



International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.699

Volume 14, Issue 4, April 2025

BIM for Efficient Water, Waste Water Management and Rainwater Harvesting for Adichunchanagiri Polytechnic

Thanup NT, Akash TP, Yogarsha S, Sumanth Naik P

Diploma Student, Department of Civil Engineering, Adichunchanagiri Polytechnic College, Chikkamagaluru,
Karnataka, India

Diploma Student, Department of Civil Engineering, Adichunchanagiri Polytechnic College, Chikkamagaluru,
Karnataka, India

Head of the department, Department of Civil Engineering, Adichunchanagiri Polytechnic College, Chikkamagaluru,
Karnataka, India

ABSTRACT: This research focuses on the application of Building Information Modeling (BIM) for the efficient management of water, wastewater, and rainwater harvesting systems at Adichunchanagiri Polytechnic. Utilizing Autodesk Revit 2025, the project involves the creation of a detailed BIM model for the water supply and plumbing lines, which enhances the design, coordination, and maintenance of these systems. Additionally, the project includes sewer line modeling and the integration of a rainwater harvesting system. The rainwater harvesting system was designed by analyzing a decade of historical rainfall data to estimate potential water collection, storage, and utilization. The study includes a cost estimation analysis for implementing the rainwater harvesting system, offering valuable insights into its economic feasibility and the long-term benefits of sustainable water management. In this context, BIM streamlines the design and implementation process while ensuring optimal resource management and cost efficiency in constructing and operating water-related infrastructure at the Polytechnic.

KEYWORDS: BIM (Building Information Modeling), Water Management, Waste Water Management, Rainwater Harvesting

I. INTRODUCTION

The population of Chikkamagaluru, Karnataka, is expected to grow significantly in the coming years, leading to increased demand for water resources. This rising demand, along with expanding industrialization and agriculture, reflects broader trends across India. As a result, water scarcity is emerging as a critical challenge in the region. Projections suggest a substantial decline in water availability due to over-extraction and limited sources. To prevent the worsening of the current water shortage crisis, implementing sustainable solutions is crucial for the region's future. Rainwater harvesting is emerging as a promising solution in Chikkamagaluru. With substantial rainfall during the monsoon season, the region is well-suited for capturing rainwater from heavy downpours. This collected water can be stored above ground or used to recharge groundwater sources, helping maintain a steady water supply during dry periods. Rainwater harvesting is the practice of collecting and storing rainwater for future use by capturing natural precipitation in tanks, reservoirs, or underground aquifers. In Chikkamagaluru, it serves as a vital strategy to address water scarcity, promoting sustainable management for agricultural, domestic, and industrial needs. As water resources continue to deplete, rainwater harvesting plays a crucial role in ensuring a reliable and consistent water supply for the region's future.

II. LITERATURE SURVEY

Building Information Modeling (BIM) has become a powerful tool for improving water, wastewater, and rainwater management in buildings and campuses. Studies have demonstrated that BIM enhances the design and maintenance of

water systems by generating detailed 3D models of water supply, distribution, and treatment networks. Research by Tursunbayeva et al. (2019) highlights how BIM helps in visualizing water systems, detecting leaks, and improving the efficiency of water flow. Similarly, Kazi et al. (2017) focused on how BIM could be used to design rainwater harvesting systems, such as storage tanks and filtration units, ensuring maximum water collection and quality. Studies have also explored integrating BIM with sustainability efforts, such as Shao et al. (2020), who demonstrated how BIM could simulate water usage and identify areas for improvement in conservation. In the context of wastewater management, Li et al. (2019) highlighted how BIM can help optimize wastewater treatment processes, ensuring the reuse of treated water. The integration of sensors with BIM models, as discussed by Wang et al. (2020), further enhances the ability to monitor and adjust water systems in real time. These advancements can be implemented at Adichunchanagiri Polytechnic, where BIM can aid in designing and optimizing efficient water management systems, minimizing water wastage, and incorporating sustainable practices such as rainwater harvesting and wastewater recycling into the campus infrastructure.

III. METHODOLOGY

The methodology for implementing BIM (Building Information Modeling) for efficient water, wastewater management, and rainwater harvesting at Adichunchanagiri Polytechnic focuses on using advanced digital tools to design and optimize water systems. First, data on water usage, rainfall, and the existing infrastructure of the campus is collected. This data is then used to create a 3D BIM model that simulates the entire water system, including the collection, distribution, and treatment of water. The model identifies opportunities for water conservation and recycling, including rainwater harvesting and wastewater treatment. Once the system is modeled, simulations are run to optimize the design, ensuring that water is used efficiently and sustainably. After the design is finalized, the systems are implemented and monitored using BIM, allowing for real-time tracking of water usage and enabling future improvements or adjustments to meet evolving needs. This approach promotes a sustainable and efficient water management system for the campus.

IV. EXPERIMENTAL RESULTS

Below are the experimental results visualized through the BIM model for efficient water, wastewater management, and rainwater harvesting at Adichunchanagiri Polytechnic.

FIG 1. RAINWATER HARVESTING, WATER SUPPLY SEWER LAYOUT PLUMBING MODEL OF ADICHUNCHANAGIRI POLYTECHNIC

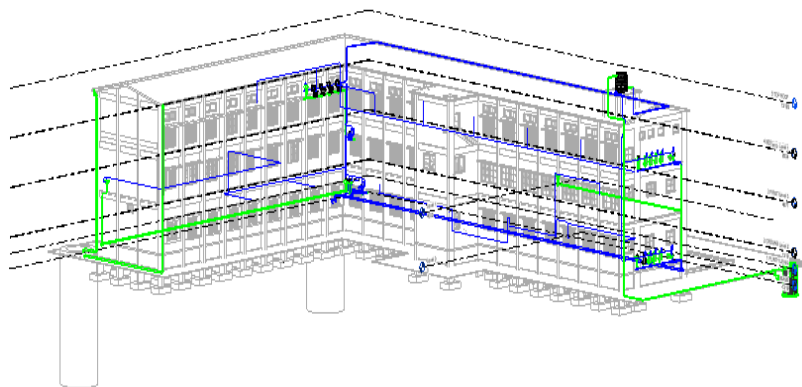


FIG 2. ARCHITECTURAL MODELS OF ADICHUNCHANAGIRI POLYTECHNIC

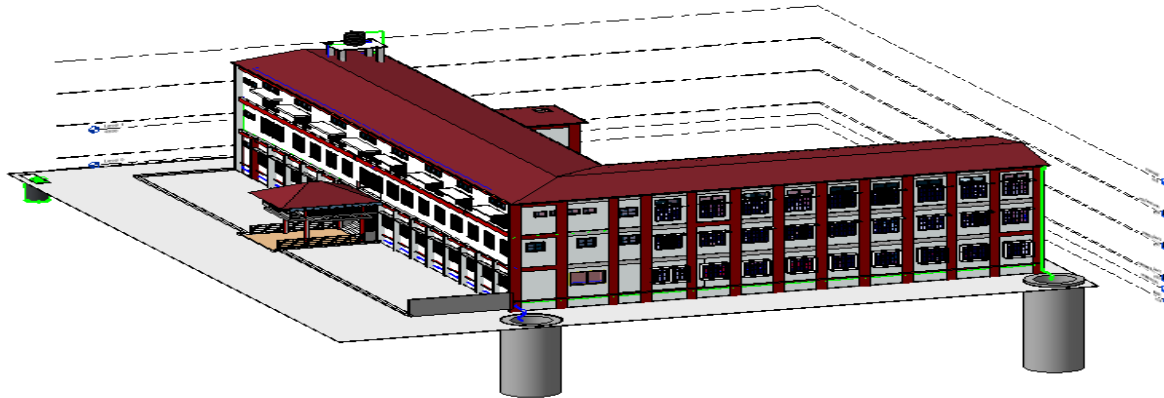
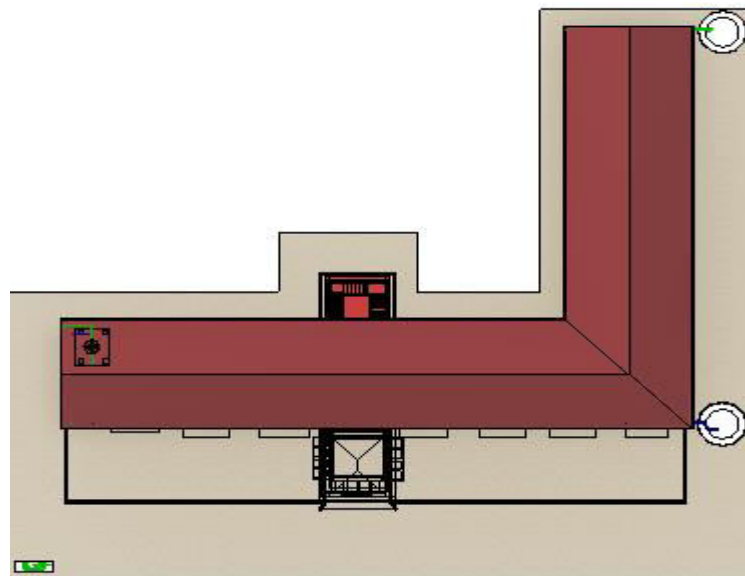


FIG 3. RAINWATER HARVESTING OF ADICHUNCHANAGIRI POLYTECHNIC



4.2 Data collection

TABLE 1: DAILY WATER USAGE OF ADICHUNCHANAGIRI POLYTECHNIC, CHIKKAMAGALURU

Use	Consumption in litre/day
Drinking	6000
Laboratories	500
Washing Floors & Labs	1000
Horticulture	5000
Toilets	6000
Total	18500

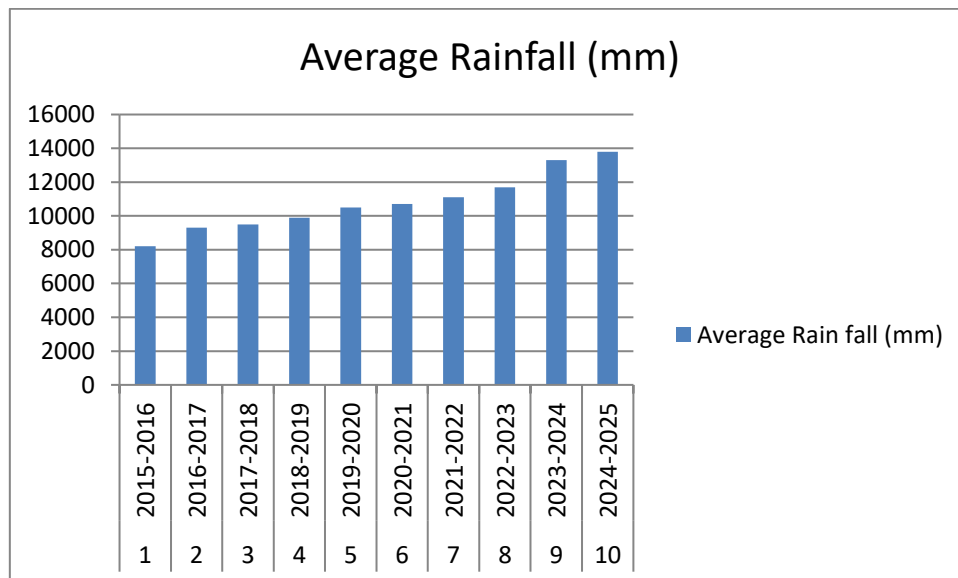
4.3 Rain fall

The average monsoon rainfall data is obtained from the Chief Planning Office (CPO), Chikkamagaluru. Table 2 presents the average rainfall data for Chikkamagaluru district from 2015 to 2025. The average rainfall over these years is considered when computing the overall rainfall data (in mm). This data is crucial for determining the total discharge into the pipeline and plays a key role in designing the storage tank. In our project, we analyzed rainfall data from the past ten years (2015–2025). Notably, the 2024–2025 periods shows high rainfall, whereas 2015–2016 recorded significantly lower rainfall. These variations in rainfall directly impact the groundwater table in the area.

Table 2: Average rainfall data (mm)

No	Year	Average Rainfall (mm)
1	2015-2016	8200
2	2016-2017	9300
3	2017-2018	9500
4	2018-2019	9900
5	2019-2020	10500
6	2020-2021	10700
7	2021-2022	11100
8	2022-2023	11700
9	2023-2024	13300
10	2024-2025	13800

Source: Chief Planning Office (Chikkamagaluru)



AVERAGE RAIN FALL DATA OF CHIKKAMAGALURU

V. DESIGN OF ROOFTOP RAINWATER HARVESTING SYSTEM

The design of the rooftop rainwater harvesting system involves six key steps:

1. Determine the total water requirement – Calculate the daily water consumption in the college.
2. Assess the available rainwater – Estimate the quantity of rainwater that can be collected.
3. Design the catchment area – Plan the surface area for rainwater collection.
4. Design the transportation system – Develop a system to channel rainwater efficiently.
5. Implement first-flushing – Ensure initial runoff is diverted to remove contaminants.

6. Determine the required storage capacity – Compute the size of the storage reservoir needed.
 - **Total water requirement:** The daily water consumption in the college is analyzed to determine the overall demand.
 - **Available rainwater estimation:** The amount of rainwater available is calculated using the method outlined below.

Mean Annual Rainwater Supply(s)

Average Rainfall of Chikkamagaluru=1425mm

Considering 1425 mm for future

Average Rainfall (R)=1425mm

The average annual rainfall in meters.(R)=1.425m/year

Catchment Area (A)=822.989 m²

Run off Coefficient (Cr)=0.8

Mean Annual Rainwater supply(s)=Average rainfall*Area of Catchment*Runoff Coefficient (R*A*Cr)\

$$S=1.425*822.989*0.8$$

$$=928.20 \text{ cubic meter/year}$$

$$=928.20*1000$$

$$=928200 \text{ litre/year}$$

$$=77.35 \text{ cubic meter/month}$$

$$=77350 \text{ litre/month}$$

$$=2.58 \text{ cubic meter/day}$$

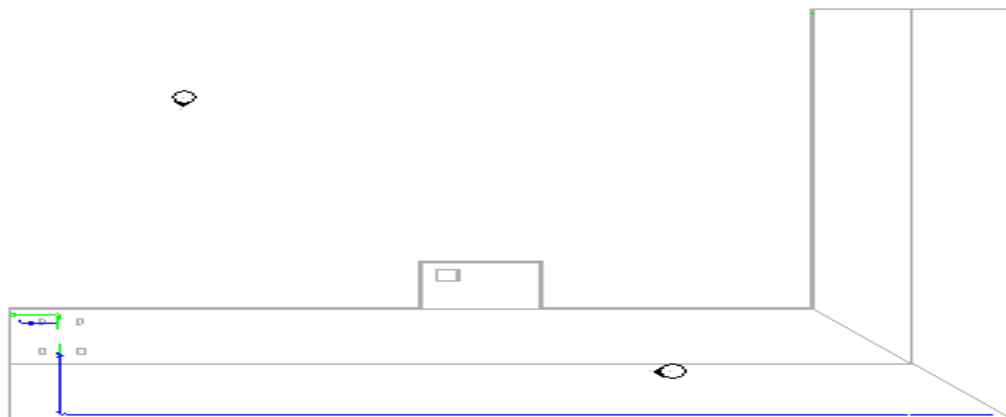
$$=2580 \text{ Litre/day}$$

Design of Proposed Catchment Area: The catchment area of a rainwater harvesting system refers to the surface that directly receives rainfall and channels it into the water collection system. Any roofing material can be used for water collection. Based on the terrace floor design, the total rooftop area of the Adichunchanagiri Polytechnic College main block was calculated.

Area of Adichunchanagiri Polytechnic main block 780.18 m²

Total Proposed Catchment Area= 822.98 m²

Figure 3: Catchment Area Top-view of Building in (meters)



- 1) **Design of Transportation System:** In this project, rainwater is transported from the catchment area using Polyvinyl Chloride (PVC) pipes and fittings. For water collection, 1.5-inch diameter pipes are used, while 6-inch diameter pipes are used for underground transportation. The number of pipes and fittings required is determined based on topographical conditions.
- 2) **First-Flushing:** A first flush device is a valve that ensures runoff from the initial rainfall is flushed out before entering the system. This step is crucial as the first spell of rain carries a higher concentration of pollutants from the air and catchment surface.
- 3) **Storage Reservoir Computation:** The storage reservoir is designed based on the calculated water intake. It is constructed using cement rings, with the number and size of rings determined by the peak water inflow rate. Considering the maximum rainwater availability, the reservoir consists of 10 cement rings, each with a 4-foot diameter and a height of 1 foot.
- 4) **Cost Analysis:** A cost analysis is conducted to assess whether the project can be completed within the allocated budget. A detailed estimate, including the cost of PVC pipes, pipe fittings, and storage reservoir construction, is provided in the table below. The estimated total cost for designing and constructing the rainwater harvesting system at Adichunchanagiri Polytechnic College, Chikkamagaluru, Karnataka, is outlined in the final budget.

Table 4: Cost Estimation for PVC Pipes & Fittings

S.NO	Description	Length (FEET)	Quantity	Cost per unit	Total pipe cost
I.	6-Inch Pipes	336	34	2745	93330/-
II.	1 & half Inch Pipes	40	4	287	1148/-
III.	L-Bends		104	350	36400/-
IV.	T-Bends		139	400	55600/-
V.	Other miscellaneous				10000/-
VI.	Fitting charges				30000/-
VII.	Total				226478/-

Table 5: Cost Estimation for Storage Reservoir Construction

S.NO	Description	Cost
I.	Excavation	6000/-
II.	Cement rings	9000/-
III.	Stone pitching	3900/-
IV.	Labour Charges	9000/-
V.	Total	27900/-

VI. CONCLUSION

The implementation of BIM technology for managing water, wastewater, and rainwater harvesting systems at Adichunchanagiri Polytechnic has proven highly effective in improving infrastructure efficiency and sustainability. By developing a detailed Revit 2025 model, we successfully designed and integrated water supply, plumbing, and sewer systems, ensuring seamless coordination of building utilities. Additionally, the incorporation of a rainwater harvesting system, based on a decade of rainfall data, supports the institution’s sustainability objectives by offering a reliable and cost-effective water source for non-potable applications. The detailed cost estimation for the rainwater harvesting system revealed the economic viability of such a system, indicating that the long-term savings in water consumption costs could offset the initial investment. The use of BIM not only improved the accuracy of the design but also facilitated a more efficient and collaborative approach to the project’s implementation and maintenance. In conclusion, this research demonstrates the effectiveness of BIM in enhancing water and wastewater management, promoting sustainable water practices, and serving as a valuable framework for future infrastructure projects in educational and public buildings.. The integration of these technologies contributes to the reduction of resource consumption, making the Polytechnic a more sustainable and environmentally responsible institution.

REFERENCES

- [1] Kumar, V., & Singh, S. (2020). Integration of Building Information Modeling (BIM) for Wastewater and Water Supply Systems in Indian Urban Buildings. *Journal of Civil Engineering and Technology*, 11(8), 45-58.
- [2] Sharma, R., & Agarwal, M. (2019). Optimizing Water Conservation and Rainwater Harvesting through BIM in Indian Educational Institutions. *Indian Journal of Environmental Engineering*, 8(3), 98-112.
- [3] Patil, S., & Desai, P. (2021). Role of BIM in Efficient Water and Wastewater Management in Indian Institutional Buildings. *Journal of Green Architecture and Construction*, 19(1), 33-47.
- [4] Singh, A., & Rathi, N. (2020). Utilizing BIM for Sustainable Water Management in Indian Educational Institutions: A Case Study of Water Supply and Wastewater Systems. *Journal of Sustainable Infrastructure*, 15(2), 58-72.
- [5] Sharma, P., & Tiwari, K. (2021). Building Information Modeling for Water and Wastewater Management: A Review of Indian Applications. *International Journal of Green Energy and Technology*, 22(3), 91-103.
- [6] Soni, S., & Mehta, J. (2020). Leveraging BIM for Rainwater Harvesting System Design and Cost Estimation in Indian Public Buildings. *Indian Journal of Water Resources*, 35(3), 45-58.
- [7] Thakur, P., & Kumar, A. (2020). Designing Water Supply and Wastewater Systems Using BIM: A Sustainable Approach for Indian Buildings. *Journal of Environmental and Civil Engineering*, 8(2), 50-63.
- [8] Choudhary, D., & Meena, S. (2021). BIM in Integrating Rainwater Harvesting with Urban Water Systems in India. *Journal of Environmental Engineering and Management*, 17(5), 111-124.
- [9] Kumar, S., & Gupta, R. (2019). BIM-Based Modeling for Efficient Water Distribution and Sewerage Systems in Indian Buildings. *International Journal of Civil Engineering & Technology*, 10(6), 341-355.
- [10] Gupta, A., & Verma, S. (2020). BIM in the Design and Implementation of Rainwater Harvesting Systems for Sustainable Buildings in India. *Journal of Sustainable Building Design*, 14(2), 76-89.



INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details