



FACULTY OF ENGINEERING

DEPARTMENT OF WATER RESOURCES AND MINING ENGINEERING.

**A DECISION SUPPORT TOOLBOX FOR OPTIMAL DESIGN
OF WATER SUPPLY SYSTEMS.**

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partial fulfilment of the requirement for the award of the bachelor of science in water
resources engineering of Busitema University.*

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ABSTRACT

This study focused on intermittent water supply, where customers receive water for less than 24 hours a day or only a few days a week commonly caused by the errors in the design process such as over-sizing or under-sizing of pipes, pumps and tanks which result from the subjective nature of traditional design methods that are complex and rely heavily on the designer's experience. The study aimed to develop a toolbox that enables Water Supply System Designers to achieve optimal design and perform automated financial analysis of water supply systems. The toolbox consists of an automated financial analysis tool, an optimal transmission network design tool, and an optimal distribution network design tool, all intended to enhance efficiency, accuracy, and decision-making during the design phase. The financial analysis was conducted by costing the sized transmission and distribution networks, using detailed cost estimates for equipment, installation, and operational expenses. Optimization was performed using Genetic Algorithms (GA) to ensure optimal sizing of pipes, pumps, and tanks in both transmission and distribution networks. The toolbox was validated through hydraulic simulations in EPANET Matlab Toolkit and tested on real-world case studies to assess its performance in comparison to traditional design methods. The toolbox successfully generated detailed cost estimates for system components, including transmission and distribution networks. Key financial metrics, such as Net Present Value (NPV) and Design Present Cost (DPC) were also obtained. The optimal transmission design tool was able to design a pump head and flow. Pipe diameters of 250mm, 160mm and 140mm were obtained for the distribution main. Results from the case studies showed that the automated financial analysis tool produced results quickly and efficiently, significantly reducing the time required for cost evaluations compared to manual methods. The optimization reduced over-sizing by leading to a reduction in lifecycle costs through improved design and reduced operational expenses. Additionally, the optimized designs enhanced hydraulic performance, improving water pressure and distribution, thus contributing to a more reliable and sustainable water supply system.

Key words: Optimization, Algorithms, Intermittent, Automated

DECLARATION

I the undersigned, declare that this research proposal is my original work except where due acknowledgement has been made. I declare that this work has never been submitted to this university or any other institute for funding/ for partial fulfillment for any award.

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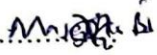
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APPROVAL

This final year project report has been submitted as a partial fulfillment for the award of Bachelor degree of science and water resources engineering of Busitema University, with my approval as the academic supervisor.

SUPERVISOR

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We extend our sincere gratitude to the Almighty GOD who has given us life and has enabled us to reach this academic height.

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DEDICATION

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List of Abbreviations

IWS	Intermittent Water Supply
IWSS	Intermittent Water Supply Systems
WSS	Water Supply System
SA	Simulated Annealing
SCE	Shuffled Complex Evolution
NPV	Net Present Value
DPC	Dynamic Prime Cost
IRR	Internal Rate of Return
DP	Dynamic Programming
LP	Linear Programming
PDA	Pressure Driven Analysis
COS	Cost of Service
CSI	Customer Service Inspection
EST	Elevated Storage Tank
GST	Ground Storage Tank
PWS	Public Water System
SWP	Source Water Protection
WDN	Water Distribution Network
NRW	Non-Revenue Water
NWSC	National Water Sewage Cooperation
GA	Genetic Algorithm
ASV	Average Supply Ratio
PSO	Particle Swarm Optimization

ACOAs	Ant colony optimization algorithms
DN	Distribution Network
TN	Trunk Network
WRA	Water Resources Assessment
ANNs	Artificial Neural Networks
ARIMA	Autoregressive Integrated Moving Average
FGA	Fuzzy Genetic Algorithm