

QUANTITY TAKE-OFF ANALYSIS OF CONDUIT STRUCTURE USING BUILDING INFORMATION MODELING AT CABEAN DAM, BLORA REGENCY

Bhagyawan Rizqol Jannata (bhagyawan.rizqol@gmail.com)¹
Putri Anggi Permata Suwandi (putrianggipermata@upgris.ac.id)²
Ikhwanudin (ikhwanudin@upgris.ac.id)³
Muslimin (181230000292@unisnu.ac.id)⁴
Firmansyah Maulana (firman.2024@mhs.unisda.ac.id)⁵

**Teknik Sipil, Fakultas Teknik dan Informatika, Universitas PGRI Semarang^{1,2,3}
Teknik Sipil, Fakultas Sains dan Teknologi, Universitas Islam Nahdlatul Ulama Jepara⁴
Teknik Sipil, Fakultas Teknik, Universitas Islam Darul 'Ulum Lamongan⁵**

ABSTRACT

Quantity Take-Off (QTO) calculation is a crucial element in construction cost management. Conventional methods based on 2D drawings are often prone to interpretation errors and human error, resulting in inaccurate cost estimates. This study aims to evaluate the effectiveness of implementing Building Information Modeling (BIM) in performing QTO for the Diversion Conduit structure at Cabean Dam, Blora Regency. The research method involved remodeling the conduit design using Autodesk Revit 2025 software to obtain concrete volume and reinforcement weight, which were then compared with conventional calculation results and field realization data. The results showed that the BIM method produced more efficient volumes compared to the conventional method. In concrete work, the BIM volume was 1.03% lower than the conventional method, while in reinforcement work (deformed bars), BIM was 7.35% more efficient. When compared with field realization data, the BIM volume represented the net quantity, with an average difference of 0.6% for concrete and 3.5% for reinforcement, representing the waste factor. This study concludes that BIM offers higher accuracy and minimizes project budget over-estimation.

Keywords: Building Information Modeling (BIM), Quantity Take-Off, Autodesk Revit, Cabean Dam, Cost Efficiency.

INTRODUCTION

Large-scale water infrastructure projects, such as dams, demand high precision in managing cost, quality, and time. One of the fundamental stages in cost management is the calculation of work volume, known as Quantity Take-Off (QTO). The accuracy of QTO significantly determines the validity of the Budget Plan (RAB). Traditionally, QTO is performed manually using two-dimensional (2D) working drawings. This method has significant limitations, including being time-consuming and prone to calculation errors. Errors in QTO can be fatal for a project, leading to material shortages, cost overruns, and delays in project completion. Construction work is becoming increasingly complex, and management handling has grown more complicated, partly due to the challenges of communication between engineers (Fawji et al., 2022). The use of BIM with new technology offers various advantages and benefits across many factors compared to the use of traditional 2D applications like Computer-Aided Design (CAD). This technology integrates diverse information into the model (Hendra et al., 2022). BIM involves the use of digital representations of built assets to facilitate design, construction, and operational processes, forming a reliable basis for decision-making (Kementerian PUPR Direktorat Jenderal Sumber Daya Air, 2023). Furthermore, BIM helps

facilitate collaboration and coordination among various parties involved in the building project's lifecycle (Soleh & Saputro, 2023). Additionally, BIM is capable of cutting QTO calculation time by up to 50% and reducing labor costs for calculations by up to 63.27% compared to conventional methods (Ridwan et al., 2025). This research conducts a case study on the Diversion Structure (Conduit) at the Cabean Dam, Blora Regency. The primary objective of this study is to analyze the comparison of QTO results between BIM and conventional methods to determine the level of BIM accuracy.

RESEARCH METHODS

This research uses a comparative quantitative method. The research location is the Cabean Dam Construction Project, Karanganyar Village, Todanan District, Blora Regency. The detail of location is presented in Picture 1.



Picture 1. Lokasi Bangunan Pengelak Konduit Bendungan Cabean (Dokumentasi Penulis, 2025)

A. Data Collection

The data used includes :

- 2D Drawings as a reference for 3D modeling.
- Conventional QTO data or manual calculation results from the project (contractor/consultant) as comparative data.

B. BIM Modeling

- 3D geometry modeling such as forming the conduit structure mass using *Generic Models* and *Sweep/Void* features.
- Material ttribution is to defining concrete quality (K-350) and segment identity parameters (*Mark*).
- Reinforcement detailing or modeling reinforcement precisely (shape, diameter, spacing, concrete cover) according to the DED.

C. Data Analysis

The volume extracted from BIM (*Schedule/Quantities*) is compared with conventional and realization volumes. Analysis is performed by calculating the percentage of deviation to observe the difference in accuracy and efficiency.

RESULTS AND DISCUSSION

A. 3D Modeling of Conduit Structure

The step-by-step implementation of Building Information Modeling (BIM) to create a 3D model of a conduit structure using Autodesk Revit 2025. The process is systematically divided into the following key stages:

- a. The workflow begins by launching Revit, creating a new project with a "Metric Multi-Discipline" template, adjusting the project units to meters, and saving the file.
- b. To ensure accuracy, 2D AutoCAD files (.dwg) are verified for metric consistency and imported into Revit's Site Plan view to serve as a foundational reference for the 3D geometry.
- c. The physical structure is built using the "Model In-Place" feature under the "Generic Models" category. The solid body of the conduit is extruded using the "Create Sweep" tool, while the inner hollow channels are carved out using the "Void Sweep" tool based on the imported 2D cross-sections.
- d. To define technical properties, a default material is duplicated and renamed to "Beton K-350" (K-350 Concrete). A "Concrete Cast-In-Place" texture is applied for realistic visualization, and each conduit segment is assigned a specific "Mark" (identity code) to organize data for future Quantity Take-Off (QTO) calculations.
- e. The final step is modeling the 3D steel reinforcement inside the concrete elements. By utilizing "Wireframe" and "Section" views, rebars are precisely sketched into the concrete host. The process involves defining exact bar diameters (e.g., 13 mm and 19 mm) and using the "Maximum Spacing" feature to automatically distribute the rebars evenly across the segments.

B. Analisis Quantity Take-Off (QTO)

Volume extraction was performed automatically using the *Schedule/Quantities* feature. The QTO results from this BIM model represent the net quantity of the modeled structure. To measure the effectiveness of the BIM method, a comparison was made between BIM QTO results and conventional calculations. The summary of this comparison is presented in Table 1.

Table 1. BIM Comparison Summary of BIM, Realization, and Conventional Volumes

No	Work Item	Specification	Volume		Unit	Deviation
			Conventional	BIM		
1	Concrete	K-350	3,696.36	3,658.78	m ³	-1.03%
2	Deformed Bar	D13 dan D19 mm	220,521.74	205,417.56	kg	-7.35%
3	Plain Bar	D19	440.00	440.00	m'	0.00%

- a. Efficiency in Concrete Work The analysis results show that the BIM method's concrete volume is 1.03% lower difference of 37.58 m³ compared to the conventional method. This difference is due to the accuracy of the BIM method utilizing the join geometry principle, where the volume at element intersections is calculated as a single net volume unit without overlap. Conversely, conventional methods often use center-to-center calculation approaches, potentially causing double counting at connection areas.
- b. Efficiency in Reinforcement Work Significant efficiency is observed in

reinforcement work, where the BIM volume is 7.35% lower difference of -15104 kg compared to the conventional method. This saving occurs because BIM calculates steel length based on precise standard bending radii. Meanwhile, conventional methods tend to use length estimates with safety factors and less accurate connection assumptions.

- c. Accuracy in Counting Items For plain bar or dowel work, all three methods show exactly the same results 0% deviation. This indicates that for work items based on unit quantity with clear installation points, the conventional method still has an accuracy level equivalent to BIM.

CONCLUSION

Based on the results of the analysis and discussion regarding the comparison of Quantity Take-Off (QTO) for the structural work of the Cabean Dam Diversion Conduit, the following conclusions can be drawn:

- The implementation of Building Information Modeling is proven to be able to increase the efficiency of volume calculations compared to conventional methods. In concrete work, the BIM volume was recorded 1.03% lower a difference of 37.58 m³, while in reinforcement work, BIM produced significant volume savings of 7.35% difference of 15104 kg). This efficiency is attributed to BIM's accuracy in eliminating double-counting at concrete joints and the precision in calculating steel bending lengths according to standards.
- The research results recommend the use of BIM as a primary instrument in cost control to avoid over-estimation. However, for material logistics purposes, the BIM volume needs to be adjusted with a measurable waste coefficient to match the actual requirements of physical execution.

DAFTAR PUSTAKA

Fawji, M., Cahya, E., & Dermawan, V. (2022). *Implementasi 6D Building Information Modelling (BIM) pada saluran pengelak Bendungan Margatiga dengan aplikasi Civil 3D dan HEC-RAS 2D*. Malang.

Hendra, D., Karsono, B., Olivia, S., & Azhar. (2022). *Pengenalan peran platform digital BIM (Building Information Modelling) dalam program Autodesk Revit bagi masyarakat pelajar Kota Lhokseumawe*. Aceh.

Kementerian PUPR Direktorat Jenderal Sumber Daya Air. (2023). *Surat Edaran Nomor 04/SE/Da/2023 tentang pedoman penerapan pemodelan informasi bangunan (Building Information Modelling) pada perencanaan teknis dan pelaksanaan konstruksi infrastruktur sumber daya air*. Jakarta: Kementerian PUPR.

Soleh, I. M., & Saputro, C. D. (2023). *Implementasi Building Information Modelling level 5D pada proyek bangunan air*. Yogyakarta.

Ridwan, M. R. M., Farizal, M., Suwandi, P. A. P., & Ikhwanudin. (2025). *Perbandingan quantity take off metode konvensional dan BIM pada struktur spillway Embung MBH IKN*. Semarang.