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Green Campus Initiative and water conservation practices in student housing

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This study investigates how Green Campus Initiative (GCI) programmes influence water conservation practices in student residences at a public university in KwaZulu-Natal, South Africa. A qualitative research design was used, involving 61 participants, including GCI members ($n = 58$), practitioners ($n = 2$), and a Residence Life Officer ($n = 1$). Data were collected through semi-structured interviews and qualitative questionnaires and analysed using thematic analysis supported by NVivo 12. The findings show that GCI initiatives such as Shower Hour, Dark Hour, water reuse (e.g. JoJo tanks) and informal environmental education raise awareness and influence daily water-use habits. However, inconsistent programme delivery, limited monitoring systems, and uneven visibility hinder sustained behavioural change. Guided by the Theory of Planned Behaviour, the study demonstrates how attitudes, subjective norms and perceived behavioural control interact to influence water-saving behaviour in residences.

Contribution: Methodologically, the study contributes by combining multistakeholder qualitative data with NVivo-assisted thematic analysis to offer residence-level insights, a context often overlooked in campus sustainability research. The study enhances understanding of behavioural and structural drivers of water conservation and provides practical recommendations to strengthen GCI implementation in higher education institutions.

Keywords: water conservation; sustainability; student residences; Green Campus Initiative; higher education; South Africa; theory of planned behaviour; environmental management.

Introduction

South African universities are increasingly facing the urgent need to strengthen environmental sustainability practices, particularly in response to the country's escalating water scarcity and infrastructure constraints. These pressures are intensified in high-density student residences, where daily water consumption is concentrated and often difficult to regulate. Safitri, Tazkiaturrizki & Hadisoebroto (2021) argue that the use of water for various purposes and interests should be undertaken wisely, with consideration for the interests of present and future generations. Therefore, it needs to be managed to ensure it is available in a safe amount, both in quantity and quality.

The Green Campus Initiative (GCI) has become a widely adopted sustainability model in South African higher education institutions (HEIs), aimed at promoting responsible water use, energy conservation and environmental awareness among students. The GCI refers to a structured institutional approach adopted by HEIs to foster environmental sustainability through behavioural change, resource efficiency and active participation of students and staff (Chen, Shahbaz & Haq 2025). It includes a variety of interventions, such as awareness campaigns, conservation programmes, policy frameworks and infrastructure upgrades, designed to reduce environmental impact and align institutional practices with global sustainability goals, such as the Sustainable Development Goals (SDGs). The GCI seeks to achieve SDGs 6: Clean Water and Sanitation and 12: Responsible Consumption and Production. Despite their widespread adoption, limited empirical research has examined how GCI programmes operate within on-campus environments, spaces that offer considerable potential to shape students' attitudes and habits towards water conservation.

Balado-Naves and Suárez-Fernández (2024) and Otrubina, Heydari and Stillwell (2025) have reported various GCI-led interventions to reduce water use; however, there is little evidence of their effectiveness in student residences, where water-use behaviour is most critical and consumption levels are highest. Challenges such as inconsistent programme rollout, limited

monitoring, uneven visibility of GCI activities, and gaps in behavioural reinforcement further complicate sustainability efforts. Consequently, universities lack data-driven insights into whether current interventions successfully influence student behaviour or address the institutional and behavioural factors driving water-use inefficiencies.

Despite the widespread adoption of GCIs in higher education, there is limited empirical evidence on their effectiveness in influencing water-conservation behaviour within student residences, where water consumption is most concentrated and difficult to regulate. Existing studies primarily focus on institutional or campus-wide sustainability frameworks, with little attention to residence-level behavioural dynamics. This creates a critical knowledge gap regarding whether GCI interventions lead to measurable behavioural change in high-density living environments.

Purpose of the study

The purpose of this study is to examine the implementation and perceived effectiveness of water-conservation initiatives in student residences at a public university in KwaZulu-Natal. This research was guided by three objectives: to identify water conservation initiatives in student residences; to examine the behavioural drivers and sustainability reinforcement mechanisms; and to analyse GCI's vision for enhancing its efforts to sustain resources and the environment.

The rest of the article is organised as follows: Section 'Theoretical framework' comprises the theoretical framework. The 'Methodology' section presents the research methodology, outlining the process and steps undertaken to collect and analyse the data. 'Results' and 'Discussion' sections are dedicated to presenting the results and discussing the findings. Lastly, the 'Conclusion' section presents the study's conclusion, summarising the key insights and implications drawn from the research.

Theoretical framework

Guided by the Theory of Planned Behaviour (TPB), the study examines how GCI-driven programmes shape student awareness, attitudes, subjective norms, perceived behavioural control (PBC) and ultimately, water-saving behaviours. Through interviews and qualitative questionnaires with students, residence practitioners, residence life officers and GCI leaders, the study identifies both enabling and constraining factors that influence water-use practices in residence environments.

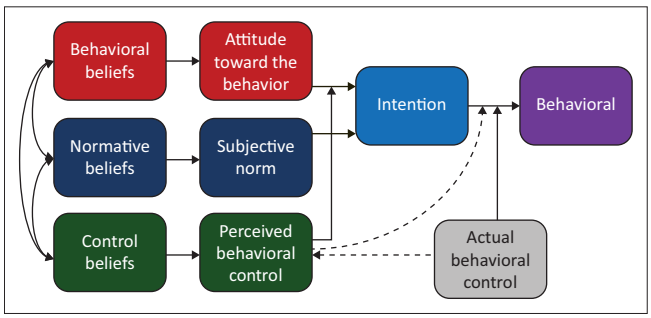
Theory of planned behaviour

The research is grounded in the TPB developed by Ajzen (1985), which enhances the Theory of Reasoned Action by incorporating PBC as a critical determinant of behavioural intentions and acts. The TPB suggests that people can hold intentions to engage in pro-environmental behaviour and experience challenges that hamper their ability to act (Macovei 2015). This theory has been effectively useful in indicating that pro-environmental activities, such as water conservation, are more likely when individuals hold positive attitudes, feel social support and believe in their own efficacy to act.

Applying the TPB to this study provides a lens for understanding how the GCI water conservation initiatives can influence students' attitudes, intentions and practices for water conservation. Through TPB, the study can understand how GCI practitioners and residence practitioners influence subjective norms, potentially reinforcing pro-environmental intentions. The TPB model posits that inputs result in outcomes that influence attitude; expectations from authority and peers, which inform subjective norms (such as peer-to-peer reminders, influence of the residence floor representative, and shared expectations around water-saving practices); and access to knowledge and resources influences behavioural control (LaMorte 2019).

Collectively, these aspects create behavioural choices that, once reinforced by favourable structural environments, coalesce into authentic water-saving behaviour. In the context of GCI, these components are deliberately targeted: the initiative seeks to cultivate positive environmental attitudes, strengthen pro-conservation norms and support student agency through campaigns, education and structured residence-level programmes. This aligns with Steg and Vlek's (2009) argument that planned behaviour towards environmental sustainability involves a deliberate set of actions aimed at reducing ecological harm.

By adopting the TPB (Figure 1), this study anchors water conservation behaviour in both psychological and situational determinants, enabling a holistic interpretation of why certain GCI practices succeed or fail in student residences. The framework provides an analytical structure that helps unpack how beliefs, norms and perceived control interact in residence environments marked by variable monitoring, inconsistent programme visibility and differing levels of institutional support. Ultimately, TPB offers a robust theoretical foundation for explaining water-saving behaviour and for identifying targeted levers to strengthen GCI-driven sustainability outcomes in higher education contexts.



Source: Adapted from Ajzen, I., 1985, *From intentions to actions: A theory of planned behaviour*, viewed 10 December 2025, from https://link.springer.com/chapter/10.1007/978-3-642-69746-3_2

FIGURE 1: Theory of planned behaviour.

Literature review

The literature on sustainability can be broad. To provide focus and context for this article, the following sections review and discuss concepts such as water scarcity in South Africa (SA), the role of HEIs in sustainability, the GCI, and gaps in residence-level water conservation.

Water scarcity context in South Africa

Water scarcity is a global concern, yet its effects are particularly acute in South Africa, where climatic variability and rising temperatures continue to intensify pressure on already fragile water systems (Matimolane & Mathivha 2025). Emile, Clammer and Jayaswal (2022) note that the recurrent crises in water access reflect the country's persistent struggle to guarantee reliable and safe water supplies. Similarly, Plessis (2021) argues that access to clean water, constitutionally enshrined as a basic human right, has, for many communities, deteriorated into an unattainable luxury. Projections for the Southern African Development Community are equally alarming: Mmakwena and Tholene (2025) report that precipitation is expected to decline by up to 20% by 2080, exacerbating scarcity in a country already ranked among the top 30% driest nations globally.

South Africa's water security challenges are further compounded by chronic infrastructural deficits. Ruiters and Amadi-Echendu (2022) highlight that the country requires an annual investment of approximately US$2.258 billion over the decade 2020–2030 to restore and expand water infrastructure. Prolonged underinvestment has significant downstream implications for national development, hindering economic productivity, public health and social well-being. According to Mugejo, Ncube and Mutsvangwa (2022), inadequate investment exacerbates vulnerability to disasters such as the 2015–2018 drought, whose effects on agricultural water supply were profound and long-lasting. They further argue that South Africa's water scarcity is reinforced by institutional fragmentation, political interference, insufficient coordination among mandated entities and shortages of skilled human resources.

Within this broader national context, HEIs are increasingly confronted with the realities of water insecurity. As Nkumbesi, Chigbu and Makapela (2025) observe, water scarcity functions as a *hidden antagonist* in the academic environment, subtly yet significantly influencing campus operations, student well-being, research productivity and the sustainability commitments of universities. The crisis compels HEIs to rethink their environmental management strategies and integrate sustainable water-use principles into their institutional planning.

Recognising the urgency of these challenges, the University of the Witwatersrand launched its flagship water research centre, Wits: H_2O, in 2025. This initiative represents a collaborative platform that unites government, industry, academia and civil society to co-develop practical, evidence-based solutions to South Africa's water crisis. By addressing both scientific and policy dimensions of water governance, the centre exemplifies how HEIs can play a decisive role in advancing national resilience, knowledge production and innovation in the water sector.

The role of higher education institutions in sustainability

The term 'sustainable university' was first used in 1990 in Talloires, France, at a meeting that included Jean Myers (Jean Mayer), head of Tufts University in the United States, and 22 university leaders from Talloires. In it, a roadmap and mechanism were developed to identify the main actions universities should take to create a sustainable future (Elsayed 2023). The GCI was developed as the mechanism that will spearhead all activities that make universities sustainable; these activities include developing frameworks to promote environmental responsibility, resource efficiency and behavioural change among students and staff (Shange, Lawa & Dlamini 2024). Green Campus Initiative is the old movement around the world rooted in SDGs 6: Clean Water and Sanitation, and SDG Goal 12: Responsible Consumption and Production, and it was only initiated in South Africa in 2012 by the Minister of Higher Education and Training, Prof. Blade Nzimande (Shange 2021). In South Africa, GCI has become an important mechanism for engaging students in environmental stewardship, particularly in contexts where resource scarcity and infrastructure pressures, such as water shortages, require innovative and behaviour-oriented solutions. As a behavioural and educational platform, GCI provides universities with practical tools to integrate sustainability into everyday campus life, positioning students' residences as key sites for transformative environmental action.

Green Campus Initiative

The GCIs is a student- and staff-led initiative launched in response to the United Nations call for HEIs to spearhead innovations and solutions towards achieving sustainable development, and has contributed to environmental sustainability through knowledge creation, green campuses, and community advising (Rosidah & Nathania 2023). However, many GCIs either fail to reach their full potential or remain hampered by inefficiencies. There is a significant GCI contribution towards reducing water consumption, an increasingly urgent priority in contexts marked by water scarcity, ageing infrastructure, and rising student populations (Ali 2025; Barnett-Itzhak et al. 2025b). Despite their potential, GCI efforts often struggle to achieve meaningful water-saving outcomes because they rely heavily on conservation technologies that many institutions cannot afford (Guo 2019). Tshivhase and Bisschoff (2024) similarly observe that constrained budgets limit universities' capacity to procure these technologies, while Marpa (2020) highlights the lack of personnel training and water-awareness education as a further barrier to sustainable water management. These challenges are compounded by the absence of an enabling national regulatory platform for environmental awareness education, one that would guide and incentivise universities to embed comprehensive green education systems in their operations (Department of Forestry, Fisheries, & Environment [DFFE] 2021).

Additional structural and behavioural challenges further undermine GCI implementation, including inconsistent student behaviour, undetected water leaks and limited monitoring tools (Ndubuisi et al. 2025). These constraints are particularly pronounced in high-density student residences, which are seldom integrated into mainstream campus sustainability assessments despite their disproportionately high levels of water consumption (Omer 2024). As a result, universities struggle to generate reliable, data-driven insights that inform targeted interventions, leading to fragmented or short-term improvements rather than sustained behavioural or infrastructural change. This underscores the need for GCI models that explicitly incorporate residential environments, strengthen monitoring capacities and reinforce behavioural drivers of water conservation to support institution-wide sustainability outcomes.

South African universities continue to implement diverse GCI programmes to improve campus sustainability.

At the University of Cape Town (UCT), the #SlowtheFlow campaign catalysed the development of a comprehensive institutional water-management guideline in 2020. Universities of South Africa (USAf) (2024) describes this as 'a well-produced organisational strategy that articulates a clear vision for a sustainable campus'. Shange, Zogli and Dlamini (2025) further argue that UCT's strategy is rooted in the principle of 'knowing our water', which emphasises systematic monitoring, prompt leak detection, digital water usage recording, the use of living-lab approaches to cultivate a waterwise community and strong collaboration with the City of Cape Town to ensure continuity during periods of water scarcity. Evidence from the Durban University of Technology (DUT) similarly demonstrates that GCI effectiveness depends on fostering active participation among internal stakeholders, such as students and staff, as well as external partners, including local schools, the media, neighbouring universities and higher education associations. Programmes such as plant-protection initiatives and cross-institutional environmental awareness campaigns illustrate the diverse nature of GCI-driven sustainability efforts (Shange et al. 2025).

Barnett-Itzhaki et al. (2025a) argue that HEI must adopt a holistic approach to water management that integrates three key strategies: runoff control, rainfall harvesting and water conservation. Water conservation strategies specifically aim to reduce consumption by implementing efficient practices and technologies that minimise unnecessary use. Beyond reducing demand, this integrated approach enhances water quality, reduces reliance on municipal water supply systems, and alleviates pressure on already-strained local water infrastructure. Collectively, these strategies support the long-term availability of water for diverse campus needs and strengthen institutional resilience in the face of increasing environmental and resource challenges.

Residence-level water conservation research

Universities have increasingly prioritised sustainability, leading to the adoption of diverse methods and frameworks for evaluating campus sustainability performance (Machado & Davim 2023). Dawodu et al. (2022) identify three main approaches to campus sustainability assessment: accounts-based, narrative and indicator-based frameworks. Accounts-based assessments convert raw resource data, such as water and electricity consumption into standardised units that enable comparability and long-term monitoring. Narrative assessments, although flexible and able to integrate multiple data sources, often lack the systematic organisation, transparency and consistency required for evidence-based decision-making. Indicator-based assessments rely on predefined metrics to track sustainability performance but tend to focus primarily on main campus operations, frequently overlooking student residences despite their substantial contribution to overall resource consumption and behavioural sustainability outcomes.

A small but growing body of literature has highlighted the particularly high levels of water use in student residences. Balado-Naves and Suárez-Fernández (2024) and Otrubina et al. (2025) report that residences consume significantly more water than other campus spaces, largely because of prolonged shower durations and restroom use. Their study showed that the current water-saving measures in homes are not very effective. They suggested some improvements to the infrastructure, such as adding flow reducers to showers and replacing washbasin mixer taps with models rated at 5 L/min and costing Euros (EUR) 138 plus Value Added Tax (VAT) (2023 prices). According to Balado-Naves and Suárez-Fernández (2024), such interventions could reduce average water consumption in residences from 10.13 m^3 to 3.81 m^3 per year. They further argue that alongside infrastructural upgrades, targeted educational programmes are essential for influencing students' water-use behaviour by raising awareness of the importance of reducing consumption.

Research methods and design

Research approach

This study adopted a qualitative research methodology, drawing on the approach used by Shange et al. (2024), who conducted a comparable investigation in South African universities.

Population and sampling

A purposive sampling strategy was employed to identify participants who met the inclusion criteria. Eligible participants included experienced GCI members, student housing Residence Life Development Officers and GCI practitioners, as these groups were directly involved in sustainability activities in student residences and were therefore well-positioned to provide rich and relevant insights. Engaging multiple stakeholder groups enhanced data triangulation and yielded a more comprehensive understanding of the GCI's role in water sustainability.

A total of 61 participants were recruited from the population of approximately 150 registered GCI members in the 2022 DUT GCI database. The sample included two GCI practitioners, one Residence Life Officer and 58 GCI members. Recruitment was facilitated through email communications disseminated through the leadership structures of the University's Student Housing Department.

Data collection instrument and procedure

Qualitative questionnaires were designed to elicit open-ended responses on participants' experiences, perceptions and involvement in GCI-related water conservation practices. The instrument included questions on awareness, behavioural practices, perceived effectiveness of interventions and recommendations for improvement. Responses were collected via Google Link Forms, adapted from an instrument previously utilised by Shange (2021), allowing participants to provide detailed narrative data and submit their responses online. Moreover, the interviews with GCI practitioners and the Residence Life Officer were conducted remotely via Microsoft Teams, following virtual data-collection approaches previously used by Maureen et al. (2020).

Data analysis

Interview data were analysed manually because of the small number of interview participants (n = 3), comprising two GCI practitioners and one Residence Life Officer. All qualitative data, both interview transcripts and questionnaire responses, were subjected to thematic analysis using NVivo 15 qualitative data analysis software (Lumivero, Denver, Colorado, United States) software to enhance the organisation and interpretation of emerging themes.

Thematic analysis followed Braun and Clarke's (2006) six-phase approach: data familiarisation, initial coding, theme identification, theme review, definition and naming of themes and final reporting. Coding was conducted iteratively using NVivo 12 to ensure systematic organisation of data. To enhance analytical rigour, themes were refined through constant comparison across data sources (interviews and questionnaires), ensuring consistency and depth of interpretation. Moreover, NVivo's hierarchical charts were used to visualise the density and distribution of responses across thematic categories, while word-cloud visualisations helped illustrate the frequency and relational patterns of key terms. These analytical strategies collectively provided a nuanced understanding of the behavioural and structural actions implemented to advance water conservation in student residences.

To enhance methodological rigour, the study applied qualitative trustworthiness criteria. Credibility was bolstered through triangulation of multiple participant groups and the use of verbatim quotations. Dependability was maintained through a systematic coding process using NVivo, while confirmability was supported by directly linking findings to participant responses.

Ethical considerations

Ethical approval to conduct this study was obtained from the Durban University of Technology Institutional Research Ethics Committee. The ethical clearance number is IREC 056/20.

Results

Residence-level Green Campus Initiative water conservation practices

The first theme captures the various GCI-led practices implemented in student residences to reduce water consumption. The participants were questioned to give their impressions of the initiatives in place to reduce water usage. That was an important question as it would inform the study about the initiatives in place to reduce water usage. The participants said there was a novel initiative to reduce water use based on time. They termed it as shower hour. Shower hour entailed using water sparingly.

The participants consistently described a range of behavioural and structural interventions aimed at reducing water consumption (see Figure 2). One of the most prominent initiatives was the dark hour, during which water is not used for an hour, and educational games are played. Students' residences used to have a programme called 'bottled water', where students filled bottles with water to drink during the day. One of the participants reinforced this by highlighting its behavioural intent:

> 'This time frame will allow students to consume less water and electricity generated through geysers.' (Participant 2, GCI practitioner, Durban)

The water usage was reduced as an outcome of the shower hour initiative, where GCI Executive implemented at the first-year residencies, shower hour initiative seeks to regulate the usage of water through having a showering time limit during which students will use less water and that shower hour was aimed at saving and reducing water usage and using it for other purposes shorter use of washing machines. As one of the GCI members explained:

> 'Shower Hour … seeks to regulate the usage of water through having a timeframe, students will use water for hygienic purposes.' (Participant 3, Residence Life Officer, Pietermaritzburg)

Beyond structured programmes, participants emphasised everyday conservation practices, such as shorter showers, controlled laundry usage, and closing taps when not in use, for example:

> 'Use your washing machine only when it is full … Avoiding long showers.' (Participant 34, GCI member, Durban)

This primarily affected water use, and closing taps when not in use was seen as a key contributor to water conservation. Reusing water from JoJo tanks for domestic use saved water. Educating people, even informally, by talking to students and explaining the importance of reducing consumption and saving water. This even included informing the representatives on the residence floor of its importance. The participants mentioned:

'We saved water by making use of Jojo tank when we were washing our clothing, that water came from the rain.' (Participant 16, GCI member, Durban)

Behavioural drivers and reinforcement mechanisms

The second theme focuses on behavioural and social processes that support water conservation within residences. Figure 3 illustrates the key behavioural strategies reported by participants to reduce water usage. Participants across all groups emphasised the importance of peer influence, awareness campaigns, and social reinforcement. For instance, students reported that reminders from peers and residence leaders contributed to behavioural compliance:

'It's a matter of informing floor reps, house committee members and even students to always reduce the use of water.' (Participant 4, GCI member, Pietermaritzbug)

Similarly, awareness programmes and educational initiatives were seen as central to shaping attitudes:

'Educate people about going green and being able to know and follow protocols ….' (Participant 34, GCI practitioner 1, Durban)

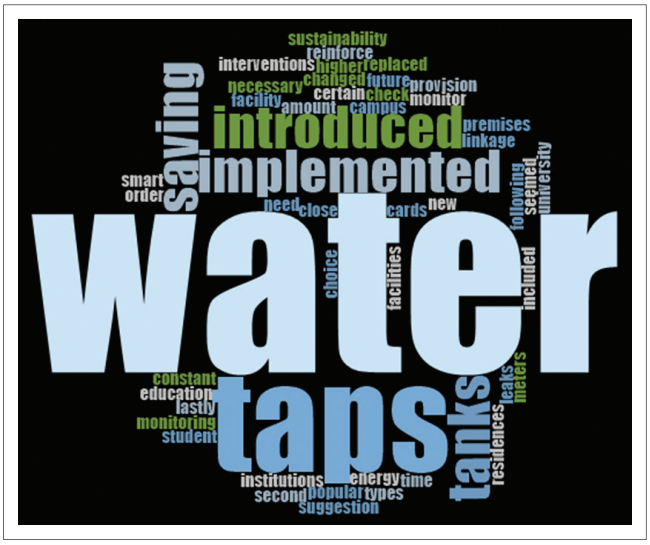
These findings demonstrate that subjective norms, as conceptualised in the TPB, are reinforced through collective expectations, peer monitoring and shared residence culture. Students are more likely to adopt conservation behaviours when such practices are normalised within their social environment. Moreover, participants also proposed future reinforcement strategies, including infrastructural and technological interventions:

'Introduce the use of smart water meters …. '

'Each residence must have its own JoJo tank.' (Participant 34, GCI member, Pietermaritzburg)

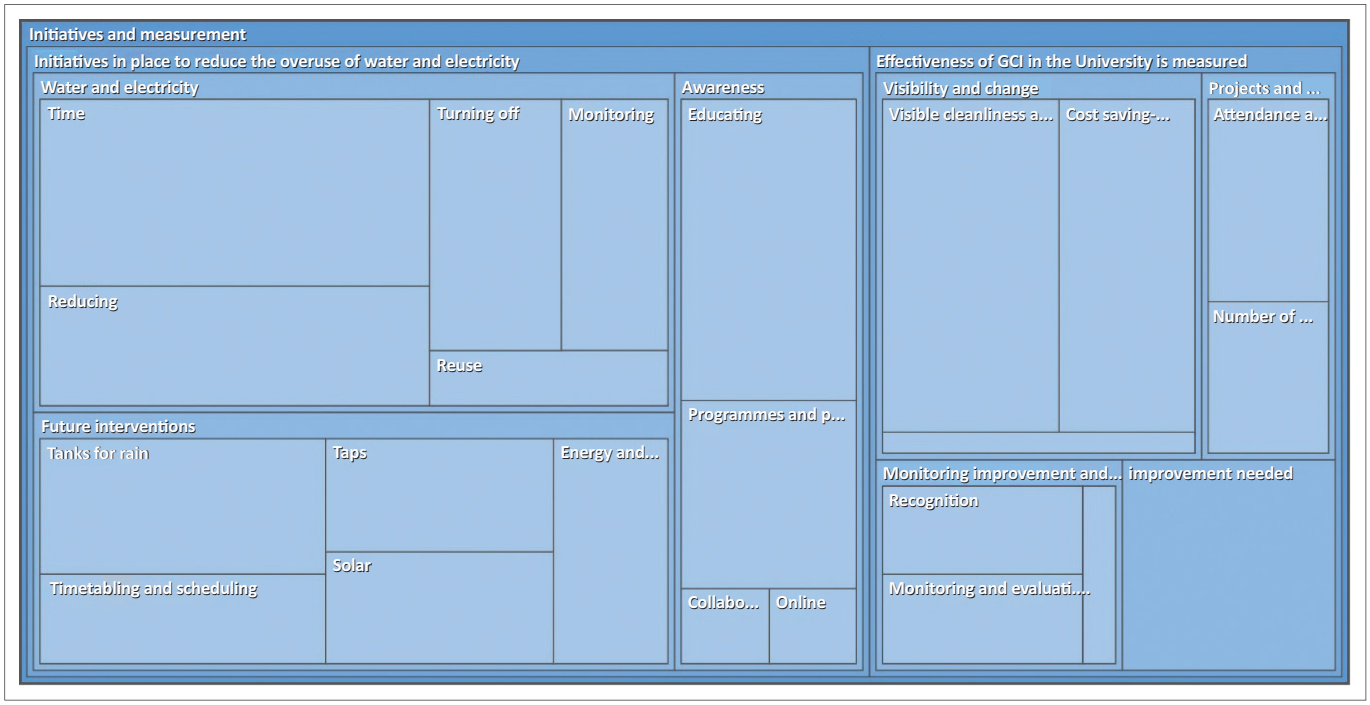
These suggestions indicate that while behavioural initiatives are important, structural support systems are necessary to sustain long-term conservation outcomes.

Informal environmental education emerged as a key behavioural lever in the residences, accounting for a significant proportion of the coded responses. Green Campus Initiative members and Residence practitioners actively engaged peers



Source: Shange, H.S., 2021, *The role of Green Campus Initiative (GCI) as integral part of environmental and sustainable resources utilization: A case study of Durban University of Technology*, viewed 18 May 2026, from https://openscholar.dut.ac.za/bitstream/10321/3945/3/HS%20Shange%20dissertation%20in%20PDF_Redacted.pdf

FIGURE 3: Water saving strategies.



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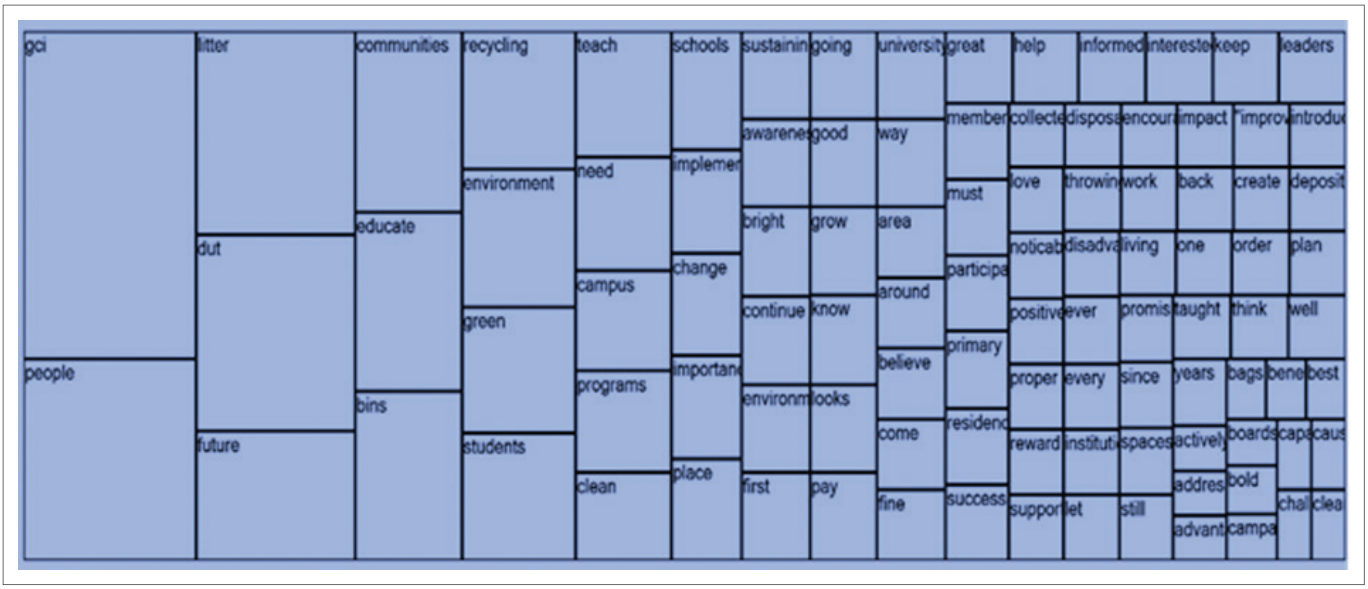
GCI, Green Campus Initiatives.

FIGURE 2: Water conservation practice.



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GCI, Green Campus Initiatives.

FIGURE 4: The future of Green Campus Initiative.

in conversations about water conservation, often using floor representatives to disseminate messages and reinforce expected practices. The participants noted that these reminders helped sustain awareness and encourage adherence to water-saving behaviours, as reflected in statements such as 'we talk to each other about saving water because some people forget' and 'Residence Practitioners (RAs) remind students on each floor, and that helps people take it seriously'. This form of peer-to-peer engagement aligns with the TPB, in which subjective norms, social expectations and perceived approval strengthen behavioural intentions. Social reinforcement further amplified these effects as students reported being more likely to adopt conservation practices when observing compliance among their peers, indicating that residence culture plays a critical role in shaping pro-environmental behaviour.

Envisioning the future of the Green Campus Initiative: Leadership, structure and sustainability potential

The NVivo tree map (Figure 4) illustrates the most frequently referenced concepts associated with participants' visions for the future of the GCI at DUT, with larger blocks reflecting higher reference density. This theme indicates strong participant engagement with discussions around the long-term sustainability of GCI. Across the responses, the participants consistently emphasised the need for high-quality, dedicated leadership as a foundational requirement for strengthening the initiative. One participant stated:

> 'GCI will only reach its full potential if there are leaders who are committed and innovative.' (Participant 34, GCI practitioner 1, Durban)

They argued that GCI would only reach its full potential if driven by leaders who are committed, innovative and aligned with the university's sustainability goals, particularly in reducing litter, improving recycling systems and promoting environmental stewardship.

A closely related theme centred on the need to institutionalise GCI within the university structure. Participants emphasised that establishing a formal GCI office or department would enhance accountability, improve coordination and ensure continuity of sustainability programmes. As one respondent suggested:

> 'There should be a proper structure or department that manages GCI so that it becomes more effective.' (Participant 1, GCI practitioner, Durban)

Participants further expressed optimism about the future of GCI, noting that its success depends on active participation from both students and staff. The findings suggest that sustained engagement, coupled with strong leadership and institutional backing, could position the university as a leading model for campus sustainability. This is supported by observations that:

> 'The institution has come a long way … but needs more support and involvement to grow further.' (Participant 1, GCI Residence Life Office, Pietermaritzburg)

Additionally, the importance of commitment and collective effort was emphasised, with participants indicating that long-term impact requires consistent involvement from all stakeholders.

Overall, the findings suggest that the future of GCI is contingent upon three interrelated factors: (1) Strong and visionary leadership, (2) Formal institutional structures and support systems and (3) Sustained student and staff engagement. Without these elements, GCI risks remaining fragmented and limited in impact. However, when

effectively integrated, it can be a transformative driver of environmental sustainability within HEIs.

Discussion

This study contributes to the growing body of scholarship on campus sustainability by foregrounding the student residence as a critical yet underexplored site of environmental practice and behavioural change. While existing literature has largely focused on institutional sustainability strategies and energy efficiency, this study extends the discourse by demonstrating how behavioural and structural dynamics interact within high-density living environments to shape water conservation outcomes. By situating the analysis within student residences, the study provides a more nuanced understanding of sustainability practices in contexts where water use is both intensive and socially mediated.

A key finding of this study is that behavioural interventions, particularly initiatives such as Shower Hour and peer-led awareness practices, play a significant role in shaping water-use behaviour. These findings align with Otrubina et al. (2025), who identify student residences as high-consumption spaces driven by routine practices such as prolonged showering. However, this study advances the literature by showing that behavioural change is not solely driven by formal programmes, but is also reinforced through informal peer engagement and social interaction. As reflected in participants' responses, practices such as 'talking to people about these issues' and reminding peers to conserve water contribute to sustained awareness and behavioural compliance.

From a theoretical perspective, these findings strongly support the TPB. Informal environmental education and peer engagement function as mechanisms through which subjective norms are constructed and reinforced, shaping individuals' intentions to adopt water-saving behaviours. The findings demonstrate that students are more likely to engage in conservation practices when such behaviours are normalised within their social environment, highlighting the importance of collective behavioural cultures within residences.

In addition to behavioural drivers, the study highlights the importance of structural interventions in enabling sustained water conservation. Participants identified the need for infrastructure such as JoJo tanks, smart monitoring systems, and improved tap technologies as critical enablers of conservation practices. These findings are consistent with the findings of Barnett-Itzhaki et al. (2025a), who emphasise the role of rainfall harvesting and runoff control in enhancing water sustainability in HEIs. However, this study extends this understanding by demonstrating that structural interventions and behavioural initiatives are interdependent, rather than standalone solutions. Without supportive infrastructure, behavioural intentions may not translate into actual conservation practices, reflecting the role of PBC within the TPB framework.

A particularly significant contribution of this study lies in identifying leadership and institutional structure as central determinants of GCI effectiveness. Participants consistently emphasised the need for committed leadership and the formalisation of GCI within the university structure. This aligns with broader institutional sustainability literature (Shange et al. 2025; USAf 2024), which highlights leadership as a key driver of strategic direction and programme continuity. However, this study deepens this insight by showing that in residence contexts, leadership is not only institutional but also relational, involving student leaders, residence staff and peer networks. This multilayered leadership structure is essential for embedding sustainability practices within everyday student life.

Despite these strengths, the study reveals a critical limitation: the absence of formal and standardised monitoring systems to measure the effectiveness of GCI interventions. While participants reported improvements in awareness and cleanliness, and perceived reductions in water use, these outcomes were largely based on subjective observations and indirect indicators, such as visible environmental changes and reduced utility costs. As noted in the observation data, effectiveness is often assessed through 'visual change' or perceived improvements rather than through empirical measurement.

This finding contrasts with studies such as Balado-Naves and Suárez-Fernández (2024), which demonstrate that water conservation initiatives can be quantitatively evaluated using meter-based data. The lack of such systems in this study context highlights a significant gap between behavioural intention and measurable environmental impact. From a theoretical standpoint, this suggests that while GCI interventions may successfully influence attitudes and subjective norms, their ability to translate into sustained behavioural outcomes is constrained by limited perceived and actual behavioural control, particularly in the absence of monitoring and feedback mechanisms.

Overall, the findings suggest that GCI initiatives in student residences operate at the intersection of behavioural, structural and institutional factors. Informal education and peer influence create a strong foundation for behavioural change, while infrastructure and monitoring systems are necessary to sustain and measure impact. Leadership and institutionalisation further provide the strategic direction required for long-term success.

This study, therefore, argues that effective water conservation in higher education cannot rely solely on awareness campaigns or technological solutions in isolation. Instead, it requires an integrated approach that combines behavioural reinforcement, infrastructural support and institutional commitment. Such an approach not only strengthens the effectiveness of GCIs but also positions student residences as transformative spaces for cultivating sustainable practices and environmental responsibility.

Recommendations

The study's findings highlight several opportunities to strengthen the implementation and impact of GCI-driven water conservation in student residences. Firstly, universities should institutionalise the GCI by establishing a formal office or departmental structure responsible for strategic planning, monitoring and coordinating sustainability programmes. This would address current inconsistencies in programme visibility, continuity and leadership. Secondly, investing in infrastructure-based interventions, including water tanks, tap monitoring systems, leak detection mechanisms and time-controlled or smart taps, is essential for supporting behavioural initiatives and reducing unintentional water loss. Thirdly, universities should adopt comprehensive monitoring frameworks, including smart water meters and consumption dashboards, to generate reliable, residence-level data that can inform decision-making. Fourthly, GCI should enhance behavioural reinforcement mechanisms by standardising residence-based educational programmes, expanding peer education networks and embedding environmental content in orientation and residence leadership programmes. Finally, to support technical training, resource mobilisation and innovative water-saving solutions, we should strengthen collaborative partnerships with local municipalities, environmental agencies and neighbouring universities.

Implications for policy and practice

The findings of this study carry important implications for both institutional policy and operational practice. At the policy level, integrating GCI objectives into the university's broader sustainability strategy would ensure alignment between residence-based programmes and institutional planning instruments. This requires developing policy guidelines for water conservation in student residences, including minimum standards for infrastructure maintenance, monitoring and reporting. Policies should also formalise the roles of residence practitioners, GCI leaders, and student housing staff in sustainability governance to improve accountability.

For practice, the study demonstrates the need to shift from ad hoc GCI activities towards structured, evidence-based implementation. Residential environments should be designated as priority zones for sustainability interventions, given their high levels of consumption and behavioural influence. Universities should operationalise routine leak inspections, introduce automated or sensor-based systems, and institutionalise behavioural interventions, such as Shower Hour, through residence handbooks and enforcement mechanisms. Training programmes for housing staff, residence practitioners and GCI volunteers should be expanded to enhance their capacity to support water-saving behaviour. Collectively, these implications reinforce the role of HEIs as catalysts for sustainability and highlight residence environments as critical operational sites for achieving significant water-saving outcomes.

Limitations and future research

Although the study provides valuable insights into residence-level water conservation, several limitations warrant acknowledgement. Firstly, the qualitative design, along with its reliance on interviews and open-ended questionnaires, limits the generalisability of the findings beyond the institution under study. Secondly, the study relied on self-reported behavioural perceptions, which may not fully reflect actual water-use practices because of recall or social-desirability bias. Thirdly, the absence of objective water-consumption metrics, such as water meter data, limited the ability to measure the direct impact of GCI interventions on actual usage patterns. Fourthly, the study examined perceptions at a single point in time; thus, it does not capture seasonal variations or long-term behavioural shifts.

Future research should therefore incorporate mixed-methods designs combining behavioural assessments with quantitative water-consumption data to evaluate programme impact more precisely. Longitudinal studies would offer deeper insights into how conservation behaviours evolve over time. Comparative studies across multiple universities could strengthen external validity and identify context-specific versus generalisable patterns in residence sustainability programmes. Finally, future work could experimentally test the effectiveness of structural interventions, such as flow restrictors, smart taps and digital dashboards on actual water reduction in residences.

Conclusion

This study advances understanding of water conservation in university residence environments by examining the behavioural and structural dimensions of GCI implementation at a public university in KwaZulu-Natal. The findings demonstrate that residence-level practices, such as Shower Hour, Dark Hour, reduced washing-machine cycles, water tanks, tap monitoring, reuse and informal educational activities play an important role in shaping student awareness and influencing water-saving intentions. However, inconsistent programme visibility, limited monitoring mechanisms and infrastructural deficiencies weaken the translation of intention into sustained behavioural change.

The application of the TPB provided a useful framework for interpreting how attitudes, subjective norms and PBC interact to shape residence-based conservation practices. Leadership and organisational structure emerged as critical to GCI's long-term sustainability, underscoring the need for institutionalised oversight and strategic coordination. Although GCI demonstrates potential to support a water-wise campus culture, the absence of robust monitoring systems limits the ability to evaluate its actual impact on residence-level consumption.

Overall, the study highlights the need for integrated behavioural and infrastructural strategies to strengthen

GCI's effectiveness. By formalising GCI structures, enhancing monitoring capacity and investing in residence-level technologies, universities can significantly improve water sustainability outcomes and contribute meaningfully to South Africa's broader environmental resilience goals.

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Competing interests

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CRediT authorship contribution

Hlanganani S. Shange: Conceptualisation, Data curation, Investigation, Project administration, Validation, Visualisation, Writing – original draft, Writing – review & editing. Bongani I. Dlamini: Funding acquisition, Methodology, Supervision, Writing – review & editing. Dumsile C. Hlengwa: Methodology, Supervision. All authors reviewed the article, contributed to the discussion of results, approved the final version for submission and publication, and take responsibility for the integrity of its findings.

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Data availability

This study involved interviews and a qualitative questionnaire at Durban University of Technology with 61 participants. A Microsoft link form was used to gather qualitative data, which was analysed to identify sub-themes. The article includes conclusions and relevant data, but sharing raw data and interview transcripts is not allowed because of privacy concerns. The corresponding author, Hlanganani S. Shange, is available for data requests.

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