Analysis of Pressure Drop in Clean Water Piping Installation Using Revit Software

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Abstract: Clean water piping systems in industrial facilities must be designed to ensure adequate residual pressure at all outlets while minimizing energy losses. One critical factor influencing system performance is pressure drop, which results from both friction in straight pipes and localized losses in fittings, valves, and other components. This study analyzes the pressure drop in the clean water distribution network of PT XYZ, Kendal Industrial Estate, using two approaches: manual calculation based on the Darcy–Weisbach equation with total loss coefficients, and simulation using Autodesk Revit's Pressure Loss Report tool. The manual calculation yielded a total pressure drop of 2.30 bar (≈ 23.0 mH_2O) along the critical path, with approximately 72% of the loss originating from fittings and 28% from pipe wall friction. The Revit simulation produced a total pressure drop of 2.10 bar (≈ 21.4 mH_2O) for the same route, resulting in a deviation of 8.7%, which is within the accepted tolerance of ±10% for BIM-based hydraulic validation. The results demonstrate that Revit can reliably model hydraulic performance when accurate material, dimension, and fixture data are provided. The findings emphasize that optimization strategies should focus on reducing localized losses by minimizing fittings, improving pipe routing, and increasing branch diameters in high-velocity sections. These measures can enhance residual pressure, improve system efficiency, and reduce pump energy requirements. The study validates the use of Autodesk Revit as an effective tool for preliminary hydraulic analysis in compliance with SNI 03-6481-2000, while confirming the importance of manual validation during the design process.

Keywords: Pressure drop, Revit, piping installation, residual pressure, technical simulation.

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Introduction

Clean water installation systems are a critical component of building infrastructure, particularly in industrial and commercial environments, where consistent and efficient water distribution is essential to meet operational demands (Ahyadi et al., 2021). One of the most common challenges in such systems is pressure drop along the distribution network. Excessive pressure drop can result in reduced water delivery, compromised user comfort, and increased energy consumption due to higher pumping requirements (Prasetyo et al., 2025; Fiorillo et al., 2024). Pressure drop in piping systems occurs primarily due to friction between the water and the inner pipe wall, turbulence caused by changes in flow direction, and head losses in fittings, valves, and other components. If not properly accounted for during the design stage, it can lead to suboptimal system performance and higher operational costs (Lilipaly et al., 2021; Abdulameer & Dzhumagulova, 2023). In industrial facilities, where multiple floors, long distribution distances, and numerous fittings are common, understanding and managing pressure drop becomes even more critical (Josey & Gong, 2023). Traditionally, hydraulic calculations for pressure drop have been carried out manually using equations such as the Darcy–Weisbach formula combined with minor loss coefficients for fittings. While these methods are well-established, they can be time-consuming and prone to human error, especially in complex multi-branch piping systems (Prasetyo et al., 2025; Fiorillo et al., 2024).

Recent advancements in Building Information Modeling (BIM) have introduced software tools like Autodesk Revit that enable engineers to model, simulate, and analyze piping systems more efficiently. By integrating 3D modeling with hydraulic analysis, Revit provides an opportunity to streamline the design process, detect potential problem areas, and optimize system performance before construction or renovation begins (Rofi et al., 2021; Atencio et al., 2022). However, despite the growing adoption of BIM in mechanical, electrical, and plumbing (MEP) engineering, studies on the accuracy and reliability of Revit's hydraulic simulation compared to conventional manual calculations—particularly in Indonesian industrial building contexts—remain limited . This creates a gap in knowledge regarding how well Revit can be relied upon for early-stage design decisions and compliance with local standards such as SNI 03-6481-2000 for plumbing systems (Lilipaly et al., 2021).

Therefore, this study aims to analyze the pressure drop in a clean water piping installation at an industrial facility in the Kendal Industrial Estate using Autodesk Revit, and to compare the results with manual hydraulic calculations. By evaluating the differences and identifying the most critical points in the system, this research provides practical insights for optimizing industrial plumbing design in Indonesia.

Research Method

This research employed a quantitative case study approach to analyze the pressure drop in a clean water piping installation system at PT XYZ, located in the Kendal Industrial Estate. The workflow consisted of several stages: data collection, system modeling, hydraulic simulation, and validation analysis. In the data collection stage, technical information was gathered from as-built plumbing drawings, schematic diagrams, and field measurements. Data included the routing and layout of the clean water pipes for each floor, pipe material specifications, diameters, lengths, and fitting details. The piping material was identified as PPR PN 10 with a roughness coefficient (ε) of 0.015 mm. Flow rate demands for each plumbing fixture were taken from SNI 03-6481-2000 (Badan Standardisasi Nasional, 2000) and pump specifications such as capacity, total head, and motor efficiency were also documented.

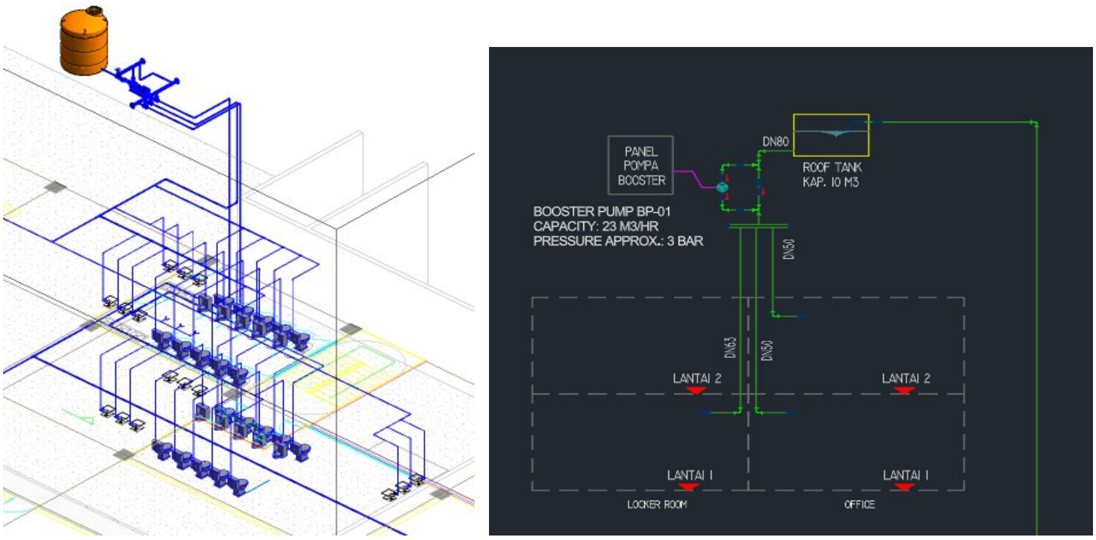

Figure 1 3D Isometric Model of Clean Water Piping System in Autodesk Revit and Schematic Diagram of Clean Water Distribution System with Booster Pump and Roof Tank

The system was then modeled in Autodesk Revit using a BIM workflow that integrates 3D visualization with hydraulic analysis. In Revit, the system classification was set to Domestic Cold Water, and water properties at 16 °C were applied: density (ρ) of 998.9 kg/m³ and dynamic viscosity of 0.001 Pa·s. Material properties were assigned to each pipe segment, and fixture flow rates were configured according to plumbing standards. Hydraulic simulation was performed using Revit's Pressure Loss Report tool to calculate friction losses, minor losses, elevation head, and residual pressure at the most distant fixture point. For comparison, manual calculations were conducted using the Darcy–Weisbach equation combined with the total loss coefficient method for fittings. The formula applied was:

$$\Delta_{P}\text{total} = \left(f \cdot \frac{L}{D} + ktotal\right) \cdot \frac{p.v^2}{2} : 100.000 \qquad (1)$$

where f is the friction factor obtained from the Colebrook–White equation, L is the pipe length, D is the internal diameter, K_{total} is the sum of loss coefficients for all fittings, ρ is the water density, and v is the average water velocity. The first term $f \cdot \frac{L}{D}$ represents major losses along straight pipes, while Ktotal accounts for minor losses due to fittings and directional change (Swamee & Jain, 1976). The term $\frac{p.v^2}{2}$ corresponds to the dynamic pressure of the flow, and the factor 1/100,000 converts the result into bar for engineering interpretation (White, 2011).

The calculated total pressure drop from the manual method was then compared to the Revit simulation results. The deviation between the two was expressed in both absolute (bar) and percentage terms, with ±10% set as the acceptable tolerance, in line with previous BIM validation studies. Additionally, the critical path—the sequence of pipe segments contributing the most to total pressure drop—was identified for further design optimization.

Result and Discussion

Manual Validation

Manual validation of the critical piping path was performed using the Darcy–Weisbach equation in combination with the total loss coefficient method. The calculation began by determining the dimensionless friction term, given by:

$$f \cdot \frac{L}{D} = 0.03 \cdot \frac{56.6}{0.04079} = 41.628$$

This term represents the contribution of major losses due to wall friction along the pipe's length. The next step was to calculate the dynamic pressure of the water flow:

$$\frac{p.v^2}{2} = \frac{1000.(1.75)^2}{2} = 1531.25\ Pa$$

This value reflects the kinetic energy per unit volume of the flowing fluid. The total dimensionless loss coefficient was then obtained by summing the friction term with the total fitting coefficient:

$$f \cdot \frac{L}{D} + ktotal = 41.628 + 108.6 = 150.228\ Pa$$

This combined coefficient accounts for both the distributed frictional resistance and the localized resistances from fittings, elbows, tees, and valves. Finally, the total pressure drop was calculated by multiplying the total coefficient by the dynamic pressure and converting from Pascals to bar:

$$\Delta_p \text{total} = 150.228 \text{ x } 1531.25 \text{ Pa} = 230.036 = 2.3 \text{ bar}$$

The resulting value corresponds to a total head loss of approximately 23.0 mH_2O. This result clearly indicates that localized losses from fittings contribute a significant portion of the total head loss, exceeding the losses from pipe wall friction. Such a finding highlights the importance of optimizing pipe routing and minimizing fittings in order to improve hydraulic efficiency (Noerbambang & Morinwa, 1999).

Revit Simulation

The hydraulic simulation was carried out in Autodesk Revit using the *Pressure Loss Report* feature to evaluate the pressure drop along the clean water piping system. The modeled system was classified as *Domestic Cold Water*, with water properties set at 16 °C, density 998.91 kg/m³, and dynamic viscosity 0.001 Pa·s. The pipe materials, diameters, and routing were modeled according to the as-built data, while flow rates for each fixture were assigned in accordance with SNI 8153:2015 (Badan Standardisasi Nasional, 2015).

In the simulation, Revit automatically computed both major losses (friction in straight pipe runs) and minor losses (fittings, valves, bends) using the Darcy–Weisbach formulation for distributed losses and K-values for localized losses. The program also incorporated elevation head and calculated the total pressure drop along each defined path in the network.

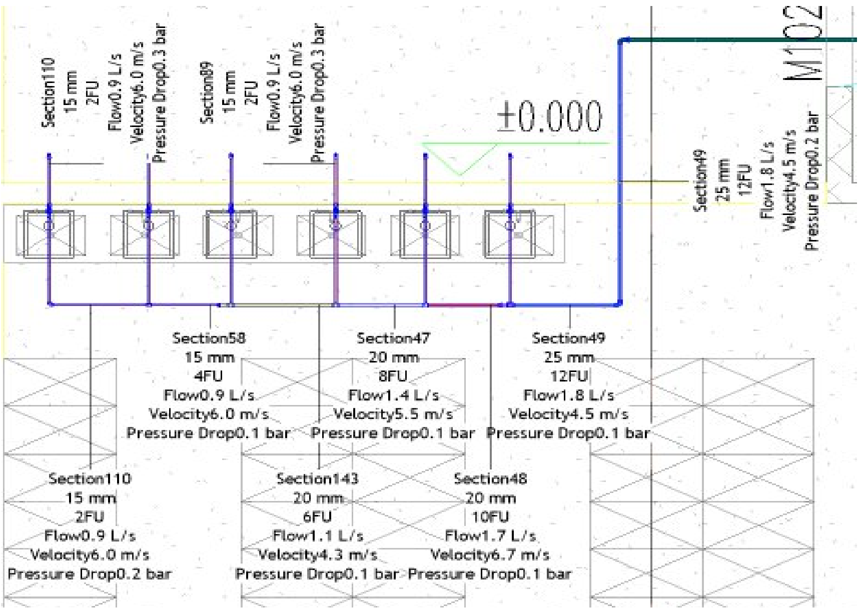

Figure 2 Simulation Results of Clean Water Piping System Pressure Drop Using Autodesk Revit

The output identified the critical path as the sequence from the main pump to the 1st Floor Toilet, which experienced the highest total pressure drop. For this path, the simulation yielded a total pressure drop of 2.10 bar (≈ 21.4 mH_2O). This value included: Friction losses from main and branch pipes, Minor losses from numerous elbows, tees, and valves along the route, Elevation head due to the vertical distance from pump to fixture.

The simulation also revealed sections with high local velocities, particularly in 15 mm diameter branches, where velocities reached up to 6.0 m/s, causing significant minor losses of up to 1.3 bar in a single branch. In contrast, larger distribution mains (40–50 mm diameter) maintained lower velocities (1.6–2.3 m/s) and proportionally smaller friction losses. Overall, the Revit model provided a detailed breakdown of losses per segment, enabling the identification of problem areas where high velocities and excessive fittings contribute to pressure drop. This information is valuable for evaluating design improvements such as increasing pipe diameters in high-velocity branches and optimizing pipe routing to reduce fittings before implementation.

Discussions

The results from both the manual calculation and the Autodesk Revit simulation exhibit a strong correlation, indicating consistency between analytical and software-based approaches for hydraulic analysis of the clean water piping system (Atencio et al., 2022; Ferreira et al., 2025). The manual calculation, based on the Darcy–Weisbach equation combined with total fitting loss coefficients, produced a total pressure drop of 2.30 bar (≈ 23.0 mH_2O) along the critical path from the main pump to the 1st Floor Toilet. In comparison, the Revit simulation calculated a total pressure drop of 2.10 bar (≈ 21.4 mH_2O) for the same route.

The absolute difference of 0.20 bar between the two methods corresponds to a relative deviation of approximately 8.7% (Atencio et al., 2022; Hapsari et al., 2021). This deviation is within the commonly accepted tolerance of ±10% for validating BIM-based hydraulic simulations against manual calculations (Rofi et al., 2021; Atencio et al., 2022). The small difference can be attributed to several factors: Software rounding and precision Revit calculates losses with predefined K-values and numerical precision that may differ slightly from the manual input assumptions. Fitting coefficient variations. The manual method uses fixed K-values from reference tables, while Revit's database may use different or more detailed values based on fitting geometry (Fiorillo et al. 2024). Flow path interpretation Revit determines critical paths automatically, which may include or exclude certain minor branches differently from manual assumptions (Syahputra et al., 2019).

Despite these differences, the trend in both results is identical, with the critical path consistently identified and the major contributor to pressure drop being minor losses from fittings rather than pipe friction. This observation underscores the importance of optimizing the pipe routing and reducing the number of fittings in high-velocity branches, as both methods indicate similar hydraulic behavior. The agreement between manual and Revit results confirms that Revit can be used reliably for early-stage hydraulic design analysis, provided that accurate material properties, pipe diameters, and fixture flow rates are input. However, manual validation remains essential for ensuring accuracy and identifying potential discrepancies in software assumptions, particularly in projects where compliance with local standards such as SNI 03-6481-2000 is required (Badan Standardisasi Nasional, 2015).

Conclusions

This study analyzed the pressure drop in the clean water piping system at PT XYZ using two approaches: manual calculation based on the Darcy–Weisbach equation with total loss coefficients, and hydraulic simulation using Autodesk Revit's Pressure Loss Report tool. The manual calculation determined a total pressure drop of 2.30 bar (≈ 23.0 mH_2O) along the critical path, with the majority of losses (≈ 72%) attributed to fittings and valves, and the remainder from pipe wall friction and elevation head. This result highlights the significant influence of localized losses on the overall hydraulic performance of the system. The Revit simulation identified the same critical path, yielding a total pressure drop of 2.10 bar (≈ 21.4 mH_2O). The absolute deviation between the two methods was 0.20 bar (≈ 8.7%), which falls within the commonly accepted ±10% tolerance for BIM-based hydraulic validation. This confirms that Revit, when provided with accurate material, dimension, and fixture data, can produce results consistent with established analytical methods. From a design perspective, the analysis indicates that the most effective strategies for improving system performance are reducing the number of fittings, optimizing pipe routing, and adjusting pipe diameters in high-velocity branches. These measures could lower total head loss, increase residual pressure at distant outlets, and reduce pump energy requirements. Overall, the findings validate the use of Autodesk Revit as a reliable tool for preliminary hydraulic design and analysis in compliance with local standards such as SNI 03-6481-2000, while reinforcing the importance of manual calculation as a verification method during the design process.

References

Ahyadi, H., Suprijatmono, D., & Alcholili, I. (2021). Analisis kinerja sistem distribusi air bersih di Anjungan Lepas Pantai PT. X. Presisi, 23(2), 73–84. Retrieved from http://ejournal.istn.ac.id/index.php/presisi/article/view/1045

Atencio, E., Araya, P., Oyarce, F., Herrera, R. F., Muñoz-La Rivera, F., & Lozano-Galant, F. (2022). Towards the integration and automation of the design process for domestic drinking-water and sewerage systems with BIM. Applied Sciences, 12(18), 9063. https://doi.org/10.3390/app12189063

Badan Standardisasi Nasional. (2000). SNI 03-6481-2000: Tata cara perencanaan sistem plambing. Jakarta: BSN.

Badan Standardisasi Nasional. (2011). *SNI 8153:2015 Sistem plambing pada bangunan gedung*. Jakarta: BSN.

Lilipaly, I. P., Badriani, R. E., & Dhokhikah, Y. (2021). Perencanaan sistem plambing dan hidran kebakaran pada proyek pembangunan Hotel Pesona Alam. Paduraksa: Jurnal Teknik Sipil Universitas Warmadewa, 10(2), 266–279. https://doi.org/10.22225/pd.10.2.2818.266-279

Noerbambang, S. M., & Morinwa, T. (1999). Perancangan dan pemeliharaan sistem plambing. Jakarta: Erlangga.

Prasetyo, A. J., Rodiyani, M., Sandi, D. M. N., Budhi, W. S., & Santoso, C. B. (2025). Perhitungan pressure drop sistem plumbing air bersih pada Gedung Pendidikan Terpadu Agribisnis Politeknik Negeri Jember. Portal: Jurnal Teknik Sipil, 17(1), 87–95. https://doi.org/10.30811/portal.v17i1.6715

Rofi, K. A., Hapsari, R. I., Riskijah, S. S., Harsanti, W., Dharmawan, M. A., & Rahman, T. (2021). Building Information Modelling for clean water and wastewater system in the medium rise school building. IOP Conference Series: Materials Science and Engineering, 1073(1), 012067. https://doi.org/10.1088/1757-899X/1073/1/012067

Syahputra, R., Nugroho, Y. S., & Pratama, A. (2019). Analisis hidraulik pada sistem distribusi air bersih menggunakan perangkat lunak EPANET. Jurnal Teknik Sipil, 26(1), 45–54. https://doi.org/10.5614/jts.2019.26.1.5

Swamee, P. K., & Jain, A. K. (1976). Explicit equations for pipe-flow problems. Journal of the Hydraulics Division, 102(5), 657–664. https://doi.org/10.1061/JYCEAJ.0004542

White, F. M. (2011). *Fluid mechanics* (7th ed.). New York, NY: McGraw-Hill.

Fiorillo, F., Esposito, L., Ginolfi, M., & Leone, G. (2024). New insights into turbulent and laminar flow relationships using Darcy–Weisbach and Poiseuille laws. Water, 16(10), 1452. https://doi.org/10.3390/w16101452

Abdulameer, L. S., & Dzhumagulova, N. T. (2023). Using simulation methods to study pressure losses in a water supply system for irrigation. Power Technology and Engineering, 56, 627–632. https://doi.org/10.1007/s10749-023-01563-3

Josey, B. M., & Gong, J. (2023). Determination of fixture-use probability for peak water demand design using high-level water end-use statistics and stochastic simulation.

Journal of Water Resources Planning and Management, 149(11). https://doi.org/10.1061/JWRMD5.WRENG-6146

Hapsari, R. I., Rofi, K. A., Riskijah, S. S., Harsanti, W., & Dharmawan, M. A. (2021). Building Information Modelling for clean water and wastewater system in the medium rise school building. IOP Conference Series: Materials Science and Engineering, 1073(1), 012067. https://doi.org/10.1088/1757-899X/1073/1/012067

Ferreira, T. V. G., Gonçalves, O. M., de Oliveira, L. H., & Kurokawa, F. A. (2025). Dynamic model integrated with BIM to evaluate building water distribution system performance. Building Services Engineering Research and Technology. Advance online publication. https://doi.org/10.1177/01436244251349104