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Towards energy sustainability and cost reduction of water supply systems through operational optimization methodologies: a comparative study of problem formulations

Marlene Brás*, António Andrade-Campos† and Ana Moura+

*Department of Economics, Management, Industrial Engineering and Tourism
University of Aveiro, Portugal
E-mail: marlenegomes@ua.pt

†Department of Mechanical Engineering, Centre for Mechanical Technology and Automation
University of Aveiro, Portugal
E-mail: gilac@ua.pt

+Department Economics, Management, Industrial Engineering and Tourism
GOVCOPP – Systems for Decision Support Research Group
University of Aveiro, Portugal
E-mail: ana.moura@ua.pt

ABSTRACT

The cost of a water supply system includes capital costs and costs associated with its daily activities, i.e., treatment, pumping, storage, and distribution. Power consumption for pumping of drinking water represents the major fraction of the total operation cost in conventional water supply systems (WSS) [1].

Over the years, there has been much research into the pump scheduling optimization of water transmission systems due to the high demand for saving energy [2]. The methods used range from the application of mathematical modeling methods to heuristic methods. The first methods have been studied using several techniques such as linear programming, dynamic programming, and nonlinear programming. In the optimization of WSS problems, the efficiency of the operation control is directly related to its mathematical formulation, existing several formulation approaches present in the literature, being the most efficient approach still an open question.

When solving real-world problems, problem formulation becomes more complex, as the number and type of decision variables and objectives is generally larger and, the selection and numerical specification of the most appropriate decision variables, constraints, and objectives become more difficult [3]. This work aims to present a comparative study of the efficiency of WSS problem formulations existing in the literature. For such, several formulations presented and published in reference studies are implemented, and a comparative study of their effectiveness is made using WSS benchmark problem instances, as a case-studies.

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