Effective Conceptual Cost Estimating Method for Highway Projects

Brendon J. Gardner
Masters Student
Iowa State University

Douglas D. Gransberg PhD, PE
Professor of Construction Engineering
Iowa State University

H. David Jeong PhD
Associate Professor of Construction Engineering
Iowa State University

Background to Conceptual Estimating

The conceptual cost estimate is the first estimate of the construction cost for a project. At this early stage in the project timeline there is very little information known about the project, yet this cost estimate is used for:

- Long-term budget allocation at state Departments of Transportation (DOTs)
- Benefit-to-cost analysis of different project options
- Allocating the preconstruction services budget

An incorrect conceptual estimate can result in misallocation of funds, inappropriate project selection and underfunding design effort which can lead to construction cost growth.

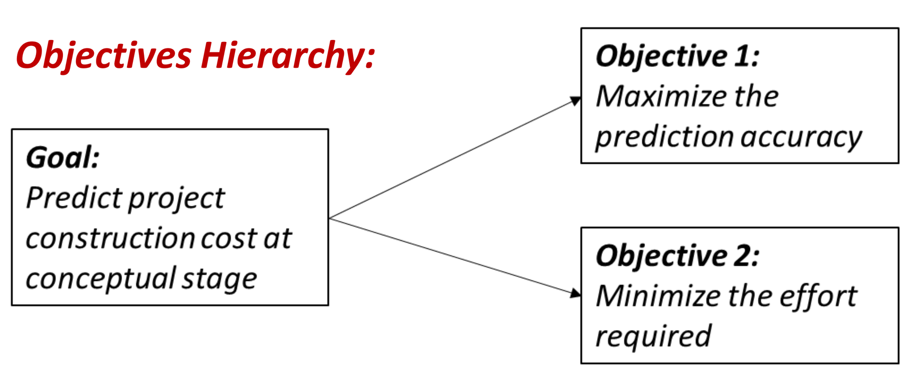
Project Development Timeline:

Project Stage:	Conceptual Development	Design	Advertisement	Bid/Award	Construction
Time:	→				
Estimate:	Conceptual Estimate	Design Estimates	Engineer's Estimates	Bid Analysis	Change Orders

Research Overview

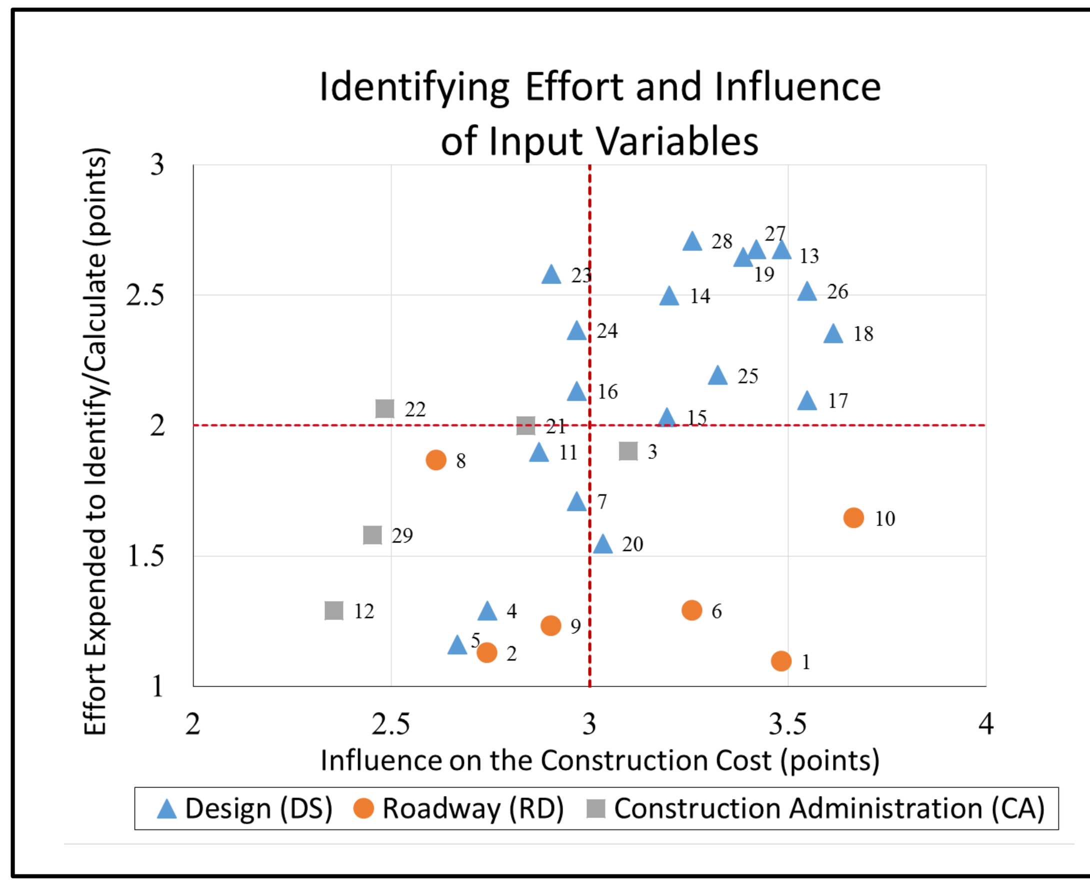
Artificial neural networks and multiple regression analysis are two data-driven techniques proven in the literature to calculate the conceptual construction cost using historical project data. The authors of these studies have solely focused on model performance and little attention has been paid to the effort expended to conduct the estimate. Input variables (or project attributes) used in these models require design and therefore effort to calculate or identify them. The least information that can be used to calculate the conceptual estimate within reasonable accuracy the better.

Objectives Hierarchy:



A survey was conducted at Montana Department of Transportation (MDT) to help the research team identify those variables that best meet both objectives. A total of 31 preconstruction engineers answered perceptive questions on the effort required to compute/identify 29 potential input variables for an estimating and the perceived influence that each variable would have on the construction cost.

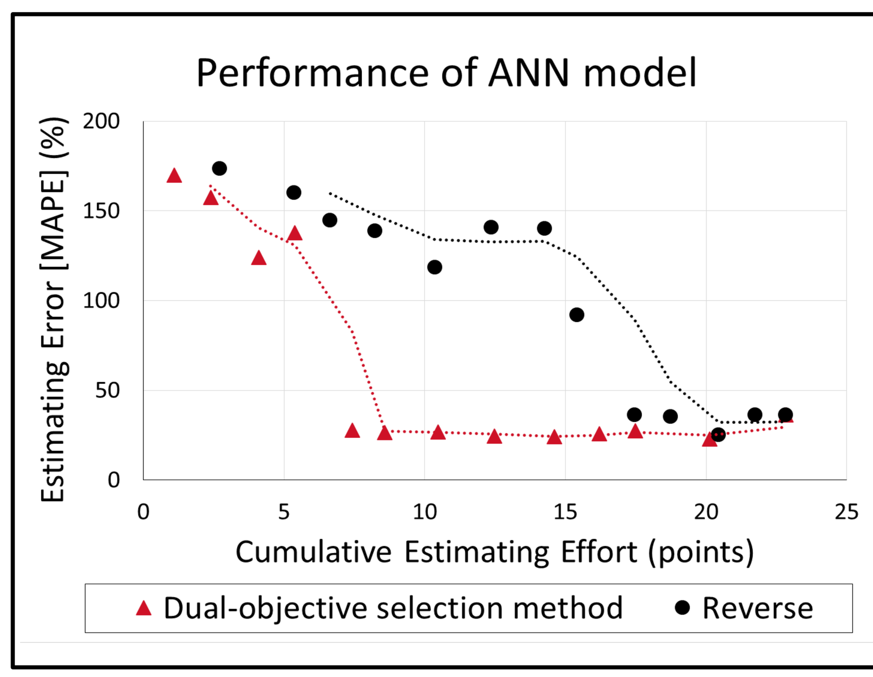
Survey Results

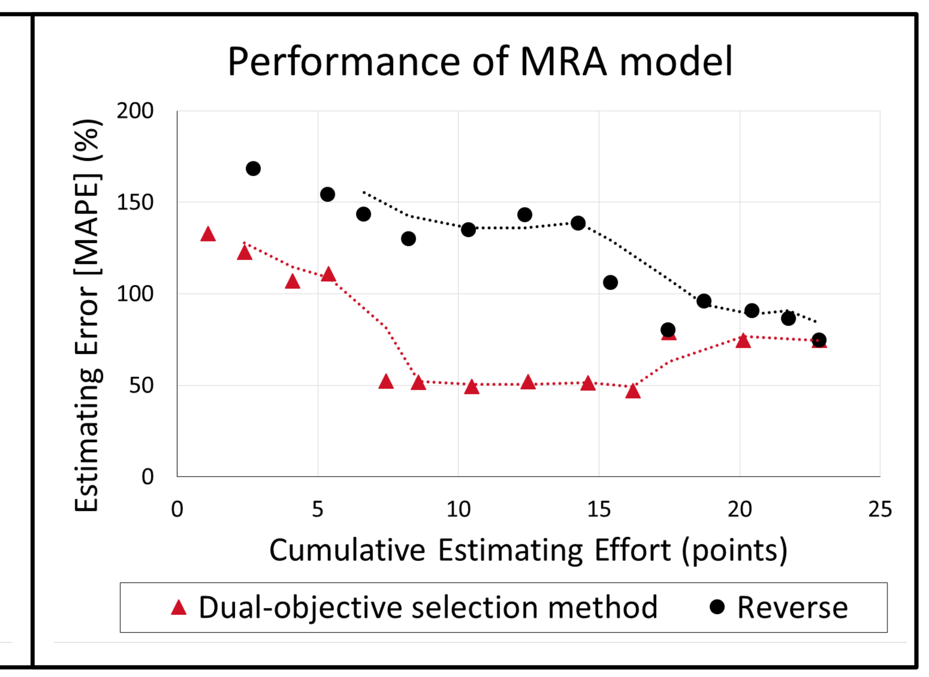


1	Urban or rural project (RD)	16	Curb, gutter and sidewalk (DS)
2	Construction on Native American Reservations (RD)	17	Bridge complexity (DS)
3	Context sensitive design issues (CA)	18	Volumes of excavation and embankment (DS)
4	Design AADT (DS)	19	Geotech complexity (DS)
5	Design speed (DS)	20	Bridge deck area (DS)
6	Site topography (RD)	21	Traffic Control - closures or detours (CA)
7	Start and end stations, length and width (DS)	22	Environmental permit requirements (CA)
8	Existing conditions (RD)	23	Hydraulic complexity (DS)
9	Number of intersections (RD)	24	Storm sewer extents (DS)
10	Number of bridges (RD)	25	Bridge span lengths (DS)
11	Intersection signalization and signage (DS)	26	Foundation complexity of the bridge (DS)
12	Letting Date (CA)	27	Right-of-way costs (DS)
13	Horizontal and vertical alignment (DS)	28	Extent of utility relocations (DS)
14	Extent of changes to the intersections (DS)	29	Contract time (CA)
15	Typical section (DS)		

Results

- Input variables were added in the suggested dual-objective selection order. Model error was calculated each time the cumulative estimating error increased.
- Selection order was verified by repeating the process in the reverse selection order.
- Once 6-8 high-impact and low-effort variables added to the model then adding further input variables yielded no reduction in estimating effort.
- Using the reverse input selection required order almost twice the perceived level of effort, yet only the same level of estimating performance obtained.
- Selection method tested with both artificial neural network (ANN) and multiple-regression analysis (MRA) models for validation

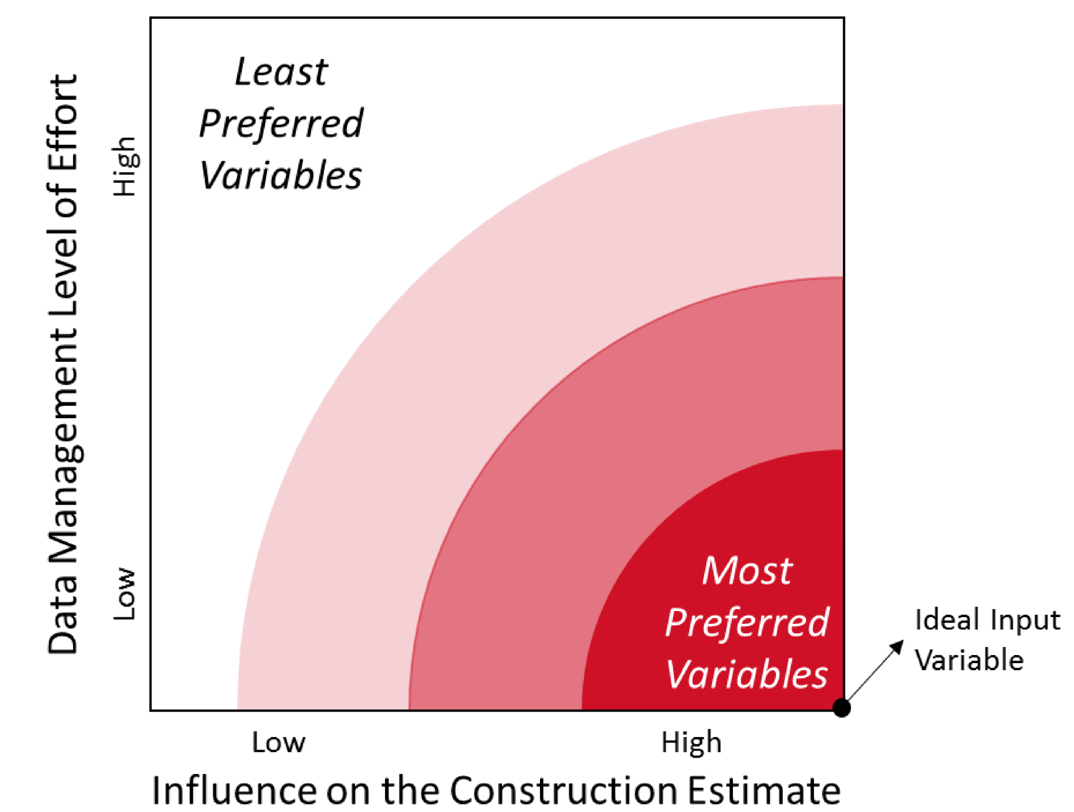




Research Implications

- Significant and positive implications for practitioners willing to employ top-down data-driven methods to conduct a conceptual cost estimate. For the first time the preconceived notion, that more detail enhances estimate accuracy, was challenged.
- Once highway agencies are confident in the input variables required to estimate conceptual costs then collection of further information is unnecessary. This saves on resources and reduces data storage costs.
- A reasonable estimate of the project costs with less project detail enables improved budgeting and earlier benefit-to-cost analysis of future projects.

Proposed Input Variable Selection Method:



Conclusions

- Conceptual cost estimating at transportation agencies need to focus on two objectives: (1) accurately estimate costs, and (2) expend the least effort
- Survey results indicate that some project attributes require much less effort to be expended in order to calculate or identify.
- If the correct 6-8 variables are selected then this is suitable to estimate the construction costs. Collecting and using further variables will not enhance estimate accuracy.
- It is believed that selecting high-impact and low-effort variables essentially selects those variables which are known to a high degree of confidence at the early estimate stages.

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