This doctoral research presents the development of a new evolutionary algorithm for optimization, named “Electimize”, and its application in construction engineering. Electimize is based on the simulation of the electric current flow through conductors. The main motive in this research is to provide the construction industry with a robust optimization tool that overcomes the limitations of other existing evolutionary algorithms.

The main objectives of this research are to 1) develop an optimization methodology that is capable of evaluating the quality of decision variable values in the solution string independently; 2) devise internal optimization mechanisms that would enable the algorithm to extensively search the solution space and avoid its convergence toward local optima; and 3) provide the construction industry with a reliable optimization tool that is capable of solving different classes of NP-hard optimization problems.

The capabilities of the developed algorithm were tested and validated on a multitude of NP-hard optimization problems. The results showed that Electimize possesses high optimization capabilities, including 1) finding the optimal solution for NP-hard optimization problems; 2) identifying alternative optimal solutions for multimodal problems; 3) enabling a high convergence rate towards the optimal solution(s); and 4) outperforming other EAs with respect to the quality of generated solution(s). The developed algorithm should prove exceedingly useful to decision makers and construction planners seeking help with regard to making optimal decisions.