EFFECTIVENESS OF IT APPLICATIONS ON CONSUMER COMPLAINT FOR IMPROVEMENT OF WATER SUPPLY: A CASE STUDY WITH CLUSTER ANALYSIS

G.D.P Fernando [1], P.K.C De Silva [1, *]

[1] Department of Civil Engineering, University of Moratuwa, Moratuwa

One of the most significant concerns of humankind has been the provision of adequate quantities and quality of water. Unfortunately, modern water distribution networks are complex and challenging to manage due to increased levels of urbanisation, varying consumer demands, and limited resources. Therefore, authorities must make critical decisions to solve problems associated with different phases and time frames of water distribution networks. Most of the management issues are challenging to solve using conventional problem-solving techniques. One of the versatile approaches for solving these management problems is to use customer complaints to develop optimisation techniques. National Water Supply & Drainage Board (NWSDB) receives various complaints about their services. This thesis presents a case study on the Biyagama water supply scheme, focusing on analysing leakage occurrence in the pipeline network. The study utilised a dataset collected by the National Water Supply and Drainage Board (NWSDB) for three years. Aim is to investigate the factors influencing leak occurrence in the Biyagama water supply scheme and develop a comprehensive understanding of pipe network vulnerability, with the objective of informing targeted maintenance strategies and improving the overall reliability and efficiency of the water supply system. The primary objective was to investigate the factors influencing leakages in the network and develop a comprehensive understanding of pipe network vulnerability. The research employed the K-means algorithm, implemented using the Python programming language, to conduct a cluster analysis of the dataset. The analysis incorporated factors, including age, inner diameter, and hydraulic parameters, such as pressure and velocity, to identify patterns and correlations associated with leak occurrence. The cluster analysis results revealed that age physical characteristics and hydraulic parameters alone were insufficient to explain the variations in leak frequency among the clusters. To account for this, additional factors were considered, including pipe material, installation quality, maintenance practices, temperature, soil condition, traffic load and environmental conditions. Incorporating hydraulic parameters, such as pressure and velocity, provided valuable insights into the relationship between fluid dynamics and leak vulnerability. High fluid velocities also correlated with leak occurrence. The findings emphasise the complexity of pipe network vulnerability and highlight the importance of considering multiple factors in assessing leakage occurrence. By gaining a comprehensive understanding of the factors influencing leaks, stakeholders can develop targeted maintenance strategies and improve the overall reliability and efficiency of the water supply system. This research contributes to the field of water supply management by providing insights into the vulnerabilities of pipe networks and the factors influencing leak occurrence. The findings can inform decision-making processes for infrastructure maintenance and support the development of sustainable water management strategies.

Keywords: Water supply, Leakage occurrence, Cluster analysis, K-means algorithm, Pipe network vulnerability

[*] Correspondence: kasunds@uom.lk

Pipe ID	Inner Diameter(mm)	Age (Years)	Frequency (Leaks per 1 km)
3	83	12	5.49
4	83	12	4.06
5	58	12	38.64
10	198	12	1.66
12	102	12	6.55
23	58	12	12.83

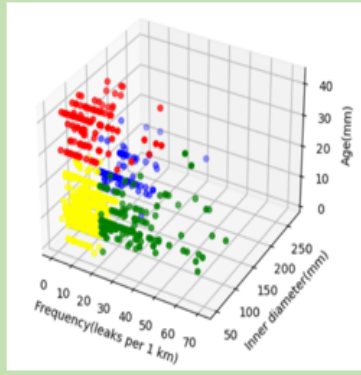
Sample of data

Pipe ID	Inner diameter(mm)	Age(years)	Frequency (Leaks per 1 km)	Cluster number
3	83	12	5.49	3
4	83	12	4.06	3
5	58	12	38.64	1
10	198	12	1.66	2
12	102	12	6.55	3

Clustered data

Cluster No	Cluster Size	Inner Diameter(mm)	Age (years)	Leakage Frequency (leaks per 1 km)
0	117	76.84	37.44	12.23
1	184	69.45	12.52	30.89
2	105	165.3	11.59	8.58
3	839	70.85	11.87	9.07

Mean values of factors for each cluster



3D scatter plot of clustered data

Indicates expected and unexpected results.

Incorporate hydraulic parameters.

Cluster No	Cluster Size	Inner Diameter (mm)	Age (years)	Leakage Frequency	Pressure (m)	Velocity (m/s)
0	117	76.84	37.44	12.23	43.43	0.249
1	184	69.45	12.52	30.89	42.87	0.479
2	105	165.3	11.59	8.58	42.27	0.189
3	839	70.85	11.87	9.07	39.55	0.195

Velocity act as a critical factor explains reasons for some of the unexpected results.

Conclusion

unexpected results challenge traditional assumptions and highlight the complexity of factors influencing leak occurrence in pipe networks. Further research and analysis are necessary to delve deeper into these unexpected findings and comprehensively understand the underlying mechanisms.