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ASSESSMENT OF THE APPLICATION OF SUSTAINABLE WATER HARVESTING STRATEGIES IN SELECTED HOSTELS OF A NIGERIAN PRIVATE UNIVERSITY: IMPLICATIONS FOR SUSTAINABLE AND EFFICIENT WATER MANAGEMENT PRACTICES

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ABSTRACT

Access to water remains a problem for many student hostels in Nigerian universities, where the available groundwater is often insufficient to meet the needs of a growing student population. This study evaluates the use of rainwater harvesting elements in three male hostels at Bingham University, Karu, as a reasonable alternative source of water supply. It examines the status of the existing rainwater harvesting infrastructure within the hostels, estimates the harvesting potential of the roof catchments, and considers the technical constraints on effective integration. A mixed-methods approach combined quantitative data from 81 male students across the three hostels with photographic evidence of the extent to which the harvesting elements identified from the literature are present on site. The work proceeded by identifying the water harvesting strategies present in the hostels, their current level of application, the barriers that inhibit their use, and the critical success factors that enhance it. Data were analysed with the Statistical Package for the Social Sciences (SPSS) version 25. The results showed that 19 water harvesting elements were represented across the three hostels, with gravity feed and pumps (electric or manual) recording the highest application levels (means of 3.87 and 3.60 respectively). Lack of awareness and knowledge, and higher upfront costs for tanks and plumbing, were the leading barriers to integration (means of 3.09 and 3.06). Regarding success factors, clear, easy-to-follow maintenance schedules and sustainable building codes ranked highest (means of 3.68 and 3.55). The study highlights the key focus areas for water harvesting in male student hostels and recommends directions for embedding the strategy in future building-design solutions.

Keywords: Access; Water Harvesting; Sustainable Water Management; Hostels; Strategies; University

1 INTRODUCTION

Water scarcity is a global concern, and there is a growing need to transition to sustainable water-management practices, especially in institutional settings. Rainwater harvesting is a vital decentralised supply method that can relieve water-scarcity stress and cut the energy cost of pumping (Tasiwuka, Silungwe & Mbilinyi, 2025). In many developing areas, ageing infrastructure and growing populations create intermittent supply at educational institutions. As climate variability continues, water harvesting features in building design have become functional necessities rather than architectural luxuries (Olowe & Akintola, 2024). Seasonal change in Nigeria's North-Central region produces harsh drought and water stress for residential facilities. According to Bello and Balami (2025), many university hostels suffer inadequate water supply, undermining hygiene and academic productivity. The failure to integrate rainwater harvesting to augment mains supply causes a significant loss of stored rainwater during the rainy season, water that could serve sanitation within the hostels and irrigation of surrounding grounds (Adidu et al., 2024).

Specific harvesting components, gutters, downpipes and storage cisterns, need to be assessed through on-site evaluation to confirm that they are efficient and fit for purpose. Chukwuma et al. (2023) argue that the architectural design of older educational facilities can make it difficult to incorporate new sustainable technologies such as rainwater harvesting, and that a baseline assessment of the state and potential of these elements is essential to building a sustainable water-harvesting roadmap for such facilities. To improve water-supply independence and reduce the environmental impact of urban runoff on campus, a diagnosis of the physical infrastructure already in place is therefore essential (Gibberd, 2024).

Water provision has become an essential resource in student accommodation because of the large population domiciled at any one time (Singh & Dwivedi, 2026), who also stress the importance of sustainable water-management systems for efficiency, consumption and environmental conservation. The institution under study lies in a part of the country that receives good annual rainfall yet still experiences supply instability. Students currently rely on groundwater and external sources for pumping, and in periods of high demand the shortfall creates a condition of “water poverty.” The hostels present large roof surfaces capable of catching rainwater, yet the elements of a viable harvesting system appear either underused or absent. In a review of nature-based harvesting for climate resilience, Coraglia et al. (2026) note that the scarcity of water has, since prehistoric times, driven ingenious systems for collecting and storing it. Where such strategies are absent, millions of litres of clean rainwater are lost to surface runoff, a waste of a renewable resource that also drives soil erosion and, over time, undermines building foundations.

Data on the technical feasibility and current status of harvesting components, gutters, filtration units and storage tanks, within hostel facilities is also missing; without assessing these elements, universities cannot rationally plan borehole use, trapping them in a cycle of high water-hauling and borehole-maintenance costs (Jindal, Tewari & Anand, 2026). Without addressing rainwater integration, hostels will continue to face sanitation problems and environmental waste. This study therefore sets out to systematically evaluate the use of water harvesting elements and to optimise them so that the water they provide can sustainably support the residents of the hostels, thereby helping to maintain hygiene, sanitation and student wellness. Specifically, the study pursues four objectives:

- To identify the different water harvesting strategies present in the selected male hostels;
- To examine the extent of their integration within the selected male hostels;
- To identify the barriers that inhibit their integration in the hostels; and
- To investigate the critical success factors that influence their integration, thereby suggesting ways to encourage the continued application of these strategies for sustainable water supply within educational facilities.

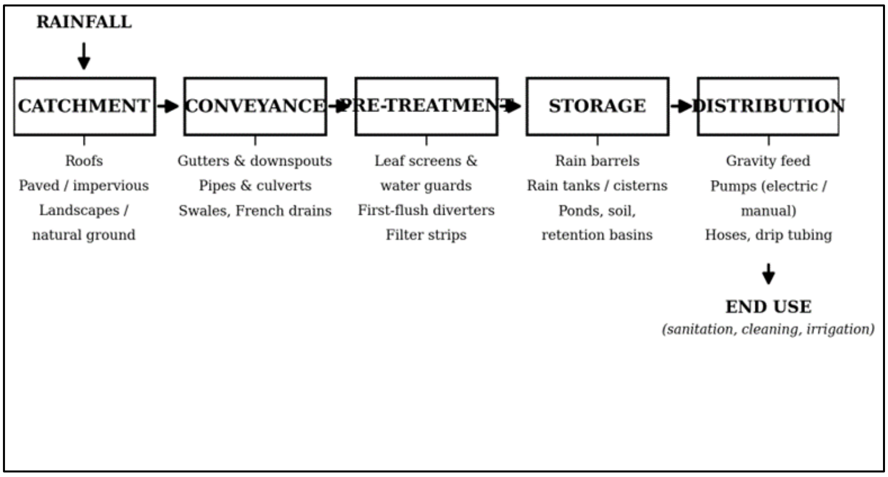
To organise the analysis, the 19 elements examined in this study are best understood as parts of a single harvesting chain that moves water from the catchment surface to the point of use. Table 1 and Figure 1 set out this framework, which underpins the results that follow.

Table 1: Classification of rainwater harvesting elements by their stage in the harvesting chain

Stage	Function in the harvesting chain	Representative elements assessed in this study
Catchment	Intercept rainfall over a surface	Roofs; paved / impervious surfaces; landscapes / natural ground
Conveyance	Channel captured water toward storage	Gutters and downspouts; pipes and culverts; swales and bioswales; French drains
Pre-treatment	Screen debris and divert the dirty first flush	Leaf screens and water guards; roof washers and first-flush diverters; vegetated buffers and filter strips
Storage	Retain harvested water for later use	Rain barrels; rain tanks / cisterns; earthen ponds and retention basins; the soil itself; inlet and tank fillers

Distribution and use	Move stored water to the point of use	Gravity feed; pumps (electric or manual); hoses and watering cans; drip irrigation tubing

Source: Authors' construction, mapping the 19 elements assessed (2026).



Source: Authors' construction (2026).

Figure 1: The rainwater harvesting chain, from catchment to end use, showing where each class of element operates

2 METHODOLOGY

The study adopted a mixed-methods approach, combining quantitative survey data from the field with qualitative photographic evidence of the actual implementation of the harvesting strategies within three selected male hostels. It was domiciled at Bingham University, Karu, Nasarawa State, and covered three male hostel buildings: the Portfolio hostel, the New hostel and the Old hostel. Questionnaires were administered to resident students, while the qualitative component drew on photographic observation of each hostel. The hostels were selected because they house large numbers of students, present different architectural configurations relevant to water harvesting, and could be studied with the appropriate institutional approval. Roofs, storage facilities and the main accommodation areas were the principal focus.

The combined population of the three hostels was 1,000 students (Old Hostel 300, New Hostel Chief Set 500 and New Hostel Portfolio 200). The Taro Yamane formula was used to determine the sample size, giving a calculated sample of 285 students. Owing to constraints of time, resources and access, a purposive sampling technique was then adopted: 150 questionnaires were administered (50 per hostel), of which 81 were correctly completed and returned, a 54% response rate considered sufficient for the descriptive analysis, while acknowledging limits to generalisability. Table 2 summarises the distribution.

Table 2: The selected male hostels and the distribution of returned questionnaires

Male hostel	Population	Administered	Returned	% of returned sample
Old Hostel	300	50	28	34.6%
New Hostel (Chief Set)	500	50	28	34.6%
New Hostel (Portfolio)	200	50	25	30.9%
Total	1,000	150	81	100% (54% response)

Source: Authors' field study (2026).

The structured questionnaire was divided into five sections derived from the research objectives: Section A captured respondents' socio-economic characteristics; Section B, the presence and awareness of water harvesting elements; Section C, their level of application; Section D, the barriers to integration; and Section E, the factors that enhance integration. Every item used a five-point Likert scale (1 = strongly disagree / very inadequate to 5 = strongly agree / very adequate). In interpreting the results, the scale midpoint of 3.00 is used as a reference: mean ratings above it indicate that an element is, on balance, present, applied, influential or agreed with, while ratings below it indicate the reverse. Descriptive statistics were computed in SPSS version 25, supported by a one-sample t-test on the leading success factor.

3 RESULTS

The results are presented in line with the four objectives: the existing harvesting elements in the hostels, their level of application, the barriers that limit integration, and the factors that enhance it, followed by supporting field observations and an inferential test.

3.1 Existing Water Harvesting Elements

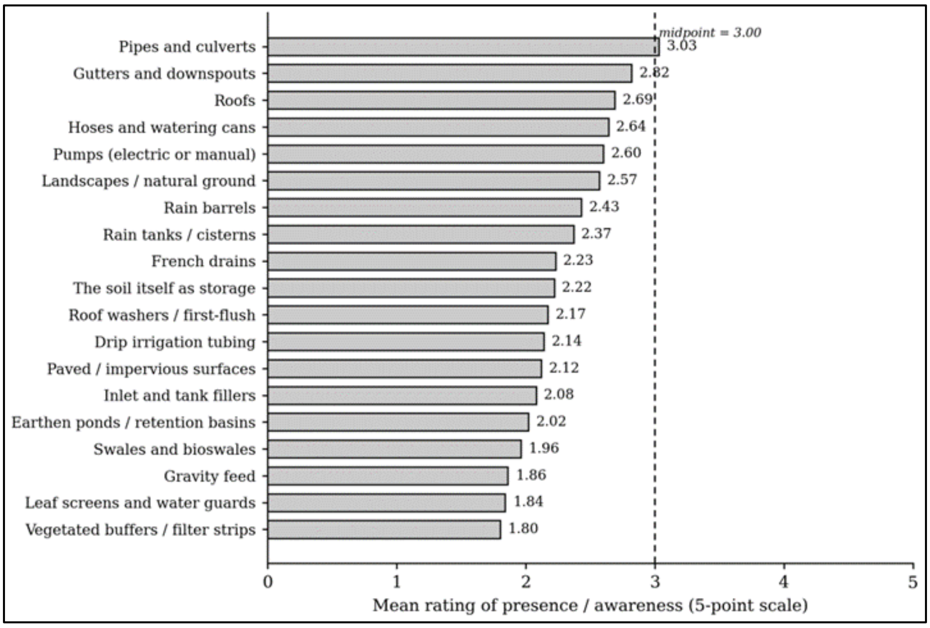
Table 3 presents descriptive statistics for the 19 harvesting elements identified from the literature. In descending order, pipes and culverts recorded the highest mean (Mean = 3.03, SD = 1.10), followed by gutters and downspouts (Mean = 2.82, SD = 0.88), roofs (Mean = 2.69, SD = 1.02), hoses and watering cans (Mean = 2.64, SD = 1.35) and pumps (Mean = 2.60, SD = 1.27). The lowest-rated were vegetated buffers and filter strips (Mean = 1.80, SD = 0.80), leaf screens and water guards (Mean = 1.84, SD = 0.83) and gravity feed (Mean = 1.86, SD = 1.26), indicating their limited presence. Figure 2 ranks the elements; conveyance components (pipes, gutters) and basic catchment surfaces dominate the upper half, while pre-treatment components sit at the bottom.

Table 3: Descriptive statistics for the presence and awareness of water harvesting elements (N = 81)

S/No	Water harvesting element	Response distribution, n (%), N = 81					Mean	SD	Rank
		None (1)	Very little (2)	Moderate (3)	High (4)	Very high (5)			
1	Roofs	13 (16.05)	19 (23.46)	29 (35.80)	20 (24.69)	0 (0.00)	2.69	1.02	3rd
2	Paved / impervious surfaces	22 (27.16)	34 (41.98)	20 (24.69)	3 (3.70)	2 (2.47)	2.12	0.940	12th
3	Landscapes / natural ground	21 (25.93)	15 (18.52)	28 (34.57)	12 (14.81)	5 (6.17)	2.57	1.20	6th
4	Gutters and downspouts	7 (8.64)	16 (19.75)	44 (54.32)	12 (14.81)	2 (2.47)	2.82	0.877	2nd
5	Pipes and culverts	10 (12.35)	15 (18.52)	20 (24.69)	34 (41.98)	2 (2.47)	3.03	1.10	1st
6	Swales and bioswales	35 (43.21)	21 (25.93)	18 (22.22)	7 (8.64)	0 (0.00)	1.96	1.00	15th
7	French drains	19 (23.46)	31 (38.27)	24 (29.63)	7 (8.64)	0 (0.00)	2.23	0.912	8th
8	Roof washers and first-flush diverters	25 (30.86)	24 (29.63)	25 (30.86)	7 (8.64)	0 (0.00)	2.17	0.972	10th
9	Leaf screens and water guards	32 (39.51)	33 (40.74)	13 (16.05)	3 (3.70)	0 (0.00)	1.84	0.828	17th
10	Inlet and tank fillers	27 (33.33)	31 (38.27)	12 (14.81)	11 (13.58)	0 (0.00)	2.08	1.01	13th
11	Vegetated buffers and filter strips	32 (39.51)	36 (44.44)	10 (12.35)	3 (3.70)	0 (0.00)	1.80	0.797	18th
12	Rain barrels	26 (32.10)	11 (13.58)	27 (33.33)	17 (20.99)	0 (0.00)	2.43	1.15	7th
13	Rain tanks / cisterns	27 (33.33)	13 (16.05)	25 (30.86)	16 (19.75)	0 (0.00)	2.37	1.14	8th
14	Earthen ponds and retention basins	34 (41.98)	12 (14.81)	34 (41.98)	1 (1.23)	0 (0.00)	2.02	0.948	14th

15	The soil itself as storage	25 (30.86)	23 (28.40)	23 (28.40)	10 (12.35)	0 (0.00)	2.22	1.02	9th
16	Gravity feed	48 (59.26)	13 (16.05)	8 (9.88)	7 (8.64)	5 (6.17)	1.86	1.26	16th
17	Pumps (electric or manual)	24 (29.63)	10 (12.35)	26 (32.10)	16 (19.75)	5 (6.17)	2.60	1.27	5th
18	Drip irrigation tubing	35 (43.21)	15 (18.52)	19 (23.46)	8 (9.88)	4 (4.94)	2.14	1.22	11th
19	Hoses and watering cans	28 (34.57)	6 (7.41)	17 (20.99)	27 (33.33)	3 (3.70)	2.64	1.353	4th

Response levels: 1 = None, 2 = Very little, 3 = Moderate, 4 = High, 5 = Very high. Percentages recomputed from reported counts. Source: Authors' analysis, SPSS v25 (2026).



Source: Authors' analysis (2026).

Figure 2: Mean rating of the presence / awareness of the 19 elements (dashed line = 3.00 scale midpoint)

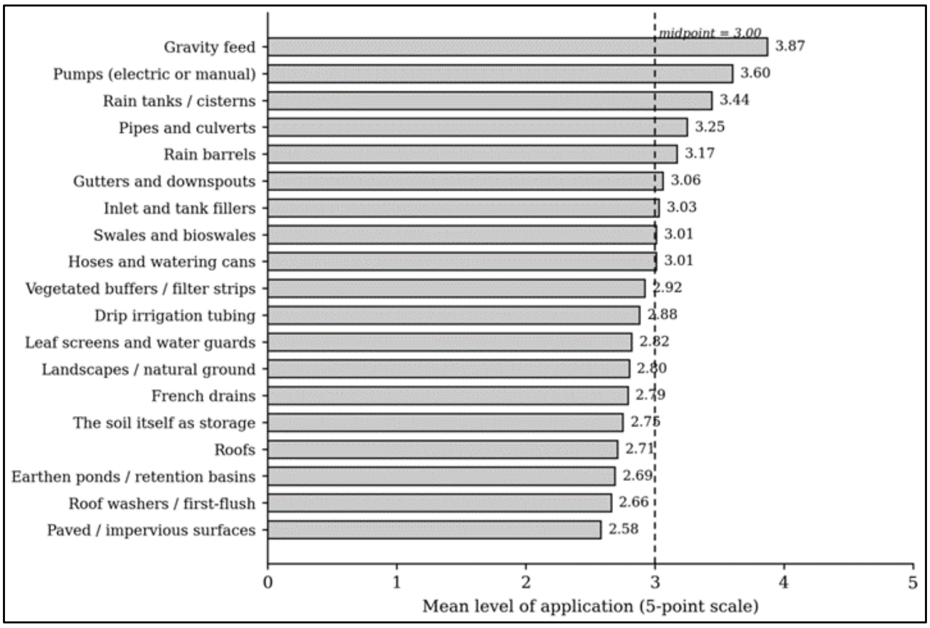
3.2 Level of Application of Water Harvesting Elements

Table 4 reports how far each element is actually applied in the hostels, as perceived by residents. Gravity feed ranked highest (Mean = 3.87, SD reported as 6.00), followed by pumps (Mean = 3.60, SD = 0.96), rain tanks / cisterns (Mean = 3.44, SD = 0.85), pipes and culverts (Mean = 3.25, SD = 0.93) and rain barrels (Mean = 3.17, SD = 0.83). The lowest-rated applications were roofs (Mean = 2.71, SD = 1.05), roof washers and first-flush diverters (Mean = 2.66, SD = 0.79) and paved / impervious surfaces (Mean = 2.58, SD = 0.91). Distribution and storage elements therefore dominate the applied set, as Figure 3 shows.

Table 4: Descriptive statistics for the level of application of water harvesting elements (N = 81)

S/No	Water harvesting element	Response distribution, n (%), N = 81					Mean	SD	Rank
		Very inadeq. (1)	Inadequate (2)	Moderate (3)	Adequate (4)	Very adeq. (5)			
1	Roofs	10 (12.35)	27 (33.33)	22 (27.16)	20 (24.69)	2 (2.47)	2.71	1.05	15th
2	Paved / impervious surfaces	9 (11.11)	28 (34.57)	34 (41.98)	8 (9.88)	2 (2.47)	2.58	0.906	17th
3	Landscapes / natural ground	7 (8.64)	27 (33.33)	23 (28.40)	23 (28.40)	1 (1.23)	2.80	0.992	12th
4	Gutters and downspouts	2 (2.47)	21 (25.93)	29 (35.80)	28 (34.57)	1 (1.23)	3.06	0.871	6th
5	Pipes and culverts	5 (6.17)	10 (12.35)	27 (33.33)	37 (45.68)	2 (2.47)	3.25	0.932	4th
6	Swales and bioswales	5 (6.17)	18 (22.22)	47 (58.02)	10 (12.35)	0 (0.00)	3.01	2.26*	8th
7	French drains	10 (12.35)	15 (18.52)	38 (46.91)	18 (22.22)	0 (0.00)	2.79	0.931	13th
8	Roof washers and first-flush diverters	7 (8.64)	21 (25.93)	46 (56.79)	6 (7.41)	1 (1.23)	2.66	0.790	16th
9	Leaf screens and water guards	7 (8.64)	14 (17.28)	50 (61.73)	6 (7.41)	4 (4.94)	2.82	0.877	11th
10	Inlet and tank fillers	12 (14.81)	3 (3.70)	39 (48.15)	24 (29.63)	3 (3.70)	3.03	1.042	7th
11	Vegetated buffers and filter strips	5 (6.17)	13 (16.05)	49 (60.49)	11 (13.58)	3 (3.70)	2.92	0.833	9th
12	Rain barrels	5 (6.17)	7 (8.64)	38 (46.91)	31 (38.27)	0 (0.00)	3.17	0.833	5th
13	Rain tanks / cisterns	4 (4.94)	5 (6.17)	25 (30.86)	45 (55.56)	2 (2.47)	3.44	0.851	3rd
14	Earthen ponds and retention basins	5 (6.17)	29 (35.80)	41 (50.62)	3 (3.70)	3 (3.70)	2.69	0.813	16th
15	The soil itself as storage	11 (13.58)	17 (20.99)	40 (49.38)	7 (8.64)	6 (7.41)	2.75	1.04	14th
16	Gravity feed	7 (8.64)	12 (14.81)	39 (48.15)	21 (25.93)	0 (0.00)	3.87*	6.00*	1st
17	Pumps (electric or manual)	5 (6.17)	2 (2.47)	23 (28.40)	41 (50.62)	10 (12.35)	3.60	0.957	2nd
18	Drip irrigation tubing	7 (8.64)	20 (24.69)	34 (41.98)	15 (18.52)	5 (6.17)	2.88	1.01	10th
19	Hoses and watering cans	5 (6.17)	20 (24.69)	26 (32.10)	25 (30.86)	4 (4.94)	3.01	1.03	8th

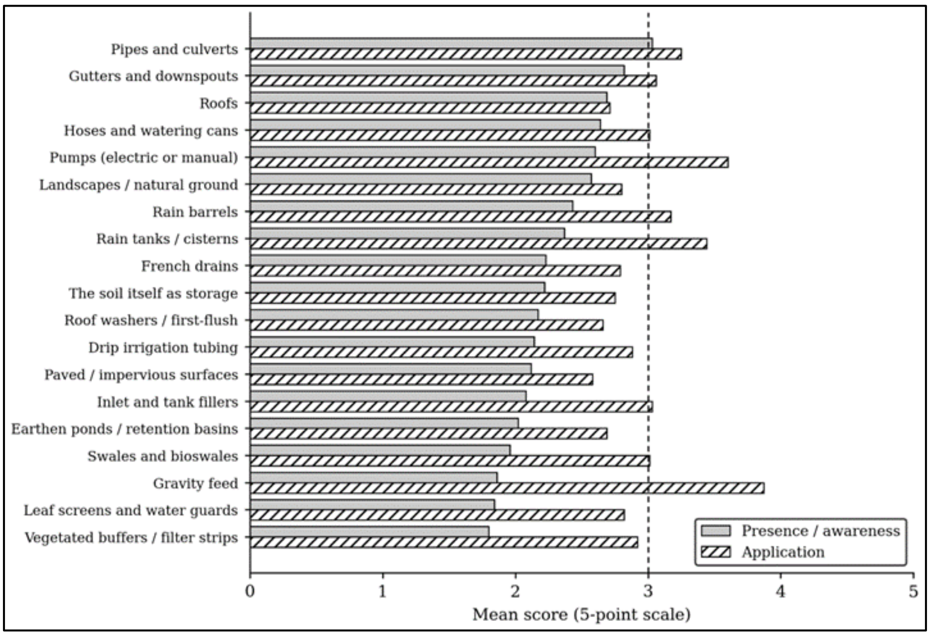
Response levels: 1 = Very inadequate to 5 = Very adequate. Percentages recomputed from reported counts. * Reported mean / SD appear inconsistent with the tabulated responses and should be verified. Source: Authors' analysis, SPSS v25 (2026).



Source: Authors' analysis (2026).

Figure 3: Mean level of application of the 19 elements (dashed line = 3.00 scale midpoint)

Placing the two sets side by side (Figure 4) shows that, for most elements, the reported level of application is higher than the reported level of presence / awareness, most markedly for gravity feed, pumps and rain tanks. This pattern is unusual and is likely influenced by the way the two constructs were labelled and measured; it is flagged here so that it can be verified against the raw data.



Source: Authors' analysis (2026).

Figure 4: Presence / awareness (solid) versus level of application (hatched) for each element

3.3 Observed Water Harvesting Applications

Field observations documented the actual implementation of harvesting strategies in each hostel. Although all nineteen elements were assessed, only those found present in each facility are shown here through photographic evidence.

3.3.1 Old Male Hostel

Figure 5: Paved / impervious surfaces as a water harvesting strategy, Old Male Hostel

Figure 6: Landscapes / natural ground as a water harvesting strategy, Old Male Hostel

Figure 5 shows the paved and impervious surfaces of the Old Male Hostel, which act as efficient catchments directing rainwater runoff into gutters. Figure 6 shows landscape and natural-ground strategies that slow surface runoff and help prevent erosion.

3.3.2 New Boys Hostel (Chief Set)

Figure 7: Roof volume as a water harvesting strategy, New Boys Hostel (Chief Set)

Figure 8: Rain tanks / cisterns as a water harvesting strategy, New Boys Hostel (Chief Set)

Figure 7 shows the extensive roof of the New Boys Hostel Chief Set, whose impermeable area intercepts rainwater that would otherwise be lost. Figure 8 shows the rainwater tanks and cisterns that store the intercepted water.

3.3.3 New Boys Hostel (Portfolio)

Figure 9: Paved / impervious surfaces as a water harvesting strategy, New Boys Hostel (Portfolio)

Figure 10: Roof as a water harvesting strategy, New Boys Hostel (Portfolio)

Figure 9 shows the paved impervious surfaces of the New Boys Hostel Portfolio, which direct runoff toward storage tanks, and Figure 10 shows its roofs acting as harvesting catchments.

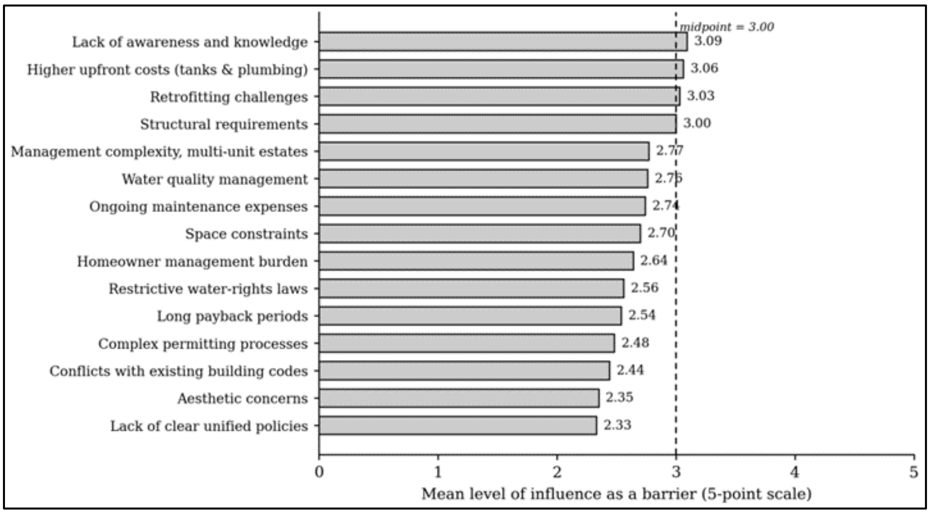
3.4 Barriers to the Integration of Water Harvesting Elements

Table 5 presents the 15 barriers to integration, selected for their recurrence in the literature on water harvesting adoption. Lack of awareness and knowledge ranked highest (Mean = 3.09, SD = 1.18), followed by higher upfront costs for tanks and plumbing (Mean = 3.06), retrofitting challenges (Mean = 3.03) and structural requirements (Mean = 3.00). Aesthetic concerns (Mean = 2.35) and lack of clear unified policies (Mean = 2.33) ranked lowest. As Figure 5's companion chart (Figure 11) shows, only four barriers reach the scale midpoint, and the leading ones combine a knowledge gap with cost.

Table 5: Descriptive statistics for barriers that inhibit the integration of water harvesting elements (N = 81)

S/No	Barrier to integration	Response distribution, n (%), N = 81					Mean	SD	Rank
		Not signif. (1)	Slightly (2)	Moderately (3)	Significant (4)	Very signif. (5)			
1	Higher upfront costs for tanks and plumbing	15 (18.52)	7 (8.64)	18 (22.22)	40 (49.38)	1 (1.23)	3.06	1.17	2nd
2	Long payback periods	20 (24.69)	14 (17.28)	30 (37.04)	17 (20.99)	0 (0.00)	2.54	1.08	10th
3	Ongoing maintenance expenses	18 (22.22)	12 (14.81)	25 (30.86)	25 (30.86)	1 (1.23)	2.74	1.15	6th
4	Space constraints	10 (12.35)	26 (32.10)	24 (29.63)	20 (24.69)	1 (1.23)	2.70	1.01	7th
5	Structural requirements	9 (11.11)	13 (16.05)	32 (39.51)	23 (28.40)	4 (4.94)	3.00	1.04	4th
6	Water quality management	23 (28.40)	7 (8.64)	25 (30.86)	18 (22.22)	8 (9.88)	2.76	1.34	6th
7	Retrofitting challenges	11 (13.58)	4 (4.94)	38 (46.91)	27 (33.33)	1 (1.23)	3.03	0.993	3rd
8	Restrictive water-rights laws	24 (29.63)	13 (16.05)	19 (23.46)	24 (29.63)	1 (1.23)	2.56	1.23	9th
9	Lack of clear unified policies	29 (35.80)	7 (8.64)	35 (43.21)	9 (11.11)	1 (1.23)	2.33	1.11	14th
10	Conflicts with existing building codes	22 (27.16)	14 (17.28)	32 (39.51)	13 (16.05)	0 (0.00)	2.44	1.06	12th
11	Complex permitting processes	25 (30.86)	10 (12.35)	31 (38.27)	12 (14.81)	3 (3.70)	2.48	1.18	11th
12	Lack of awareness and knowledge	13 (16.05)	8 (9.88)	24 (29.63)	30 (37.04)	6 (7.41)	3.09	1.18	1st
13	Aesthetic concerns	22 (27.16)	20 (24.69)	28 (34.57)	10 (12.35)	1 (1.23)	2.35	1.05	13th
14	Homeowner management burden	19 (23.46)	13 (16.05)	27 (33.33)	22 (27.16)	0 (0.00)	2.64	1.12	8th
15	Management complexity in multi-unit estates	20 (24.69)	13 (16.05)	17 (20.99)	27 (33.33)	4 (4.94)	2.77	1.28	5th

Response levels: 1 = Not significant to 5 = Very significant. Percentages recomputed from reported counts. Source: Authors' analysis, SPSS v25 (2026).



Source: Authors' analysis (2026).

Figure 11: Mean influence of the 15 barriers to integration (dashed line = 3.00 scale midpoint)

3.5 Success Factors that Enhance Integration

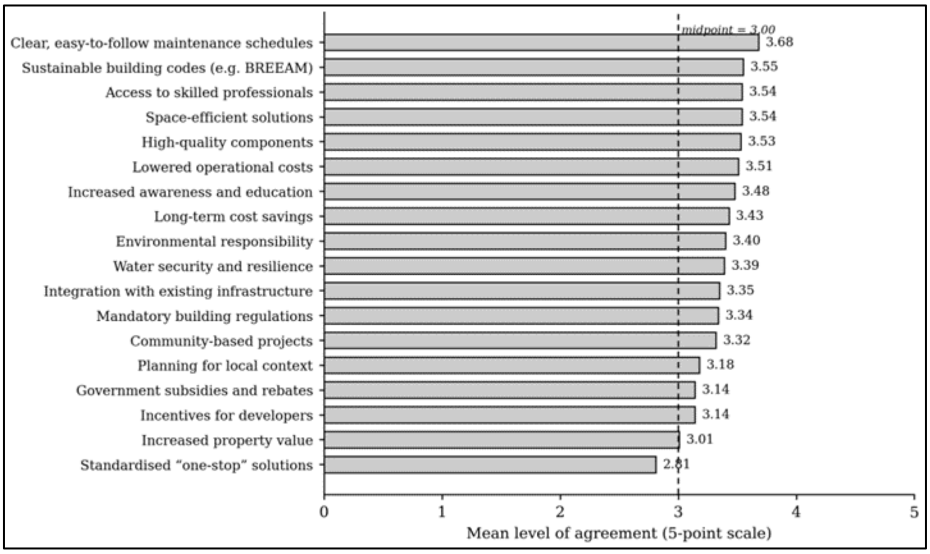
Table 6 presents the 18 critical success factors, also drawn from the literature. Clear, easy-to-follow maintenance schedules for cleaning filters and tanks ranked highest (Mean = 3.68, SD = 0.93), followed by sustainable building codes such as BREEAM (Mean = 3.55), space-efficient solutions and access to skilled professionals (both Mean = 3.54) and high-quality components (Mean = 3.53). Increased property value (Mean = 3.01) and standardised "one-stop" solutions (Mean = 2.81) ranked lowest. Every factor except the last reaches the scale midpoint, indicating broad agreement on the enablers (Figure 12).

Table 6: Descriptive statistics for factors that enhance the integration of water harvesting elements (N = 81)

S/No	Success factor	Response distribution, n (%), N = 81					Mean	SD	Rank
		Strongly disagree (1)	Disagree (2)	Not sure (3)	Agree (4)	Strongly agree (5)			
1	Mandatory building regulations	8 (9.88)	5 (6.17)	27 (33.33)	33 (40.74)	8 (9.88)	3.34	1.07	11th
2	Sustainable building codes (e.g. BREEAM)	6 (7.41)	1 (1.23)	25 (30.86)	40 (49.38)	9 (11.11)	3.55	0.974	2nd
3	Incentives for developers	0 (0.00)	10 (12.35)	49 (60.49)	22 (27.16)	0 (0.00)	3.14	0.615	14th
4	Planning for local context	5 (6.17)	8 (9.88)	38 (46.91)	27 (33.33)	3 (3.70)	3.18	0.895	13th
5	Long-term cost savings	4 (4.94)	6 (7.41)	25 (30.86)	43 (53.09)	3 (3.70)	3.43	0.879	7th
6	Lowered operational costs	0 (0.00)	9 (11.11)	36 (44.44)	41 (50.62)	5 (6.17)	3.51	0.776	5th
7	Government subsidies and rebates	0 (0.00)	18 (22.22)	38 (46.91)	20 (24.69)	5 (6.17)	3.14	0.838	14th
8	Increased property value	4 (4.94)	16 (19.75)	41 (50.62)	15 (18.52)	5 (6.17)	3.01	0.915	15th
9	Standardised "one-stop" solutions	2 (2.47)	25 (30.86)	41 (50.62)	12 (14.81)	1 (1.23)	2.81	0.760	16th
10	Integration with existing infrastructure	7 (8.64)	9 (11.11)	17 (20.99)	44 (54.32)	4 (4.94)	3.35	1.04	10th

11	Space-efficient solutions	2 (2.47)	10 (12.35)	19 (23.46)	42 (51.85)	8 (9.88)	3.54	0.922	3rd
12	High-quality components	1 (1.23)	11 (13.58)	24 (29.63)	34 (41.98)	11 (13.58)	3.53	0.936	4th
13	Increased awareness and education	5 (6.17)	10 (12.35)	17 (20.99)	39 (48.15)	10 (12.35)	3.48	1.06	6th
14	Environmental responsibility	7 (8.64)	6 (7.41)	19 (23.46)	45 (55.56)	4 (4.94)	3.40	1.00	8th
15	Community-based projects	7 (8.64)	4 (4.94)	31 (38.27)	34 (41.98)	5 (6.17)	3.32	0.985	12th
16	Water security and resilience	4 (4.94)	10 (12.35)	24 (29.63)	36 (44.44)	7 (8.64)	3.39	0.983	9th
17	Access to skilled professionals	5 (6.17)	3 (3.70)	22 (27.16)	45 (55.56)	6 (7.41)	3.54	0.922	3rd
18	Clear, easy-to-follow maintenance schedules	0 (0.00)	12 (14.81)	16 (19.75)	39 (48.15)	14 (17.28)	3.68	0.933	1st

Response levels: 1 = Strongly disagree to 5 = Strongly agree. Percentages recomputed from reported counts. Source: Authors' analysis, SPSS v25 (2026).



Source: Authors' analysis (2026).

Figure 12: Mean level of agreement on the 18 success factors (dashed line = 3.00 scale midpoint)

3.6 Inferential Statistics

A one-sample t-test examined whether clear, easy-to-follow maintenance schedules, the leading success factor, was rated significantly above the scale midpoint. The result (Table 7) showed a mean of 3.67 (SD = 0.93), t = 35.48, $p < 0.001$. Since $p < 0.05$, the null hypothesis is rejected: respondents regard clear maintenance schedules as a significantly important factor in enhancing the integration of water harvesting in hostels where such elements are in place. This supports the view that sound maintenance practice underpins sustainable water management in male hostel residences.

Table 7: One-sample t-test for "clear, easy-to-follow maintenance schedules"

Variable	N	Mean	SD	t	Sig. (2-tailed)
Maintenance schedules	81	3.67	0.93	35.48	< 0.001

Note: 95% CI [3.37, 3.73]. The reported degrees of freedom (df = 119) are inconsistent with N = 81 and should be verified. Source: Authors' analysis (2026).

Taken together, the four objectives are summarised in Table 8: conveyance elements are most in evidence, distribution elements are most applied, a knowledge gap and cost are the main barriers, and maintenance discipline is the strongest perceived enabler.

Table 8: Summary of the leading finding for each research objective

Research objective	Leading item	Mean	Key inference
Existing / available elements	Pipes and culverts	3.03	Conveyance elements are the most in evidence
Level of application	Gravity feed*	3.87*	Distribution elements are the most applied (*see data note)
Barriers to integration	Lack of awareness and knowledge	3.09	Awareness, not only cost, constrains uptake
Success factors	Clear maintenance schedules	3.68	Maintenance and codes are seen as key enablers

Source: Authors' analysis (2026). * See the data note under Table 4.

4 DISCUSSION

This study provides empirical evidence on the current state of water harvesting in selected male hostels of a Nigerian private university and its relationship with environmental sustainability, contributing to a limited body of research on the topic.

The most-applied elements were gravity feed (Mean = 3.87) and pumps (Mean = 3.60), which move collected water from storage to points of use, gravity feed exploiting the natural downward pull of stored water. This agrees with Anchan et al. (2025), who note that universities with large rooftop areas can enhance rainwater collection and the storage of non-potable water, and with Kalengay et al. (n.d.), who found positive associations between rooftop harvesting and reductions in institutional utility bills.

The limited presence of roof washers and first-flush diverters is a concern for water quality, system longevity and resident health, because the first flush of rainfall carries contaminants washed from roof surfaces into storage. This aligns with Maykot et al. (2025), who report that rainwater runoff can be highly contaminated, detectable through turbidity and colour change, and that first-flush diversion is a proven sanitary barrier that improves water quality and system reliability.

The strong showing of clear, easy-to-follow maintenance schedules (Mean = 3.67), confirmed by the t-test, is consistent with Antão-Geraldes et al. (2024), who found that continuous maintenance and cleaning schedules delivered water savings in two university residences. Lack of awareness and knowledge ranked highest among the barriers, echoing Ali et al. (2025), who identify capital cost, public perception and limited knowledge as major obstacles to urban rainwater harvesting. The prominence of maintenance among the success factors also aligns with work identifying maintenance discipline as one of many enablers of sustainable water-supply projects in Nigeria.

The photographic observations revealed clear differences between the hostels. The New Hostel Chief Set showed the greatest integration of harvesting strategies, followed by the New Hostel Portfolio; both are newer buildings in which water harvesting was treated as part of a sustainable water-management approach. The differences reflect variations in user behaviour, institutional priorities and infrastructural design, consistent with Shange et al. (2026) on green-campus initiatives and water conservation. It should be noted that the reported application ratings generally exceeded the reported presence / awareness ratings; this counterintuitive pattern (Figure 4) warrants confirmation against the raw survey data.

5 CONCLUSION AND RECOMMENDATIONS

This study underscores the importance of sustainable water management in educational institutions. Among the harvesting elements present, pipes and culverts, gutters and downspouts, and roofs were the most in evidence, while leaf screens and water guards and vegetated buffers and filter strips were largely absent. Residents were broadly aware of the extent to which the various elements had been integrated, and agreed that gravity feed, pumps and rain tanks / cisterns were the most applied, whereas roofs, earthen ponds and paved / impervious surfaces were the least. They further agreed that clear maintenance schedules, sustainable building codes and access to skilled professionals were the key enablers, and that planning for local context, developer incentives, increased property value and standardised "one-stop" solutions were the least influential.

Concern for sustainability, health and institutional efficiency is rising in student accommodation. Failure to adopt these strategies leads to higher water costs, greater vulnerability to shortages, and a missed opportunity for environmental education, while their adoption reduces water and electricity consumption and reliance on municipal supply.

Integration is therefore critical for a sustained supply in the high-density living spaces of male hostels. On this basis, the study recommends:

- Introducing smart monitoring, IoT sensors for tank levels, filter status and leak detection;
- Integrating nature-based solutions such as green roofs, permeable pavements and bio-retention basins;
- Linking harvesting systems to renewable energy, for example solar-powered pumps;
- Aligning hostel water harvesting with building codes and regulations through policy integration; and
- Running student-centred awareness programmes to build understanding of the benefits of water harvesting.

Further studies are suggested on the application of water harvesting strategies and their influence on sustainable water management in male hostels elsewhere in Nigeria, and in other building types within educational institutions.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare no conflicts of interest regarding this manuscript.

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