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Pipe Replacement Assessment prior to Leakage in Urban Areas Using Big Data Analytics

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Extended Abstract

A network of water distribution pipes (WDPs) is a crucial infrastructure of worldwide water supply organisation to serve safe water to their customers. Leakage in the distribution system is not only the economic issues but also the various perspectives such as an environmental topic, health and safety for people well-being and sustainability issue [1]. Nowadays, Metropolitan Waterworks Authority (MWA)'s water loss rate is approximately 29%. The majority of leakages result from the real loss caused by pipe leakage in the water distribution systems which most of the distribution pipe material is Polyvinyl chloride (PVC). Although PVC pipes possibly have a lifetime nearly 100 years, it can be decreased due to the usage throughout a service [2]. The maintenance report demonstrates that the average age of PVC pipe leak is roughly 13 years while the MWA's design period of PVC pipe is indicated to equal 30 years.

Due to the rapid urbanisation in MWA's responsibility areas, occurring leakage in urban areas is an important obstacle of the urban development, that is, it is difficult both in repairing and replacement of WDPs because MWA is not an authority of the area over the buried pipes. Additionally, it can be hazardous the other infrastructures such as a pedestrian, an adjacent shallow foundation and a public road. In addition to pipe repairing, pipe replacement is a final step of an effective solution not only to reduce the rate of water loss but also to improve pipe performance in long-terms. The criteria to select 28,484 km. of MWA's WDPs to replace a deteriorated pipe is a critical issue as a result of a large number of information to make a decision. Generally, the conventional approach to decide a pipe route replacement is the scoring approach that associated with pipe physical factors of each route depending on the evaluator's opinions.

Currently, Urban Informatics topic using to analyse the high complicatedness, variety and volume of data resulted from urban environments, strongly associate with big data [3]. Similarly, MWA intends to implement big data analytics approaches to reduce the water loss via pipe replacement of 1,000 km per year in urban areas that must have least disturbance on customers and do not affect the adjacent infrastructures. Consequently, the high accuracy of supportive information is necessary for arranging deteriorated pipe routes.

The aims of this study are to model an analytic prototype to assess WDPs prior to leakage, and to investigate main factors which are the cause of reducing pipes' lifetime. Advanced data analysis as called random forest and gradient boosting that is an ensemble learning methods and prediction, i.e. classification or regression technique, are implemented to compare the accuracy of model's results. To set up this prototype, 8 key features of the differently physical 3 branches from 18 branches were adopted to these developed algorithms such as the pipe length, pipe ages and the historical pipe leakage from Geographic Information System (GIS) as well as water pressures in each area from remote terminal unit (RTU). Furthermore, unordinary pipe leakages data that pipe ages less than 20 years are separated to be a test and train dataset as called split test to evaluate models. The results reveal the accuracy of 84.11% and 92.24% for random forest and gradient boosting techniques respectively while the frequency of pipe leakages is a significant factor. It can prove that these prototypes can predict the reliable information to assess pipe replacement. However, the cause that reducing pipe's lifetime is not clear in this study. Hence, it should be further investigated by more related factors such as soil properties, the construction quality and the transient pressure.

References

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