

# Model to Predict Labor Requirements for Scaffold Construction



Alex Barber-Cross, Lingzi Wu, Dr. Simaan Abourizk  
Department of Civil Engineering, University of Alberta



## Introduction

- Scaffolding is used on construction sites to give workers access to higher elevations.<sup>1</sup>
- Planning and construction of a scaffold typically takes place over a week.
- Planning and cost estimating is based, primarily, on industry experience.<sup>2</sup>
- The purpose of this research is to train a model to predict the scaffold labor requirement (amount of manhours) to make estimation and planning of scaffolding easier and more accurate.



Figure 1: Scaffolding

## Methodology

### Data

ScaffoldID	Date Requested	Date Required	Requested by Trade	Elevation	Actual Volume	Erection Mhrs	Completion Date
A-002	25-Sep-08	29-Sep-08	Pipefitters	0	8	5.817271278	29-Sep-08
A-003	30-Sep-08	2-Oct-08	Labourers/Carpenters/Mi	623	240	108.5890639	7-Oct-08
A-004	9-Feb-09	16-Feb-09	Pipefitters	628	48	98.89361173	17-Feb-09
A-005	17-Mar-09	16-Mar-09	Pipefitters	630	24	33.93408246	26-Mar-09

Figure 2: Portion of scaffolding database

- Database (14000+ scaffold requests) was loaded into R (programming language and environment)
  - The data has been scaled for confidentiality

### Data Preparation

- Clean up human errors and inconsistent data
- Create and add new variables

### Data Exploration

- Gain insight into trends within the data
- Use graphs to visualize relationships between variables

### Modelling

- Create a model that, when trained with the historical data from our database, will predict the total manhours required to build the scaffold

## Results

### Data Exploration

- On average, scaffolding was requested less than one week in advance and completed one day late.

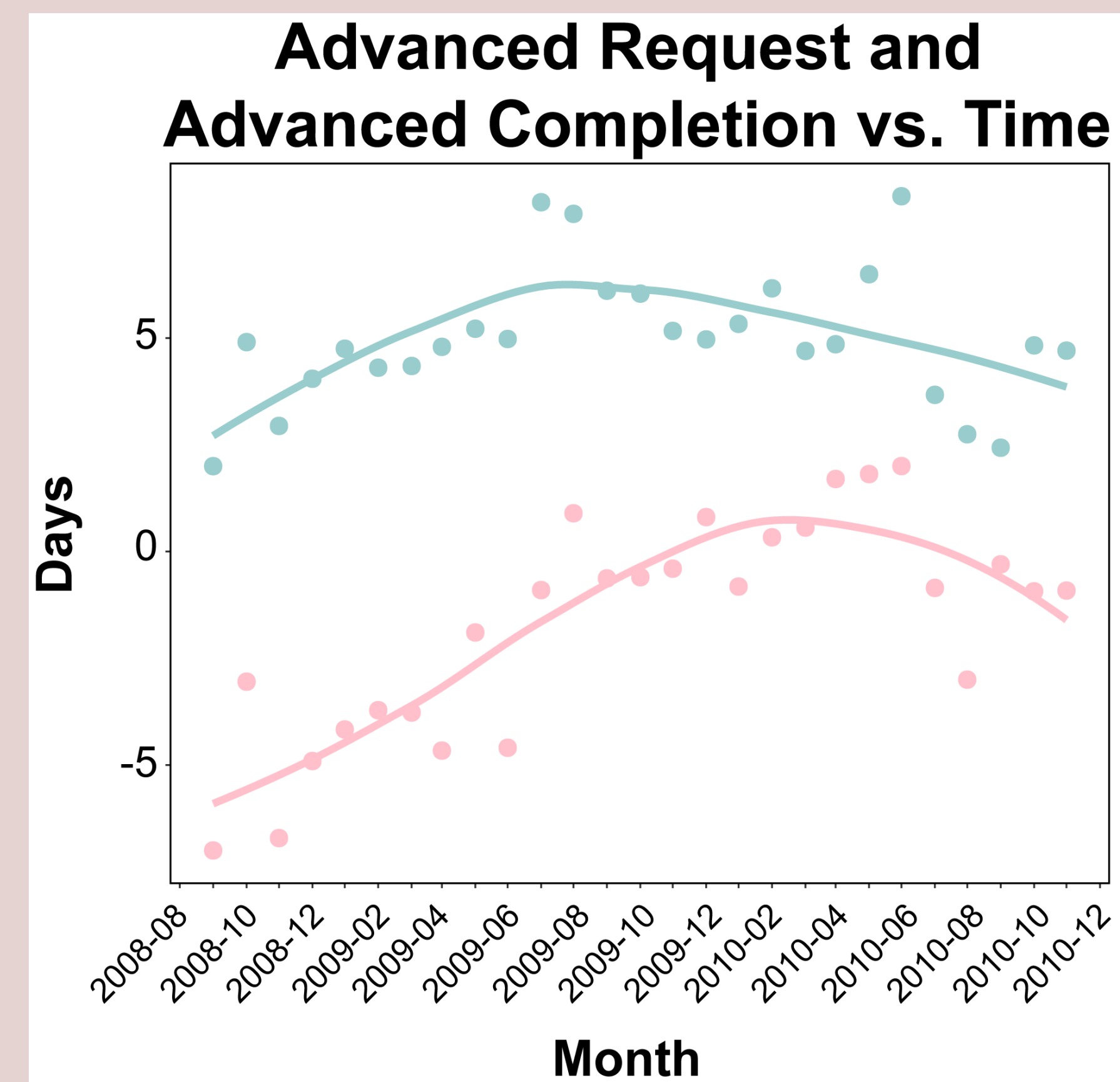


Figure 3: Average advanced request of scaffold per month (Date Requested – Date Completed, blue line) and average advanced completion per month (Date Completed – Date Requested, pink line)

- Graphs were used to reveal the relationship between certain factors (listed in figure 6) with total manhour values. (Figure 4)

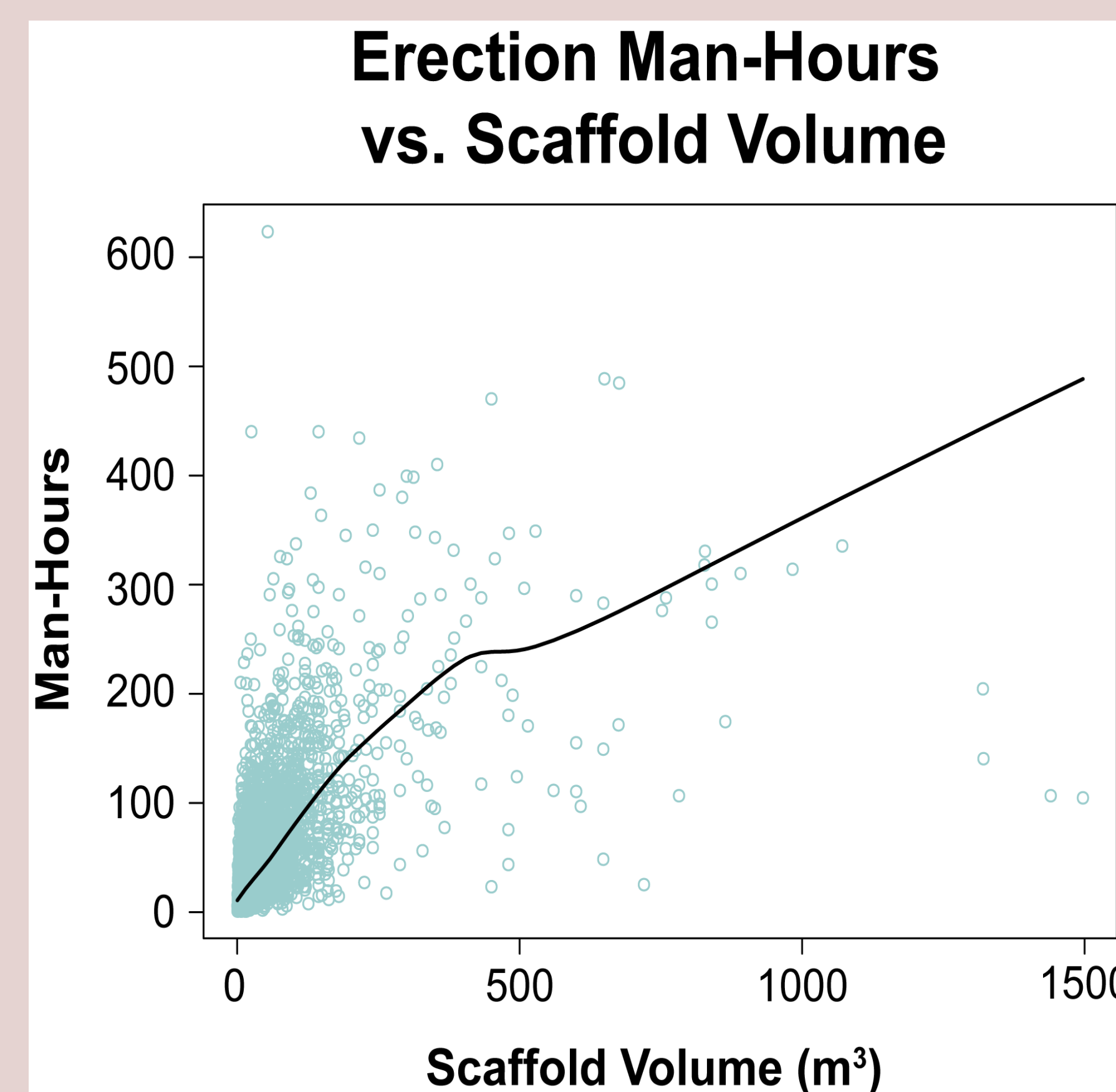


Figure 4: Total manhours to construct the scaffolding compared to the scaffold's volume, trend shown as specific points and as a general trend

### Modelling

- Two models were created using factors that showed high correlation with total manhours (in the data exploration phase):

Model	Average Residual Error
1. Linear Regression (fits a linear equation to data)	30 hours
2. Random Forest (multiple decision trees)	26.5 hours

- The second model's performance is better than the linear model (Figure 5). When model predictions are compared to actual values, the closer the points are to the 45° line, the more accurate the model.

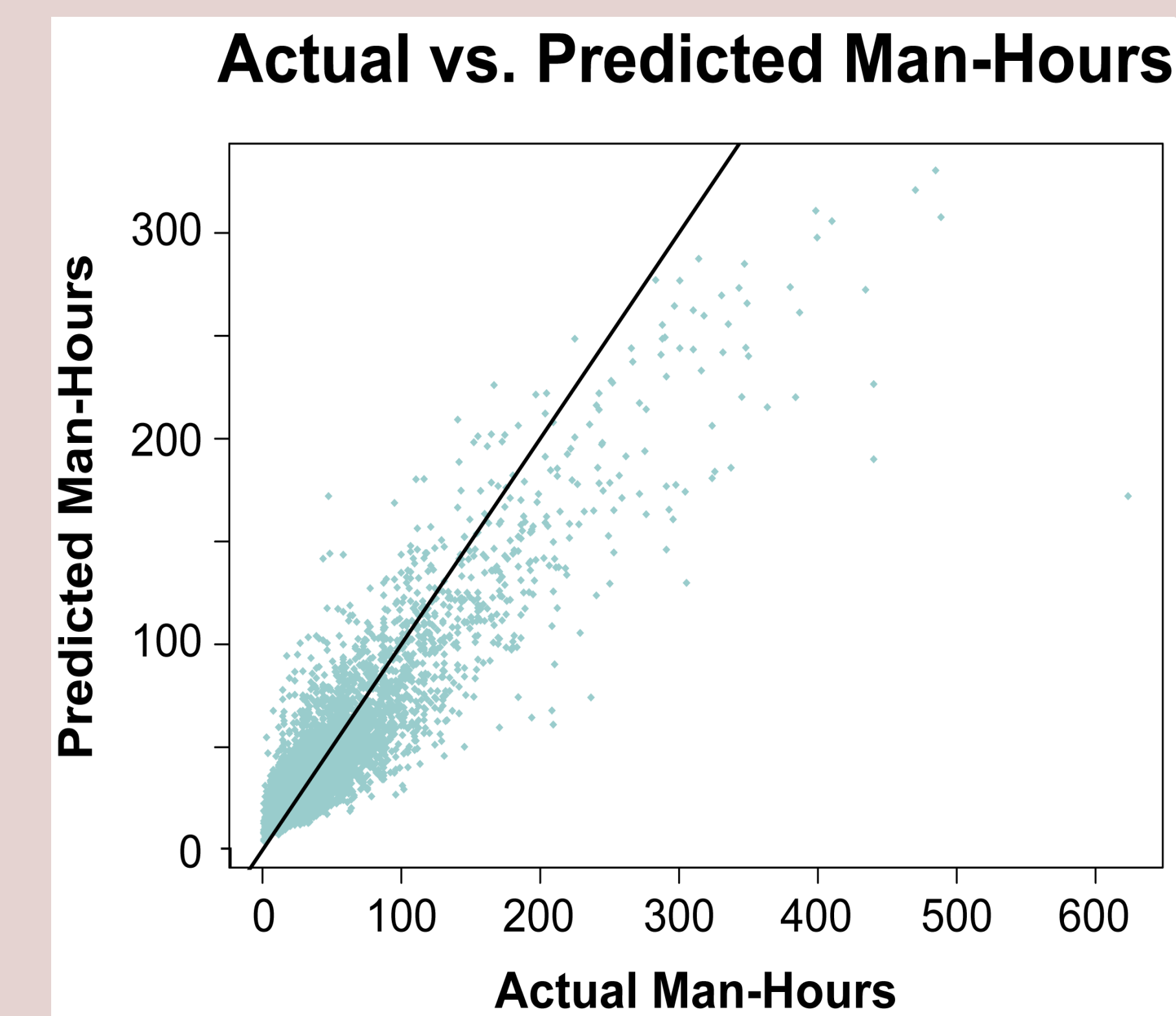


Figure 5: Predicted values compared to actual values of model 2, plotted on 45° line

- The variables used in the random forest model are ranked by importance (Figure 6).

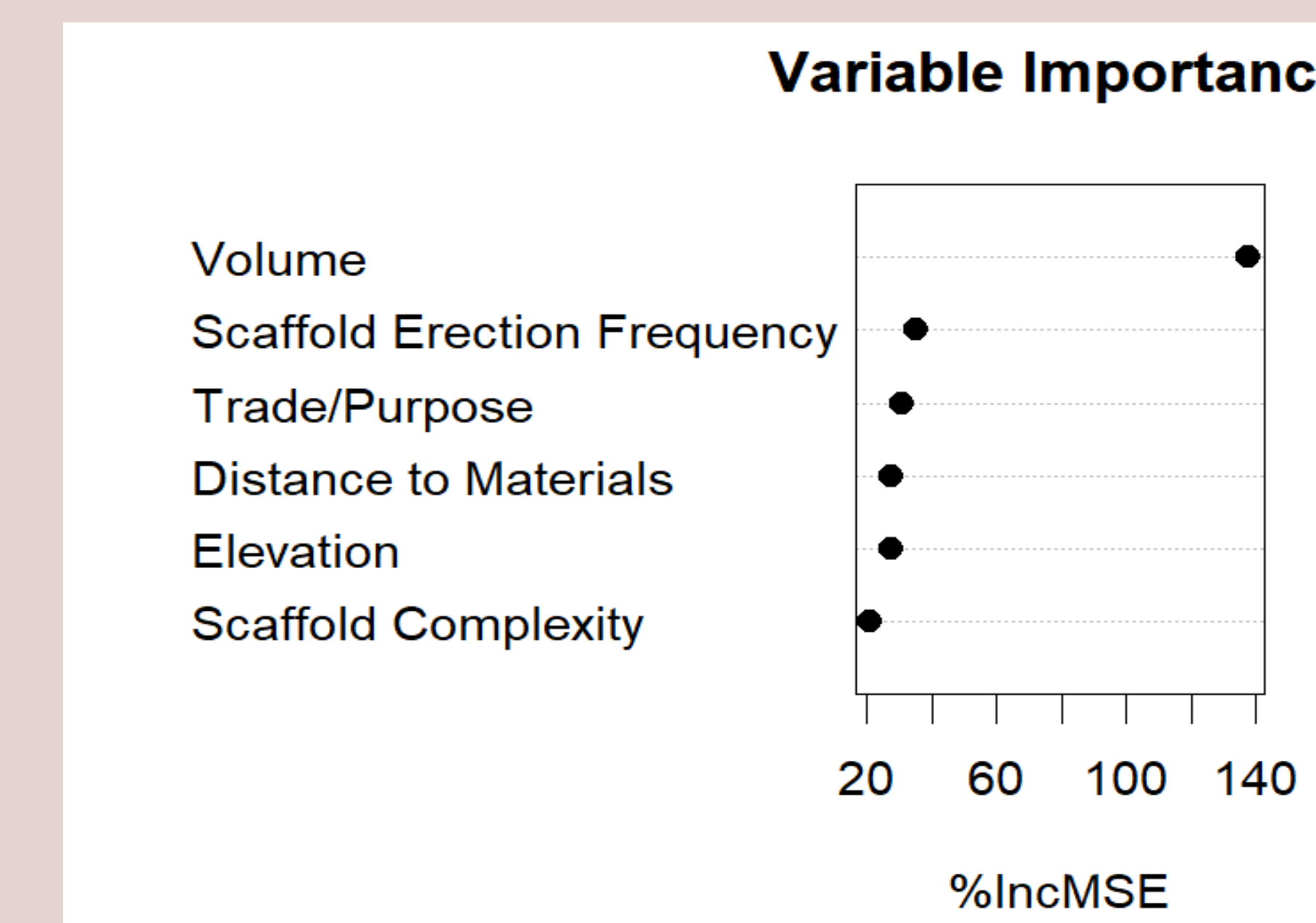


Figure 6: Variables in random forest model

## Conclusions

- The current method of scheduling scaffold construction is inefficient.
- Factors related to labor requirements were identified, and may improve the planning of scaffold construction.
- A predictive model was created to be used by an estimator to improve accuracy and ease of labor estimates.
- The model had a large margin of error due to data limitations, possible improvements to be made are:
  - Training the model with a better database (less human error) and more data
  - Recording factors, such as the season or the scaffold type, to be included in the model

## Acknowledgements

- Thank you to Dr. Simaan Abourizk and WISEST for giving me this opportunity, and to Lingzi Wu for guiding me through this project.
- Thank you to my sponsors, SPECEF and Canada Summer Jobs, for the support.

## Citations

- [1] Desai, Jaydeep & Pitroda, Dr. Jayeshkumar & Bhavsar, Jaydev. (2014). Scaffolding: Safety and Economical Aspect For Scaffoldings in Construction Industry.
- [2] Wu, Lingzi. (2013). Analyzing Scaffolding Needs for Industrial Construction Sites Using Historical Data.