

ARTIFICIAL INTELLIGENCE (AI) BASED TOOL TO ESTIMATE CONTRACT TIME

Project URL:

https://www.mdt.mt.gov/research/projects/const/ai_based_contracting_tool.aspx

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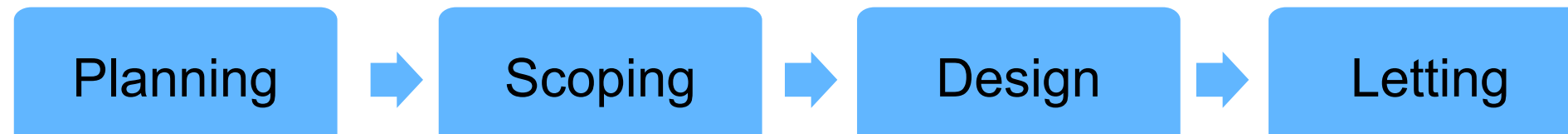
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Abstract

Pre-construction phases



Contract time determination

Before design: project time prediction based on pre-correlation between project variables

After design: project time prediction based on the pre-construction schedule using sequence logic templates

Methods

Regression analysis

Scheduling techniques

- ✓ Time estimation when limited information is available
- ✓ Fast and quick
- ✓ No skill required
- ✓ Can be used to evaluate project duration obtained from scheduling
- ✓ New AI techniques allow more accurate predictions

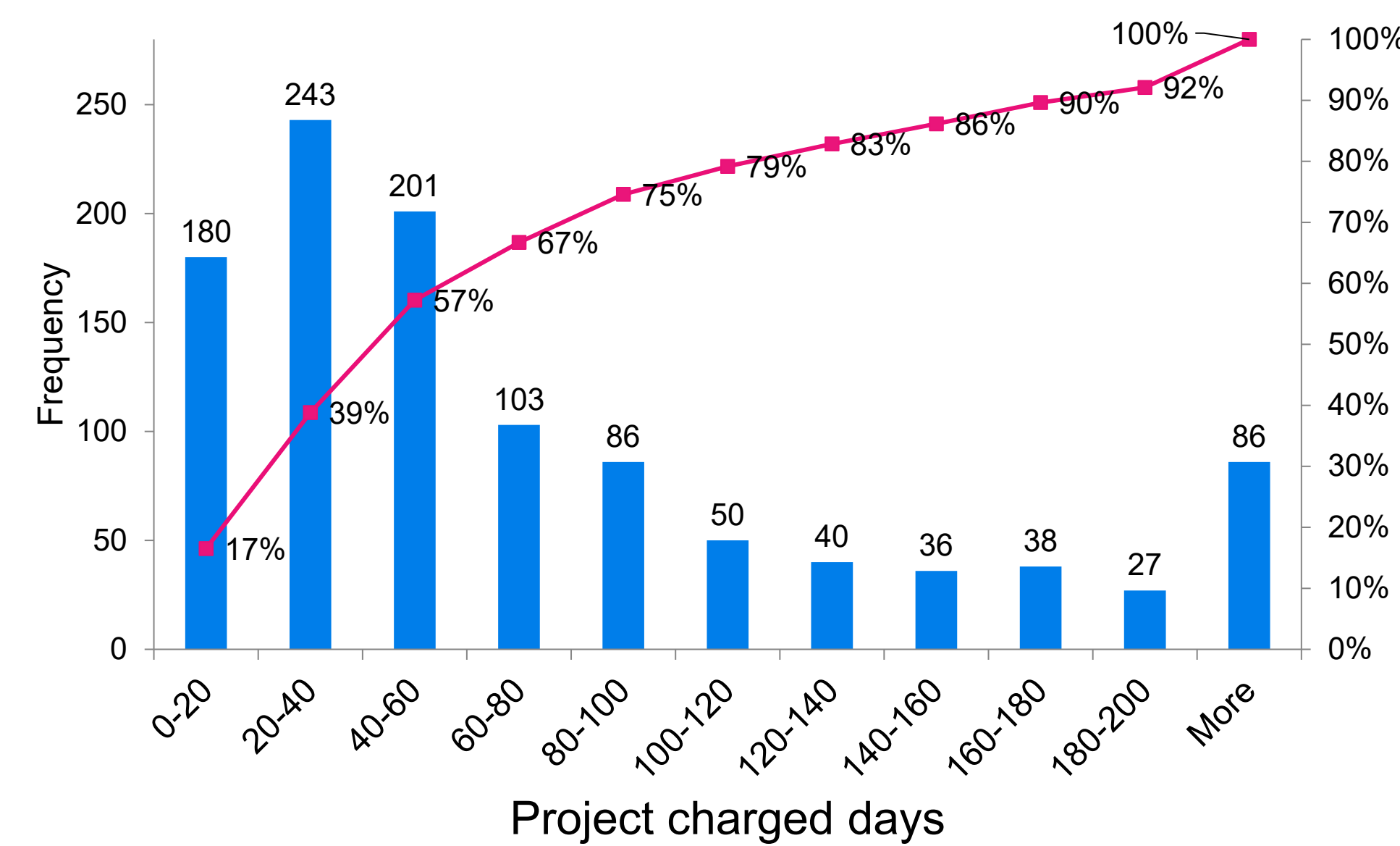
Project objectives

- Obtain and analyze historical project data
- Identify the most influential factors that affect the duration of highway projects
- Develop an AI-based project duration estimation model and validate the results
- Develop an MS Excel-based tool that provides a user-friendly interface for using the AI model

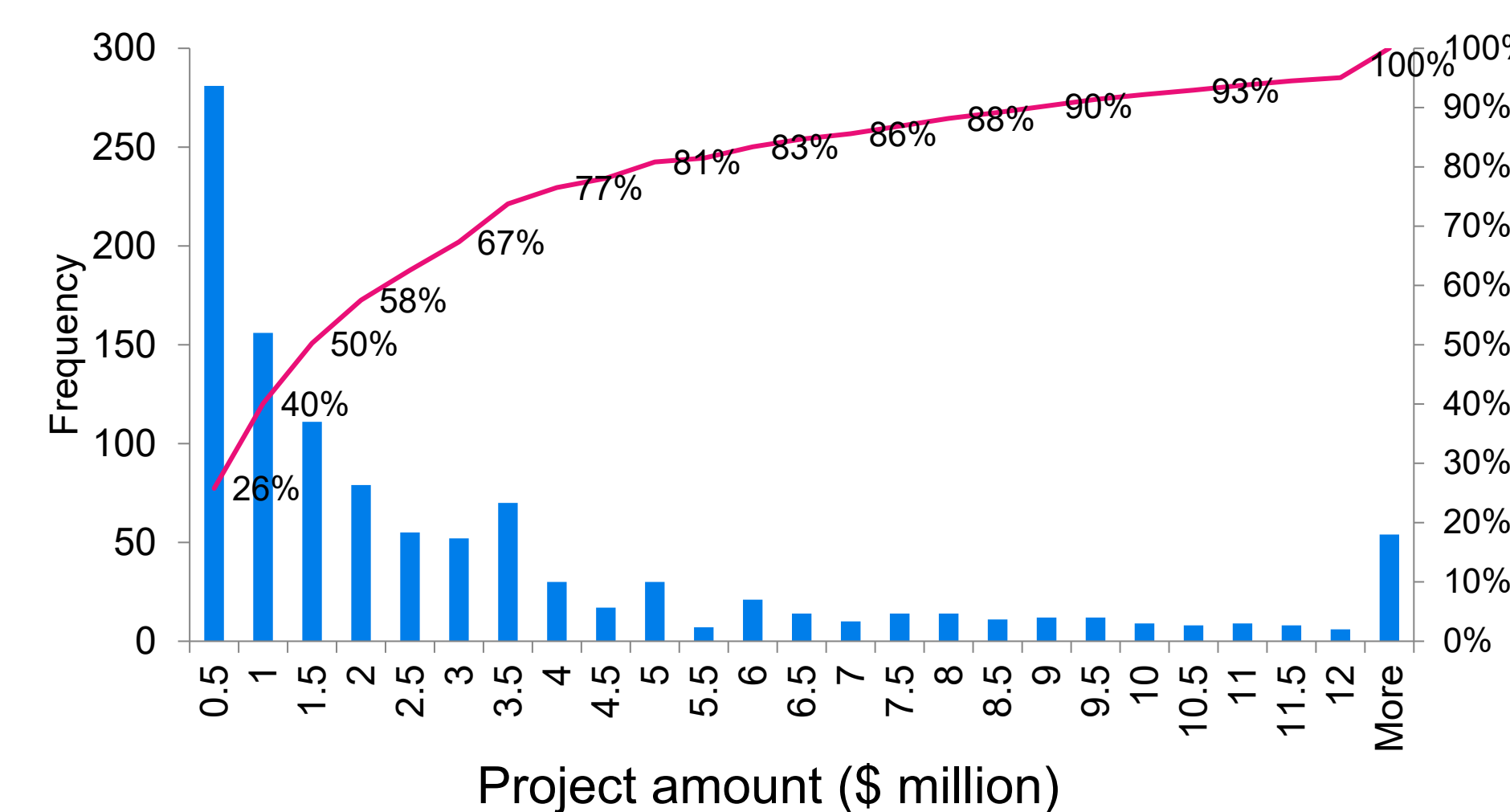
Historical projects data

- Historical bid data of 1,090 highway projects of MDT
- Data from 2008 to 2019
- Data attributes: project number, location (urban/rural), bid price, bid duration, adjusted cost, charged days, work type, letting date, and bid item (work item) title and quantities
- 24 project work types
- Bid items are converted to controlling work items (total of 32 items)

Historical projects description

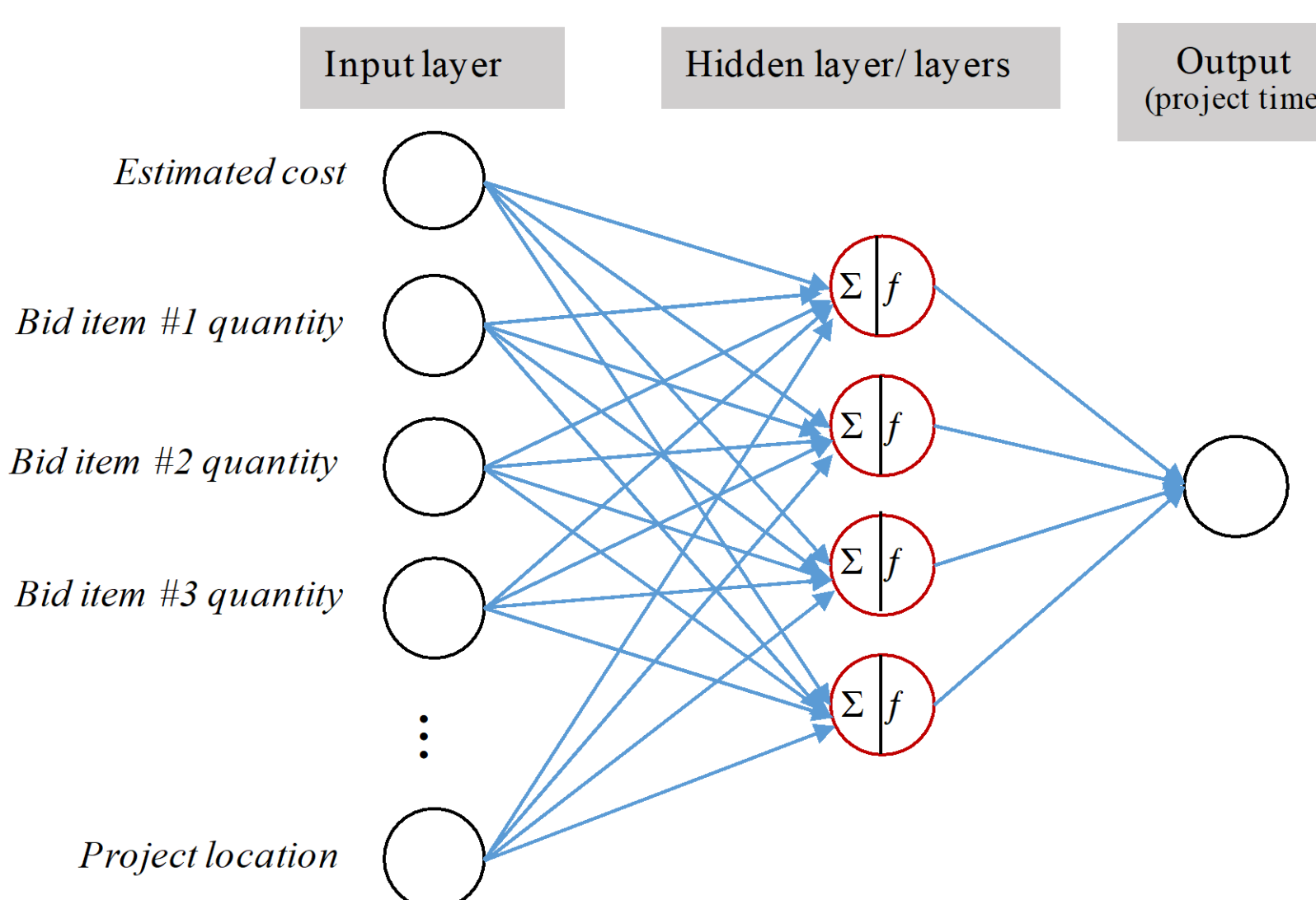


- Histogram of actual project durations per working days
- 75% of projects took less than 100 working days
- Most MDT projects take less than a year to complete



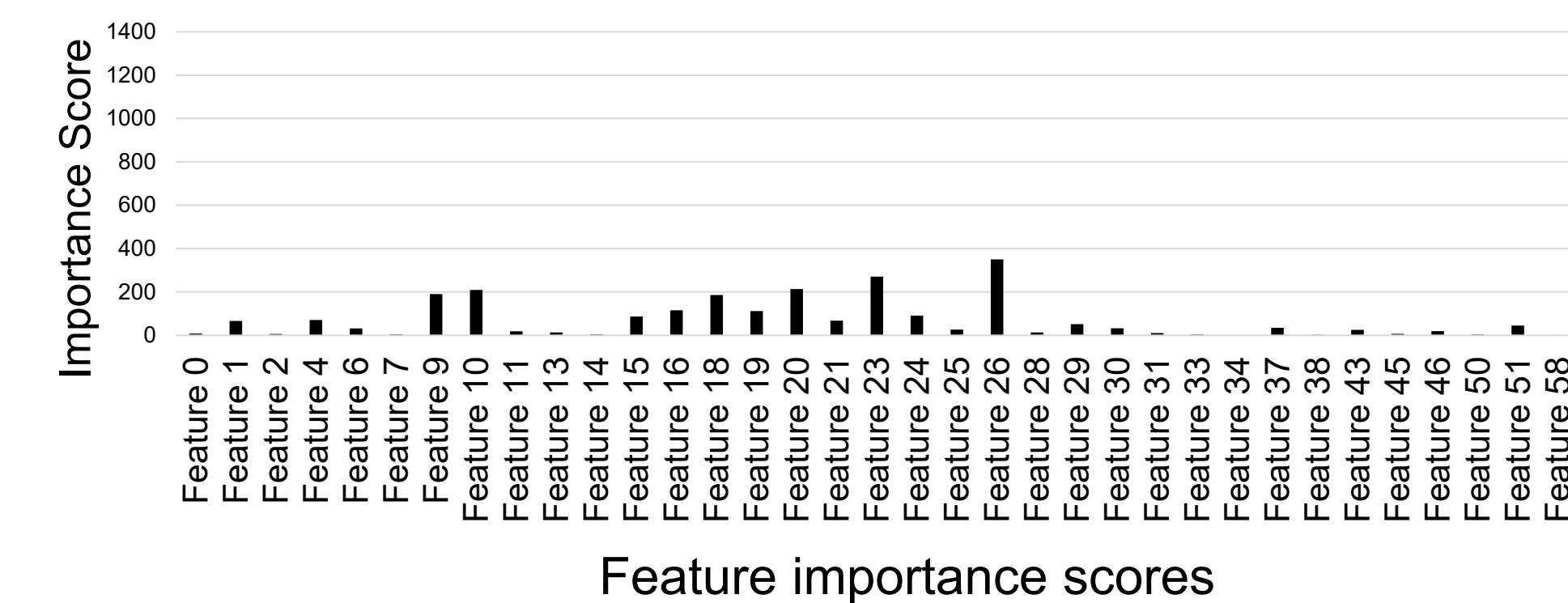
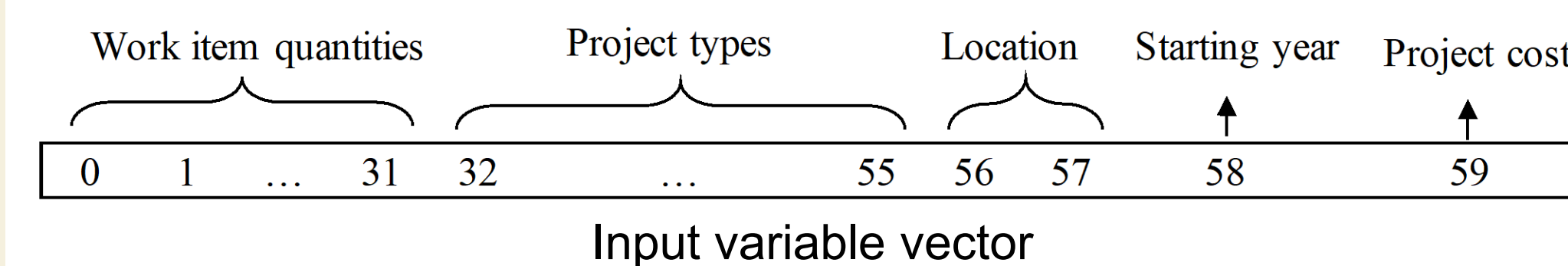
- Project costs are adjusted to the base year of 2018 using the National Highway Construction Cost Index
- 77% of costs are lower than \$4.5 indicating that small-size projects are very common in the MDT

AI model development



- The Artificial Neural Network (ANN) model takes project characteristics and passes them through hidden layers to predict the project time as the output

Feature selection



- F-test was conducted to obtain feature importance scores
- **Important features:**
 - Project cost (engineer's estimate) and the quantity of some controlling work items

- A linear regression model is developed to be compared to the ANN model
- Mean Squared Error (MSE) and R-squared are used to compare models

Model	MSE	R-squared
ANN	0.0022	0.72
Linear Regression	0.0034	0.75

- Higher performance of the ANN model
- No significant difference, keeping both models

Excel tool overview

Project time estimation using the Excel tool

Yellow cells are input variables must be entered by the user including the engineer's estimate and the quantity of major controlling work items

The output section provides the project time estimation using two methods

Project characteristics	Case1	Case2	Case3
Project number	9617133000	9149077000	8085164000
Project ID	IM 90-91(13)528	TA 411771	BRIDGE CONSTRUCTION/RE
Project type	MISCELLANEOUS	BIKE AND PEDESTRIAN	CASCADE COUNTY
Project location	Bighorn County	Ravalli County	
Project begin year	2019	2019	2019
Engineer's estimate (\$)	\$	2,682,663	\$
Project time (working days)	75	162	519,287
Resource	MDT website	MDT website	MDT website
Activity quantities			
Deck Grooving	0	0	0
Embankment in Place	0	0	31.56
Piling	0	0	0
Guardrail	0	0	5
Curb and Gutter	0	0	0
Commercial Mix	398	0	1006.23
Plant Mix Surfacing	0	0	0
Mobilization	1	1	1
Milling and Pulverizing	0	0	6322.2
Crushed Aggregate Course	540.15	30.5	540.15
Reinforcing Steel	0	0	30444
Excavation-unclassified	0	507.9	0
Cover	5188.7	0	7441
Riprap	0	0	59704
Traffic control	19916	1	295704
Bridge Deck	0	0	0
Signs	0	0	360
Seeding	2.9	0	0
Asphalt Cement	0	0	0
Drainage Pipe (< 24 in)	0	0	0
Special Borrow	0	0	0
Sidewalk	0	1231	0
Drainage Pipe (> 24 in)	0	0	0
Rumble Strips	10.44	0	0
Emulsified Asphalt	10.44	0	0

Sample projects are provided as examples to estimate project time and compare it to the actual project time

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