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Early Stage Construction Cost Prediction in Function of Project Sustainability

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1 Introduction, Research Goal and Research Hypothesys

In the construction practice, the contracted construction cost overrun is a very common occurrence (Le-Hoai *et. al.*, 2008, Žujo *et al.*, 2010, Mlađen, 2017). The goal is to avoid or minimize cost overruns by accurately estimating costs during project preparation. Scientific knowledge (Žujo *et al.*, 2010, Petrusheva *et al.*, 2019) and experience show that the successful cost estimation requires registering data on constructed structures and application of multiple assessment methods.

This research aims to analyze the relationship between the realized and contracted costs for building construction. The thesis is that the real value of the works most often exceeds the contracted value. There is a dependence between these values, which can be mathematically determined with satisfactory accuracy. The set research hypothesis will be tested by applying linear regression and neural networks on data on constructed or reconstructed structures and by comparing the model accuracy. The goal is to identify the model that provides the most accurate cost estimate and implementation guidelines.

2 Research Methods, Data Processing and Discussion

Data on contracted and realized prices of public and private 24 building construction structures built in the period from 2006 to 2017 in the Republic of Croatia have been used (Mlađen, 2017). The average overrun of the realized project values is 12.15%. The standard deviation is 11.87%. Predictive Modelling Software DTREG (Sherrod, 2014) is used for data processing.

In this research, the target variable is the value of the real construction cost C_R, and the predictor is the value of the planned and contracted construction costs C_C. Mathematical procedure includes the application of linear regression, General Regression Neural Network (GRNN), Radial Basis Function (RBF) and Support Vector Machine (SVM) and that using in the first phase original data and in the second phase natural logarithms of these data. After three iterations in the first phase, the three-neuron RBF network gave the best result of 10.976% for MAPE considering validation data.

Following the time-cost model, the following model is assumed:

$$C_R = E \times C_C^F \tag{1}$$

$E =$ model parameter that shows the average real price for monetary value construction
$F =$ model parameter that shows real cost dependence of contracted cost changes

Logarithmizing the previous model the regression function is obtained:

$$lnC_R = 0,07 + 1,03367lnC_C \tag{2}$$

The value of t Statistic is 62.64 with a probability of p (t) <0.00001. By applying the SVM model to logarithmic values, the lowest model error value is obtained. MAPE is 6.469 % for validation data (Table 1.).

Table 1. Results for linear regression and neural networks for logharitmized data.

Parameter	LR	GRNN	SVM	RBF
R^2	0.993	0.962	0.995	0.693
R	0.997	0.985	0.997	0.839
MAPE /%/	11.816	12.291	6.469	23.810

Compared to the lowest MAPE obtained by processing the original data, this one is lower by 4.507%. It means that by applying linear regression and neural networks to the values of the natural logarithms of the variables, it was found that more accurate results can be obtained compared to models with original data. Despite the small database, the obtained insight could be relevant to solving the real cost prediction problem when working with larger databases. The results should also be investigated for civil engineering databases.

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