

A REVIEW PAPER ON DESIGN OF SOFTWARE BASED WATER DISTRIBUTION SYSTEM FOR A VILLAGE

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Abstract:-

Human life as all with plant life and animal life is totally dependent on water. Water is considered as a basic component of our life, not only we need water for proper metabolism and functioning of our body but also we need it for various purposes as growing food, power generation, to run industries. Hence, demand of potable water is increasing with corresponding increase in population that has lead to serious global issue, Water crises. This ever increasing water demand can be satisfied by designing efficient water distribution system based on advanced computing systems, hydraulic modeling and design softwares. India is a country in which 70% of the population lives in villages, this makes villages a focal point of various issues of global and national concern one of which is water scarcity. In present study the extensive review is carried out for water distribution system softwares that include public domain softwares like LOOP 4, EPANET 2.0 and JalTantra as well as commercial softwares like GIS also the study in selection of effective software to design a software based water distribution system for Ratnappa Kumbhar Nagar a area in Morewadi village, Kolhapur, Maharashtra. For this the paper is divided into two parts viz; review of water distribution softwares and selection of effective software for design of water distribution system for Ratnappa Kumbhar Nagar.

1. Introduction:-

Potable water is one of the fundamental requirements of all living creatures to carry out their day to day activities [5]. Design of water distribution system is a critical part in water supply system which contributes a major share of overall expenditures incurred proper systematic design and hydraulic modeling of an effective water distribution system [13]. Advancements in the field of water supply and the usage of computers in it has urged field experts, scientists, research scholars, developers and programmers to develop number of softwares for the design and modeling of water distribution networks including public domain softwares like EPANET, LOOP and JalTantra as well as commercial softwares like GIS, Water GEMS etc[13]. The present paper aims to carry out the review of available design softwares for water distribution system and selection of efficient software for designing water distribution system for Ratnappa Kumbhar Nagar, Kolhapur, Maharashtra.

The area selected for this project is Ratnappa Kumbhar Nagar (R.K Nagar), Kolhapur. The locality Ratnappa Kumbhar Nagar falls in Kolhapur district situated in Maharashtra State situated at a height of 563 meters above mean sea level and 16°65' North latitude and 74°24' East longitude. It comprises of seven sub-housing societies, consisting of 200-225 residential plots each and 20-30 commercial plots. It was founded in the year 1969 and is considered as Asia's largest housing society, the population of R.K Nagar area is around 9868. Presently this area is served by municipal water supply on alternate days which has lead to reliability of the people on bore water which may lead to problems like ground water depletion and health issues as kidney stone among the people living the locality.

1.1 Aim of study:-

1. To carry out the review of Water Distribution Network softwares.
2. Selection of effective design software for study area.

1.2 Objective of study:-

1. To carry out the review of Water Distribution Network softwares.
2. To study the water requirement of the area in context with living standards
3. Selection of effective design software for study area.

1.3 Study area:-

The area selected for this project is Ratnappa Kumbhar Nagar (R.K Nagar), Kolhapur. The locality Ratnappa Kumbhar Nagar falls in Kolhapur district situated in Maharashtra State situated at a height of 563 meters above mean sea level and 16°65' North latitude and 74°24' East longitude.



2. Review of Modeling Softwares:-

As we observe we come across the fact that there are different modeling softwares that are available in market of which some are public domain and some are commercial. These can be used for designing water distribution system for the area under consideration; some of those are classified below.

2.1) GIS

Many have characterized Geographic Information Systems (GIS) as one of the most powerful of all information technologies because it focuses on integrating knowledge from multiple sources and creates a crosscutting environment for collaboration. GIS is a system for the management, analysis, and display of geographic knowledge, which is represented using a series of information sets. GIS can be used to organize the data for usage in water distribution networks design, and analysis. In addition, GIS is used as a tool for number of created applications for network management; such as identifying valves to be closed in case of pipe break, service area for treatment plants, and network skeletonization. Finally, GIS is used to provide graphical display of results obtained from both hydraulic simulation, and optimization models; linking tabular data with geographic locations, and graphical drawing [9].

2.2) EPANET 2.0

EPANET 2.0 is a computer program that performs extended period simulation of hydraulic and water quality behavior within pressurized pipe networks. EPANET 2.0 tracks the flow of water in each pipe, the pressure at each node, the

height of water in each tank, and the concentration of a chemical species throughout the network during a simulation period comprised of multiple time steps. [5]

EPANET 2.0 is a public domain software package developed the United States Environmental Protection Agency's Water Supply and Water Resources Division. It provides variety of advantages like water quality analysis, extended period simulation, residual chlorine calculations for disinfection. It can also be used to restore and renovate existing water distribution system [10].

2.3) JalTantra

JalTantra is a web based system developed by Indian Institute of Bombay that aids these government engineers in sizing both pipe diameters and various other water network components such as tanks, pumps and valves. It uses integer linear program model which allows solving the problem optimally and quickly [12].

2.4) LOOP 4

Loop4 is a program that is developed of by the World Bank for simulation, design & optimization of looped water distribution networks. The program is free and is in the public domain. The code for loop was developed by Dr. Prasad Modak and Juzer Dhoodia in 1990. Loop software is a computer- aided planning and design of low cost water supply and waste water disposal systems in developing countries [7].

3. Literature Study:-

3.1.) A. N. Alkali, S. G. Yadima, B. Usman, U. A. Ibrahim and A. G. Lawan in their study they propose that Maiduguri Water Supply Scheme designed by its consultants in 1983 has divided the town into five water supply distribution zones. Zone 3 is one of three remaining zones in the city without a distribution network supplied from the Maiduguri water treatment plant. Consequently, residents obtain water from local water vendors, who retrieve the water from shallow boreholes which has proven to be tedious, cost ineffective and physically exhausting. A water supply network was proposed with the aid of EPANET software and the results obtained conformed to the design criteria established by the previous designers of the Scheme. A total water demand, projected for the year 2031 of 420LPS, minimum pressure head of 14.08m and maximum velocity of flow in the pipes of 1.24m/s was obtained. The use of EPANET software has proven to be time saving and its application is especially for the analysis of larger distribution networks is recommended.

3.2) Emengini, Ebele Josephine, Unigwe, Ozioma in their research paper titled "DEVELOPMENT OF A GIS-BASED SYSTEM FOR MANAGEMENT OF WATER DISTRIBUTION NETWORK OF ACHARA LAYOUT ENUGU, ENUGU STATE, NIGERIA" have identified inefficiencies in water distribution and management of water distribution facilities is commonly attributed to absence of a functional management system. This has been identified as a major issue facing water distribution agencies in Enugu State, Nigeria. Thus, there is need to develop a system that will help improve service delivery and facilitate infrastructural maintenance. This study applies Geographic Information System (GIS) in the management of water distribution network for Achara Layout Enugu, Nigeria. To execute this study, a number of datasets were used such as Achara layout design plan, map of existing water pipelines, the design plan and map of existing water pipelines. These datasets were obtained from the Ministry of Lands and Survey, Enugu State and Enugu State Water Cooperation. This study suggests the efficiency of the developed system in enhancing understanding and management of water distribution system.

3.3) Bhavana K. Ajudiya, Dr. S. M. Yadav, Prof. B.H.Pandit has published a paper "Water Distribution Network Design and Analysis": A Case Study. This paper concerns for the design of rural water distribution systems in developing countries. For designing of best economical water distribution system LOOP version 4 heuristic software is used with a case study. Design procedure satisfied all constraints with a minimum total cost. The constraints include residual nodal pressure, velocity of flow in pipe, pipe material, reservoir level, peak factor and available commercial pipe diameters. In investigation, it is found that water distribution network cost occupied almost 70% of the total cost of water supply system. Extensive research has been done to minimize cost through optimization in design of water distribution network. In addition to the simulation tool, optimization

techniques to identify the least cost design of distribution systems, while achieving the most equitable distribution of water have been developed.

3.4) Nikhil Hooda, Om Damani discussed the classic problem of the capital cost optimization of branched piped networks consists of choosing pipe diameters for each pipe in the network from a discrete set of commercially available pipe diameters. Each pipe in the network can consist of multiple segments of differing diameters. Water networks also consist of intermediate tanks that act as buffers between incoming flow from the primary source and the outgoing flow to the demand nodes. In this work, the authors motivate why the choice of tank configuration is important to the design of a network and describe an Integer Linear Program (ILP) model that integrates the same to the standard pipe diameter selection problem. To aid the designers of piped water networks, the improved cost optimization formulation is incorporated in our existing network design system called JalTantra.

3.5) Dr. H. Ramesh, L. Santhosh and C. J. Jagadeesh have worked on Simulation of Hydraulic Parameters in Water Distribution Network Using EPANET and GIS. For this they worked on generation of satellite based thematic layers, town and ward boundary maps and Geospatial Information System based census data and to estimate water demand, design of transmission lines and main pipe lines to meet the requirement of future demand. GIS has been used to integrate and estimate quantity of earth work to be excavated in terms of cutting and filling through Digital Elevation Model (DEM). The pipe network system is simulated to understand its behavior for different inputs using EPANET 2.0. In the present study, both single period and extended period simulation were carried out for distribution network system for one ward. Simulation has been carried out for hydraulic parameters such as head, pressure and flow rate. Here the results obtained from EPANET are crosschecked against hydraulic calculations and found correct.

3.6) A.N. Chavan, U.L. Deshpande has worked on Design of Optimized Water Distribution System for Jambhali, District-Satara, Maharashtra. The design is based on use of EPANET 2.0 and comprise of a cost-optimized system so as to make it economical for villagers and other stakeholders to bear the expenses of implementation. The design follows various guidelines laid by various Indian Standards created by Bureau of Indian Standards for maintaining the quality of process.

3.7) Arjun Kumar, Kankesh Kumar, Bharanidharan B, Neha Matial, Eshita Dey, Mahan Singh, Vivek Thakur, Sarit Sharma, Neeraj Malhotra carried out the work process on design of water supply system for an area named **KATHGARH** with the help of software “**EPANET**”. This design of the water supply scheme for proper supply of water is efficient to meet the daily requirement of water of the study area.

3.8) A.R.AYAD, H.A.AWAD, A.A.YASSIN thoroughly studied the use of GIS(GEOGRAPHIC INFORMATION SYSTEMS) in water distribution network. In the present study, GIS is used to organize the data for usage in water distribution networks design, and analysis. In addition, GIS is used as a tool for number of created applications for network management; such as identifying valves to be closed in case of pipe break, service area for treatment plants, and network skeletonization. Finally, GIS is used to provide graphical display of results obtained from both hydraulic simulation, and optimization models; linking tabular data with geographic locations, and graphical drawing.

3.9) Manoj Nallanathel, B. Ramesh, A P Santhosh thoroughly studied the existing water distribution system of SAVEETHA University and re-designed it with the help of EPANET software. Their work also included analysis of pressure for supplying water to the consumers, hence, there was no shortage of water and excess water was stored in sumps and water tanks, which could be useful at peak hours.

3.10) Nitin P Sonaje, Mandar G Joshi carried out a review of various water distribution network softwares and studied their feasibility and applications. The study included various public domain and commercial softwares that concluded software feasibility, factors affecting choice of software.

3.11) Rushikesh Jagtap, Rakesh Gawali, Vinayak Kanade, Sanket carried out the work of design and analysis of water distribution system of ADYPU(Ajeenkya D Y Patil University Campus,Charholi,Pune with help of EPANET software. The study was focused on detailed analysis of existing water distribution system of the study area and determining deficiencies (if any) along with pressure at all nodes and flows with their velocities at all links in the distribution network.

4. Research Methodology:-

4.1) Area/ Zone Selection:-

The area selected for study is decided after considering the water distribution problem i.e.; intermittent water supply. Ratnappa Kumbhar Nagar, Kolhapur is the study area.

4.2) Data Collection:-

Obtaining google image of the selected area, Water use survey, Current population, General layout map, current water supply details, existing water distribution layout map, Elevation of water distribution nodal points etc [15].

4.3) Data Analysis:-

Population forecasting of the area, Water quality tests of current water supply (tap water and ground water) [15].

4.4)Study of suitable software:-

The software available for designing water distribution system are studied to determine the suitable software.

4.5) Preparation of necessary maps

4.6) Designing a suitable water distribution system for 24x7 water supply.

5. Conclusions:-

5.1) The extensive review carried out for water distribution softwares brings us to the conclusion that there are several factors on which the selection of efficient water distribution network software depends such as, availability of resources, data and finance, applicability and compatibility of the design project.

5.2) For designing of Water Distribution Network(WDN) where accuracy is of prime importance freeware or public domain softwares can be adopted but where speedy and accurate designs are to be achieved, it becomes necessary to implement commercial softwares.

5.3) As study area selected is very small in area with less population where living standard is high thus here public domain softwares can be adopted.

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