time with particular reference to Hong Kong
    - Chan (1999) did a similar research for Malaysian construction industry
    - Choudhury, Khan, & Matin (2002) conducted a study on health sector construction projects in Bangladesh. All these studies found that the mathematical model presented by Bromilow et al. holds good for prediction of construction time if the cost of construction is known.

INTRODUCTION

- Limitations of the Study
  - This study is limited to verify whether the time-cost relationship model developed by Bromilow et al. holds good for residential construction in Texas. It does not incorporate the implications of other factors that are likely to influence the total time required for the completion of a construction projects.

METHODOLOGY

- Data Collection
  - An instrument was prepared and mailed electronically to 450 residential construction companies in Texas, randomly selected from a list obtained from the Texas chapter of the National Association of Home Builders. The firms selected specialized in single-family and multi-family residential construction projects. Data related to 55 residential projects completed within last five years was obtained.

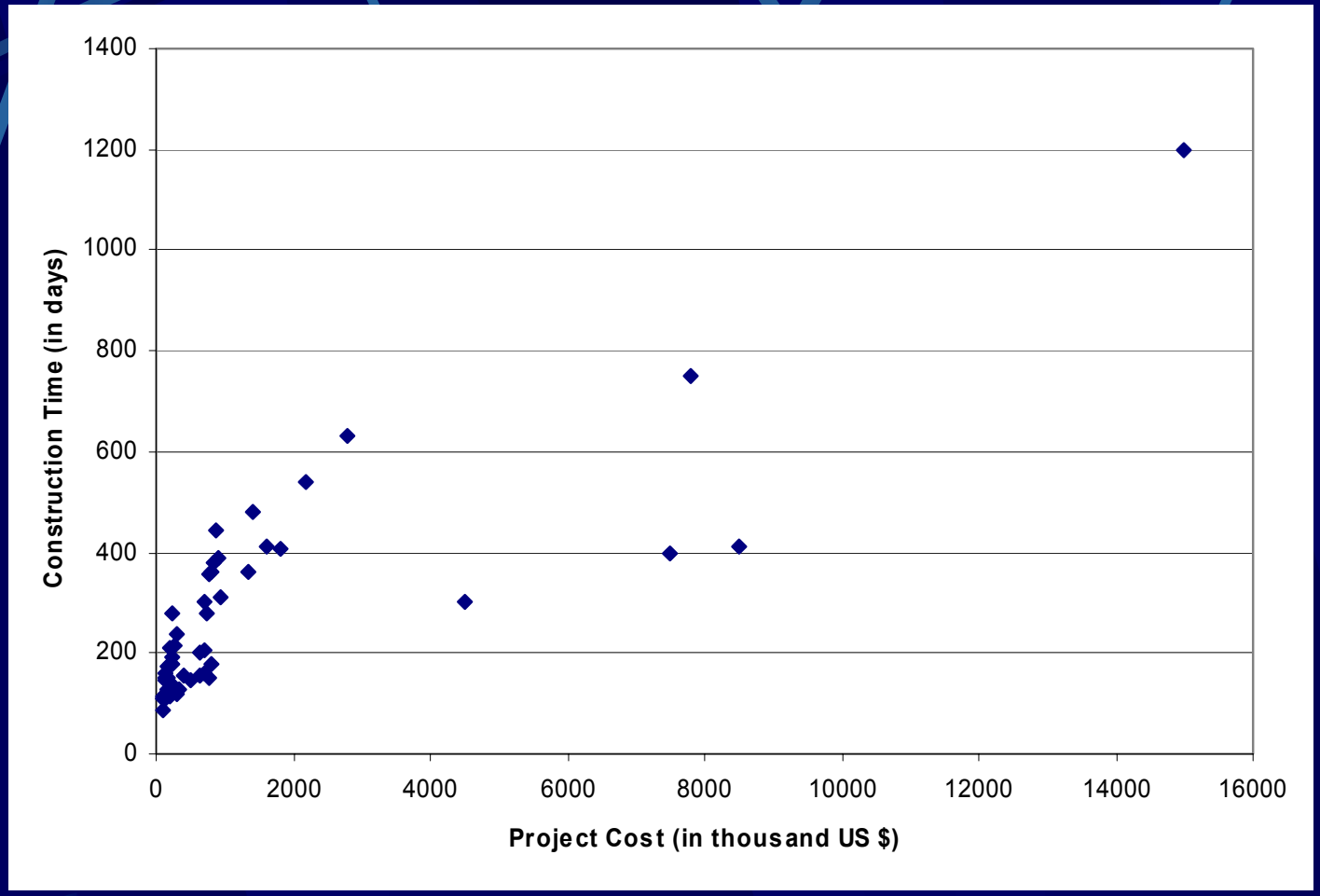
METHODOLOGY

- Variables and their operationalization
  - Construction Time (TIME): It is the actual time for completion of the project measured in working days.
  - Construction Cost (COST): It is the total cost of the construction of the residential projects measured in thousand US dollars.

METHODOLOGY

- **Analysis**
  - The data collected for the study was then used to validate the time-cost relationship model derived by Bromilow et al. for the Australian construction industry using the following equation:
    - $TIME = K*COST^{\beta}$
    - where
      - *TIME* = duration of construction time in days,
      - *COST* = completed cost of the project in thousand US $,
      - *K* = a constant indicating the general level of time performance for a project worth one thousand US $, and
      - β = a constant indicating how the time performance is affected by the size of the construction project measured by its cost.

Relationship between construction time and project cost



METHODOLOGY

- Analysis
  - A simple linear regression technique was used to analyze the data. For statistical analysis, Bromilow et al.'s model was rewritten in the natural logarithmic form as follows:
    - $LnTIME = Ln\ K + \beta\ LnCOST$
    - where
      - *LnTIME* = natural logarithm of time,
      - *LnK* = natural logarithm of *K*,
      - β = coefficient of *LnCOST*, and
      - *LnCOST* = natural logarithm of cost .

REULTS

Variable	Intercept (*K*)	Coefficient *LnCOST* (β)	*T*	*p*>*T*	Critical Value of |*T*|
Intercept	2.91		14.44	<0.0001	12.71
LnCOST		0.39	12.44	<0.0001	
Model R^2					0.7449
Adjusted R^2					0.7401
F-value of the Model					154.77
Critical Value of *F*					5.32
p>Model *F*-value					<0.0001

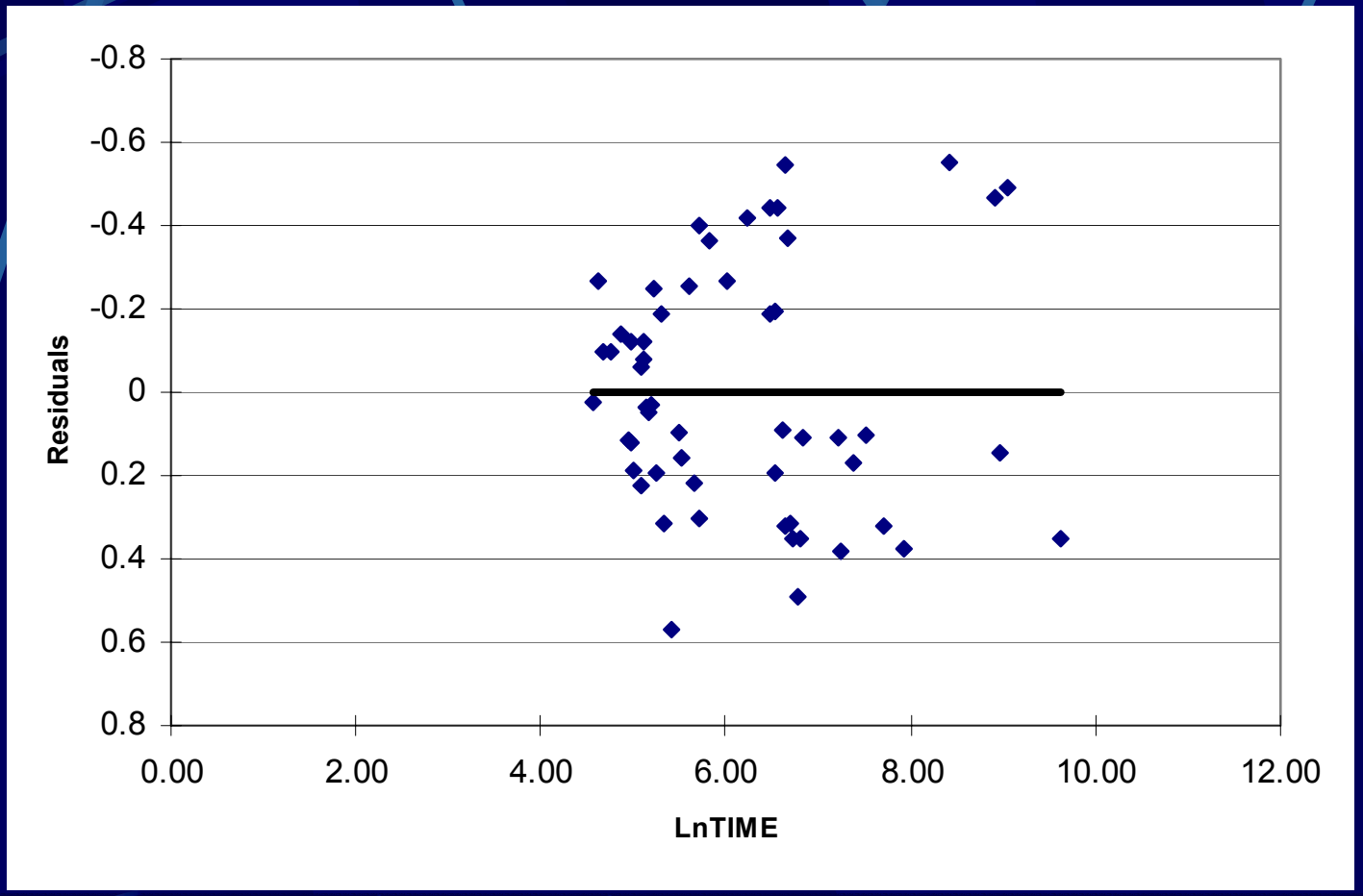
REULTS

- The value of *LnK* was required to be transformed to *K*, using an exponential function [exp(*LnK*)], for expressing the model in its original form. It was found to be 18.96.

INTERPRETATIONS

- An important aspect of a statistical procedure that derives model from empirical data is to indicate how well the model predicts results. A widely used measure of the predictive efficacy of a model is its coefficient of determination, or R^2 value. If there is a perfect relation between the dependent and independent variables, R^2 is 1. In case of no relationship between the dependent and independent variables, R^2 is 0. Predictive efficacy of this particular model was found to be quite high with an R^2 of 0.7449, and an adjusted R^2 of 0.7409. A residual plot indicated a good fit of the sample data.

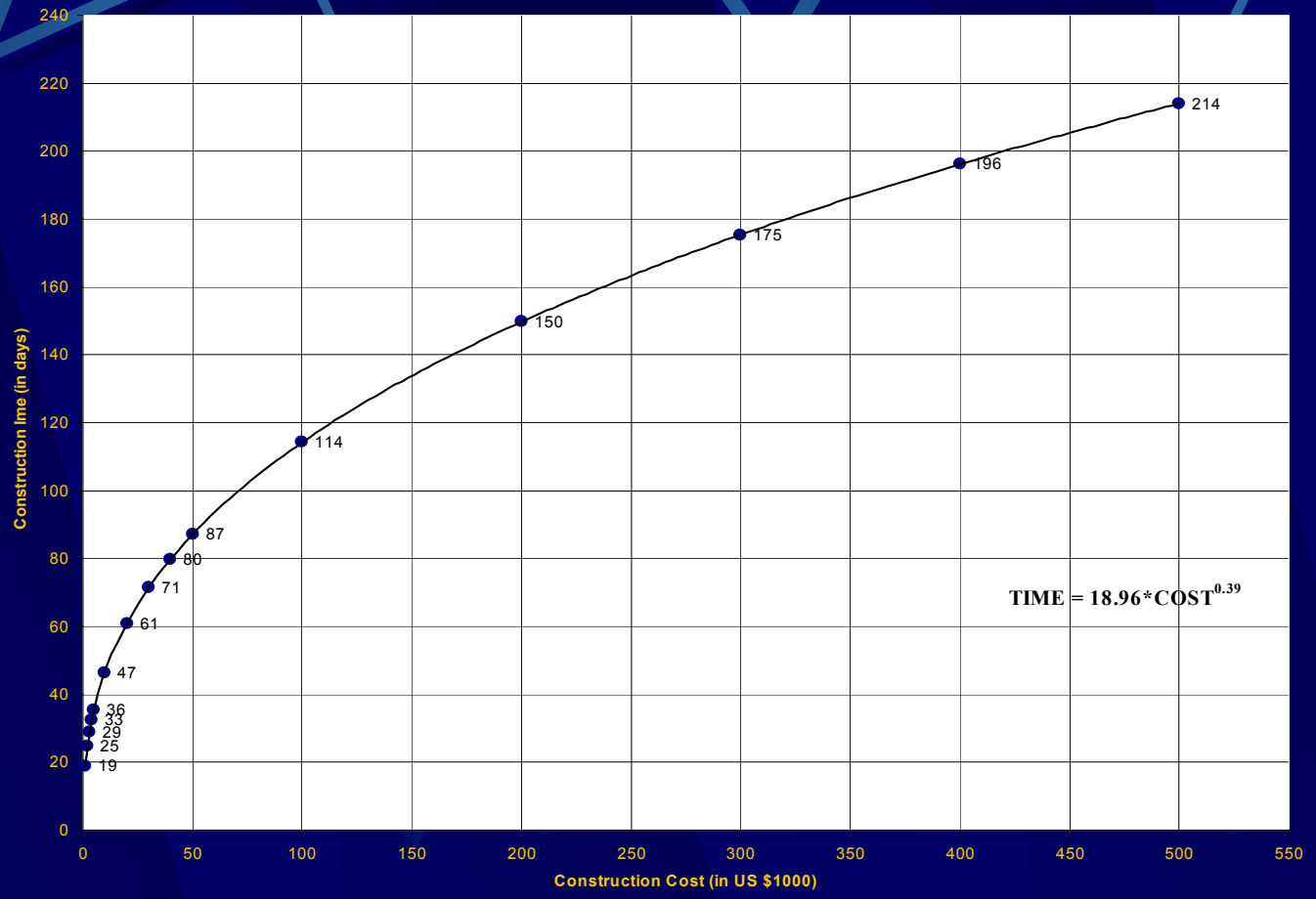
Residual plot



Results

- The results indicate that the actual completion time of the project is positively related to the total project cost at the level of significance of 0.0001. The F statistic of a model basically tests how well the model, as a whole, accounts for the dependent variable's behavior. The F-value of this particular model was found to be statistically significant at the 0.0001 level. It can therefore be concluded that the time-cost relationship for the residential industry in Texas can be expressed using the model developed by Bromilow et al. It can be expressed in the form:
  - $TIME = 18.96 * COST^{0.39}$

Time-Cost Relationship for Residential Projects in Texas



DISCUSSIONS

- The results of the statistical analysis indicate that for a residential construction project in Texas, an increase in the construction cost results in an increase in the construction time. It is found that for a project worth us $1000, the construction time is 18.96 days for the project completion.

DISCUSSIONS

- The model is useful for all parties associated with the construction industry to predict the mean time required for the delivery of a project, when the cost of the project is known. It provides an alternative and logical method for estimating construction time, both by bidders and clients, to supplement the prevailing practice of estimation predominantly on individual experience. The study will hopefully generate enough interest to do further research for deriving models for time-cost relationships of construction projects in other sectors and in construction industries in different regions.

DISCUSSIONS

- Developing time-cost relationship models for different construction industries will have a far-reaching effect on international competitive bidding. Along with electronic bidding sets, an automated version of such a model could be made available to the prospective bidders to calculate a fairly accurate construction time for completion of the project. All that will be required is to create a project database containing, among other data, historical information about actual construction cost and time for similar type of projects. This database may be made accessible to the bidders from any place, at any time, using web technology.

DISCUSSIONS

- The study was limited to investigate only the effect of cost on construction time in the context of residential projects in Texas, keeping all other variables constant. For future studies, it will be useful to include other variables such as productivity of the workforce, impact of client decision-making, management attributes, construction materials, and project environment, and analyze their effect on total construction time.


Thank you!