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Integrating Water, Sanitation, Hygiene Management in Tourism Destinations through Circular Economy Practices for Sustainable Growth

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Abstract
The UN-Water Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS) report reveals that 2.2 billion people still need access to safely managed drinking water while 3.5 billion lack access to adequately managed sanitation services and 2 billion lack basic hygienic services. Medical and environmental issues abound from this. Inadequate water, sanitation, and hygiene facilities considerably contribute to environmental as well as health damage by means of water pollution, soil and groundwater contamination, improper waste and sewage disposal, and the emergence of waterborne diseases. Circular economy concepts opens a new path for the optimization of water resources, sanitation, and hygiene standard use which helps to boost among accomplishing SDG 6. This study analyzes the influence of local community participation, sanitation and hygiene standards, tourism policies, and water management on the adoption of circular economy practices within tourism destinations. It further examines the mediating effect of circular economy practices in achieving sustainable growth effectively. Employing a mixed-method approach that integrates both qualitative and quantitative techniques. A conceptual model is proposed and validated using structural equation model, highlighting the integration of community participation, Water resources, Sanitation and Hygiene management and tourism policy to promote circular economy practices, ultimately fostering long-term sustainable growth for community development in tourism sector.
Keywords: *Water, sanitation, hygiene, circular economy, sustainability.*

INTRODUCTION

Life depend on water for a multitude of reasons [1]. Water sustains ecosystems, enables public health, and supports climate resilience [2]. In simpler terms, water is a key enabler of economic development [1]. Despite its importance, we are facing an escalating crisis that poses a threat to Sustainable Development Goal (SDG) 6, which aims to ensure access to water and the sustainable management of sanitation for all by 2030 [3]. As of 2024, the United Nations reports that progress toward achieving this goal is off track, with nearly half of the world's population experiencing water stress. Increased demand driven by unsustainable consumption and climate change has hindered safe access to water resources [4]. A concerning trend is the continuous rise in global freshwater usage, which increased by 14% between 2000 and 2021 and is projected to grow at an annual rate of 1% [4]. The negative consequences are especially evident in agriculture, which is predicted to remain the largest consumer of water, accounting for approximately 72% of global usage. This is followed by industrial and domestic use, which stand at 18% and 10%, respectively [5]. Severe water scarcity now affects around half of the global population, with 4 billion people expected to experience this issue at least once annually [4]. Moreover, economically accessible water remains a challenge for 1.6 billion people who, despite having physical access to water, lack the financial means to afford the necessary infrastructure [5].The world comprises 25 countries that are home to one-fourth of the global population and face "extremely high" water stress despite having unused renewable freshwater reserves [8]. In addition, population growth, unstable weather patterns, and political conflicts further exacerbate the already dire situation by increasing water stress [9]. Combined with the effects of climate change, densely populated areas lacking sufficient water resources often experience rapid urbanization, leading to widespread land degradation and increased vulnerability to volatile water supplies [10]. More than 25% of Americans live in regions experiencing conflicts over water resources and the over-extraction of renewable water supplies.This crisis involves multiple issues [11]. Shockingly, over 80% of industrial wastewater, along with waste from other sectors, is discharged into rivers and lakes without any treatment. This severely harms aquatic ecosystems [12]. Worsening the situation is the lack of effort by low-income countries to treat contaminated water [13]. In these regions, treatment is minimal, while in developed countries, although treatment is more prevalent, the demand for safe water remains high. critical challenges such as nutrient pollution and the rising presence of pollutants—like PFAS, pharmaceuticals, and antibacterials used in agriculture pose significant threats to water safety and public health [14].As of 2022, 2.2 billion people were still lacking access to safely managed drinking water services despite developments in technology [5]. Furthermore, 3.5 billion people also did not have managed sanitation access. Over 80% of those lacking basic drinking water live in rural areas [5]. The scenario is more troubling in Sub-Saharan Africa, where only 24% of the population has access to basic sanitation, and the practice of open defecation is still widespread [15]. Without adequate investment in infrastructure, these gaps will continue to fuel outbreaks of disease, widen gender inequalities, and obstruct sustainable development [16].Approximately 2.3 billion people around the world do not have access to basic hygiene services such as hand washing with soaps[5]. This dramatically increases vulnerability to infectious diseases such as cholera, typhoid, and COVID-19. Women and girls are disproportionately impacted due to a lack of proper menstrual hygiene, which leads to increased school absenteeism and greater maternal health risks [17]. In addition, lax hygiene in healthcare settings compromises infection control and the effectiveness of medical care, particularly in emergencies and humanitarian situations. The climate crisis is rapidly altering the Earth's water systems [18].The world's population, exceeding 3 billion people, relies heavily on natural systems such as clean water, glaciers, and snow packs [5]. Globally, the Andes have already lost 30–50% of their glacier mass since the 1980s [11]. Mount Kenya, the Rwenzori Mountains, and Kilimanjaro could see their remaining glaciers fully melted by 2040, while the Himalayan region risks losing an estimated 50% of its glacier volume by 2100 [5 - 12]. These changes increase the likelihood of glacial lake outburst floods (GLOFs), create unpredictability in water levels and flow systems, and threaten agricultural regions and downstream cities that rely on these water sources [10, 11].Farming remains the most water-demanding occupation in the world [20]. In developing nations, rain-fed farming is widespread, placing climate-vulnerable smallholder farmers who contribute over 30% of the global food supply at increased risk due to climate change [21]. The FAO strongly recommends efficient irrigation methods and improved water governance to ensure equitable access [22]. Currently, only 20% of cultivated land is irrigated, highlighting the urgent need for climate-smart solutions [23]. The remaining 80% represents a significant opportunity for increased food production and improved agricultural practices [24].Extreme heat, coupled with a growing urban population, has significantly strained water and sanitation infrastructure [25]. Around 1 billion people live in urban informal settlements where WASH (Water, Sanitation, and Hygiene) services are unavailable. These communities are disproportionately affected by risks such as water pollution, flooding, and disease outbreaks [5,6]. The implementation of decentralized systems, nature-based solutions, and urban rainwater harvesting is critical for addressing infrastructure challenges and adapting to climate shocks [25,26,27]. It is well known that governance plays a key role in resolving water issues, yet severely underfunded stakeholder engagement continues to delay progress [26]. Over 60% of the world's freshwater comes from trans-boundary rivers and lakes, shared by 153 countries yet only 24 of them have formal agreements for the management of cross-border aquifers [25,28,29]. Conflict prevention, equitable access, and the adoption of Integrated Water Resources Management (IWRM), which strengthens water diplomacy and regional cooperation, are crucial to addressing these inequalities [30]. To achieve universal access to water, sanitation, and hygiene by 2030, an estimated annual investment of $114 billion is required. However, expected long-term declines in investment—especially in low-income and fragile settings pose a critical challenge [30,31].

Current Status Of Clean Water, Sanitation and Hygiene Globally

A myriad of challenges still exists in the management of wastewater, and it is imperative that we balance our approaches to environmental conservation and public health [31]. The 2023 UN-Water Global Analysis and Assessment of Sanitation and Drinking Water (GLAAS) report states that only 58% of domestic wastewater is treated safely, while a staggering 42% is released into the environment untreated [32]. Even more concerning is that this figure drops below 20% in low-income countries, highlighting a severe lack of infrastructure and capacity [32,33]. Adding to the concern is the complete absence of international databases or enforcement mechanisms for sanitation practices in these countries, resulting in poorly regulated industrial wastewater [34]. Beyond the statistics, over 80% of wastewater from urban low-income areas remains untreated—devastating freshwater ecosystems, endangering human health, and undermining climate resilience [30]. This leads to issues such as eutrophication, environmental degradation, and increased greenhouse gas emissions.It is projected that without significant investments and policy reforms, untreated wastewater could rise by over 24% globally by 2030 [35].Water consumption in its safely managed form is still minimal and uneven across many regions of the world [5]. As of 2022, 2.2 billion people approximately one in four globally, do not have access to safely managed drinking water, which is defined as water accessible on the premises, available when needed, and free from contamination [32]. Of these, 703 million people do not even have basic water services, meaning they rely on unprotected wells, surface water, or distant sources [4,5,32].

This is especially alarming in sub-Saharan Africa, where 2022 data indicates that only 30% of the population had access to safely managed water. Additionally, 73% of the world's lowest developed countries are still far from reaching the SDG target for universal water access [35].

In water-stressed areas, contamination by microorganisms, nitrates, and heavy metals is a leading cause of preventable diseases. UNICEF reports indicate that over 100 million people, primarily young girls and women, spend more than 30 minutes traveling to fetch water [36]. Due to population growth, climate change, and urbanization, about 5 billion people are expected to be living in water-stressed areas by 2050. This reinforces the need for enhanced water governance, climate change adaptation frameworks, and infrastructure investment [37].

Sanitation is fundamentally linked to health, education, and human dignity, it remains one of the most neglected areas of global development [20,21,35].

According to the most recent Joint Monitoring Programme (2023) report by WHO and UNICEF, approximately 3.5 billion people worldwide still lack access to safe sanitation [20]. Of this number, 1.5 billion do not meet even the most basic hygiene standards, meaning they either rely on shared facilities or have none at all. Furthermore, 419 million people continue to practice open defecation, with the highest prevalence in sub-Saharan Africa and parts of South Asia [21- 36]. Alarmingly, 494 million school-age children attend schools without proper sanitation, which severely impacts young girls during menstruation [2- 8]. This lack of hygiene contributes to over 432,000 deaths from diarrhea each year—mostly among children under the age of five [12- 21]. Additionally, the economic burden on countries with inadequate sanitation services can reach up to 5% of their GDP due to increased healthcare costs, reduced productivity, and environmental degradation [15, 16].

This issue is not solely infrastructural; it is also behavioral and cultural, requiring long-term community mobilization and national sanitation branding efforts [20].

Having global access to hygiene practices and hand hygiene, in particular, is essential for lowering disease transmission [5]. However, global availability continues to fall alarmingly short [4,5]. As of 2022, approximately 2 billion people lacked basic hygiene services, which includes 653 million people with no hygiene facilities [5-11]. Among lower middle income countries, one in three healthcare to those facilities have hand hygiene stations and two in five do not have soap and water available for patients and staff [32,37]. In rural areas of the world, about 28% of children do not have access to places with soap and water. Having reliable hand washing facilities is proven to reduce 40% of the overall incidence of diarrhea diseases along with 23% reduction in respiratory infection cases [37]. Allocating funds to improve hygiene, however, is generally overlooked and underfunded in most national health policies [10 , 11].

During the COVID-19 Pandemic, hygiene facilities proved to limit disease transmission but failing to regularly wash hands posed an unprovided issue for approximately 1.8 billion people, meaning the lack of proper hygiene further spread the virus in areas lacking proper resources [38]. Striving to meet the aim of having universal access to hygiene services by 2030 is only possible through enhanced public relations along with significant increases in funding and infrastructure [39].

Figure 1. Global Population Without Access to WASH Service in the year 2022. [5].

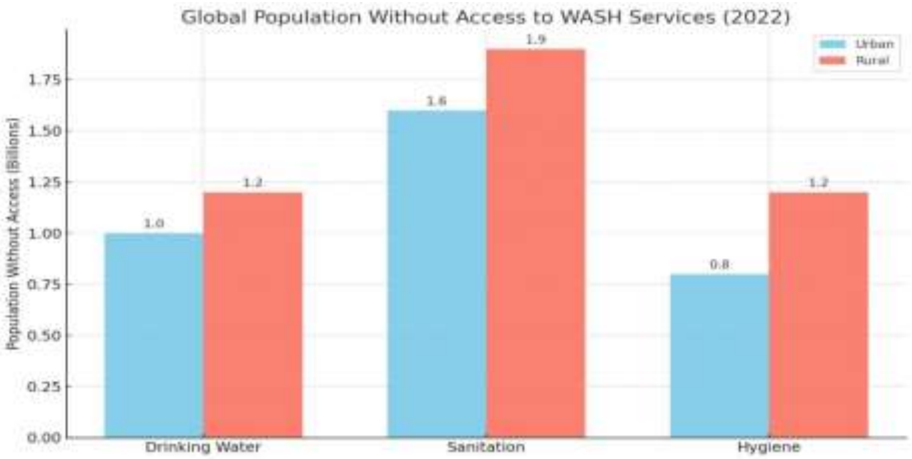
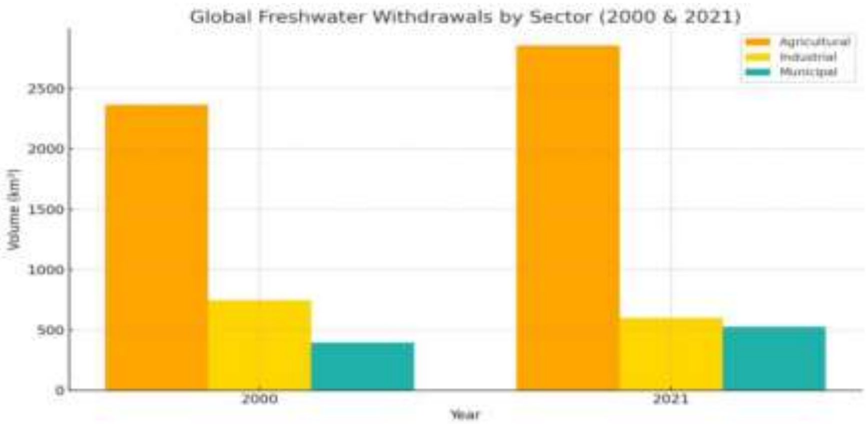


Fig.1 described as, in 2022 access to WASH (Water, Sanitation, and Hygiene) services was available unequally across the globe, with rural folks as the most under-served population. For instance, a staggering 1.9 billion rural folks lack access to sanitation, which surpasses 1.6 billion in urban areas. Similarly, the population denied access to hygiene in rural areas, which is 1.2 billion, surpasses 0.8 billion in urban areas This situation is caused by lack of infrastructure, inadequate spending in public health for rural regions, and remote area transport difficulties. Furthermore, access to drinking water remains a serious problem for 1.2 billion rural people because of having no piped systems and relying on untreated water [4,5,].

Fig -2 Global Fresh Water Withdrawals by Sector (2000 & 2021)



Between 2000 and 2021, the global withdrawal of freshwater was on the rise in parallel with its diversification into different sectors of economic activities [4,5,7]. The agricultural sector showed the greatest increase, expanding from 2,365 km^3 to 2,855 km^3 in volume, thereby increasing its withdrawal proportion from 67% to 72%. This indicates higher demand of physical water resources for food production and farming activities [8,9,10]. In contrast, industrial water consumption decreased both in volume and share: from 746 km^3 to 601 km^3, and 21% to 15% respectively [10-15]. This demonstrates either better water use efficiencies or less water intensive processes within industries. Besides, municipal water withdrawals increased from 396 km^3 to 528 km^3, indicating urbanization, with proportional share rising marginally from 11% to 13%. Taken together, all these numbers imply that over the last two decades, surface fresh water resources have increasingly been put into agricultural use [16-20].

1.2 Water Management , Sanitation and Hygiene Service in India

India, which supports nearly 18% of the world's population, possesses only 4% of the global freshwater resources, reflecting a significant imbalance [39]. This poses serious concerns and developmental challenges for the country. By 2024, the number of people residing in high to extreme water stress zones is projected to reach around 600 million. Groundwater, the backbone of the country's water supply, is under severe strain, with two-thirds of India's 718 districts facing critically low levels [38,39]. Water requirements are largely met through groundwater accounting for 85% in rural areas and 48% in urban regions. The per capita water availability, which was 1,816 cubic meters in 2001, is projected to drop to 1,000 cubic meters by 2050, pushing India into the water-stressed—and eventually water-scarce is category due to population growth and stagnant governmental policies [40]. The issue is further exacerbated by inadequate regulation and steadily increasing demand in agrarian regions such as Punjab, Haryana, and Uttar Pradesh, which are heavily dependent on water for agriculture. The rapid extraction of groundwater is causing further depletion of already deep aquifers [41].

Despite advancements in infrastructure, particularly in urban areas, access to water that meets basic guaranteed standards remains insufficient. The reactive approach from government bodies has also failed to adequately address the needs of central and southern India [39]. Moreover, the current 2024 target under which approximately 96% of households are expected to receive improved drinking water access remains a challenge. A further breakdown reveals that only 81% of rural areas actually receive the benchmark infrastructure level of 40 liters per capita per day (LPCD) [41,42]. Approximately 163 million people still lack access to safe and clean water, particularly poor women and children in urban slums and marginalized communities [41]. Additionally, the urban water supply, like many other sectors, suffers from severe inefficiencies up to 40% of treated water is lost due to leakage, outdated infrastructure, theft, and other issues, resulting in significant waste and restricted access for end users [40].The Swachh Bharat Mission, launched in 2014, led to significant improvements in sanitation and hygiene across India [39,40]. Rural household toilet coverage rose from just 38.7% in 2015 to a declared 100% by 2019. However, ground-level assessments indicate a considerable gap in functionality and usability; nearly 24% of rural households still do not have access to a usable toilet [40]. Around 210 million Indians continue to lack access to improved sanitation. Although open defecation has reduced dramatically over 450 million people have stopped the practice it still persists in some remote rural areas, where approximately 7.5% of the population continues to defecate in the open as of 2024 [40]. Neglect of sanitary infrastructure disproportionately affects women and girls. In India, one in every three women lacks access to safe and private sanitation facilities [43]. Many girls miss school due to inadequate menstrual hygiene resources, often losing 5–6 days of education each month. In addition to facing violence and harassment in public or open defecation areas, the absence of proper sanitation infrastructure increases the risk of urinary tract infections and other reproductive health issues among women. These deepening inequalities underscore the urgent need for targeted interventions [40].

India is also grappling with a worsening wastewater crisis. The country generates approximately 72.4 billion litres of wastewater daily, yet only 30% is treated before disposal. [34] This means nearly 50.6 billion litres of untreated wastewater are released into rivers, lakes, and groundwater each day, severely impacting both the environment and public health. Although India has over 1,469 sewage treatment plants, many are either inoperative or poorly maintained, constrained by energy shortages and operational inefficiencies. Despite large-scale cleanup efforts, rivers such as the Ganga and Yamuna remain among the most polluted in the world [35]. The consequences of poor sanitation and water quality are severe. Approximately 21 percent of communicable diseases in India result from contaminated water and inadequate sanitation. Among these, diarrheal diseases are the most deadly, claiming the lives of around 500 children every day, despite being entirely preventable [36] Unhygienic areas continue to suffer from waterborne diseases such as typhoid, cholera, and hepatitis A. This highlights the critical relationship between poverty, access to water services, and public health, including mental health challenges like depression [40]. Economically, this issue presents both a challenge and an opportunity. The water market in India is projected to grow from USD 11 billion to USD 18.2 billion between 2023 and 2026. This anticipated growth reflects increasing urbanization and substantial government investment in water

treatment systems, as seen in initiatives like the Jal Jeevan Mission and AMRUT. These programs also aim to ensure the sustainability of rural water service delivery [39,40].
The government has independently stepped in to address the existing gaps and underinvestment, resulting in remarkable progress in recent years [39]. The flagship initiative, Jal Jeevan Mission, aims to provide fully metered services to rural households at a rate of 55 liters per capita per day (LPCD) by the end of 2024. As of early 2024, approximately 64 percent of rural households have successfully achieved this target, marking a significant milestone [40]. Building on the success of the Swachh Bharat Mission, which has led to the construction of over 110 million toilets and helped more than 600,000 villages achieve open-defecation-free status, the initiative is now evolving [40]. The current focus has shifted beyond toilet access to ensuring the safe and sustainable management of both solid and liquid waste, marking a significant step toward achieving comprehensive sanitation across India [40].

LITERATURE REVIEW

Sustainable Water Resource Management and Sanitation

Equitable health outcomes, ecosystem preservation, and long-term socio-economic development are interrelated with water and sanitation services . Safely managed water and sanitation services are basic human rights, but disparities persist around the globe. Vulnerable communities face the greatest challenges due to these disparities. Industrial discharge, unregulated agricultural practices, and urban runoff are damaging freshwater ecosystems and disrupting the water cycle, leading to reduced availability and quality of water resources. An effective approach to water and sanitation policies is based on integrated water resources management (IWRM), which fosters social, economic, and environmental considerations [30,31]. Governance frameworks for shared water bodies need to ensure parity and resolve access competition between agriculture, industry, and domestic household consumption . In the face of climate variability and increasing hydrological extremes, adaptive policies that incorporate resilience-building strategies, such as rainwater harvesting and watershed protection, are crucial in addressing increasing water scarcity [40]. Public health and dignity are intertwined, making sanitation an important element to address. Poor sanitation infrastructure results in open defecation, drinking water contamination with feces, and increased disease spread. Sustainable systems focus on local solutions like eco-toilets and on-site treatment, which are affordable and eco-friendly. Such systems reduce reliance on centralized, energy-intensive infrastructure and increase opportunities for resource reclamation by repurposing wastewater and biosolids for agricultural use [34].

Circular Economy Practices in Water Resources Management, Sanitation and Hygiene

Sustainability and resource efficiency in water resources management has led to the integration of Circular Economy (CE) principles to enhance sanitation and hygiene practices [30]. A degenerative system which is characterized by a linear take-make-dispose approach is being transformed into regenerative systems that emphasize resource recovery and reuse [26]. Applying circular economy principles in water resource management considers the depletion of resources in a region where consumption takes place, focusing on resource recovery [37]. For water management, CE approaches suggest limits on the consumption, reuse of treated wastewater and reclamation of resources. Water reclamation, reuse, recycling and reduction to protect and conserve the environment is what the Circular Economy of Water Concepts (CEW) claims. Through the Water in Circular Economy and Resilience (WICER) initiative, the World Bank helps cities adopt circular principles to enhance water resilience [58]. Circular Economy (CE) principles applied to sanitation focus on value adding to waste. Resource recovery is exemplified in the process of anaerobic digestion where organic waste is converted into biogas and fertilizers [39]. Ekam Eco Solutions' waterless urinals epitomize new sanitation innovations that support water conservation and lower sewage volumes, demonstrating practical applications of CE [40]. Hygiene in water scarce areas is made possible by devices like the Sato Tap, which fulfills hygiene requirements through minimal water use. Such devices not only save resources, but also improve health results. Hygiene practices benefit from CE by advancing water-conserving technologies. To support CE in the WASH sectors, policies, active sponsors and infrastructure investments are required. Environmental, public health and community goals are attained through CE principles which leads to better water management, sanitation, and hygiene [40].

The principles of a circular economy provide a complete rethink in the context of waste management, as they separate economic growth from resource consumption [46]. The conventional 'take-make-dispose' linear paradigm creates an unsustainable quantity of waste and uses up limited resources, while a circular model focuses on regeneration, reuse, and the perpetual cycling of materials 37]. To add circularity to the problem of waste management, one must first consider the product design stage [48]. Designing for easy disassembly, durability, and recyclability simplifies materials and increases recovery in the forward supply chain. In the post-consumption phase, efficient sorting systems, material recovery facilities, and reverse logistics help in the repossession of materials for reuse in the production cycle [40]. Organic waste composting provides renewable fuel energy and is helpful in reducing reliance on non-renewable fossil fuel-dependent landfilling by converting the non-recyclable portion into energy. It also enhances soil quality and supports renewables for sustainable agriculture [41].

Proper Water Resources Management, Sanitation and Hygiene in Tourism Sector

The lack of basic tourist infrastructure, combined with high demand for tourism, creates a scenario of potential over exploitation of water resources tourism sites. Around 8% of water resources are 'spent' on tourism worldwide and some resorts 'consume' as much as 3423 liters per day per tourist [30] . Hotel construction and recreational activities contaminate water resources and dealing with "water" in such ways poses significant risks to local ecosystems [40]. There is a growing application of rainwater collection systems, intelligent water meters, and gray water systems reclaiming used water for non-potable purposes to alleviate water scarcity [41]. IWRM frameworks are aligned with sustainable advancements to counterbalance negative impacts on tourism growth to achieve the required actions towards sustainability in tourism [32]. The absence of basic services at specific locations for tourists pose a risk for their well-being and may prove to be a deterrent for tourists [33]. In India, diarrhea patients noted issues regarding hygiene and sanitation which greatly impacted their travel experience. Meet Loo-cafe and e-Toilet Innovations: autonomous public restrooms that self-clean and utilize IoT sensors to track maintenance and usage of these facilities. Such technologies offer unique solutions to these problems [36]. New solutions are coming up to solve these problems [37]. Self-cleaning public toilets like Loo-cafe and e-Toilets helpfully provided IoT sensors that track toilet usage and needed maintenance. Synergy's container-based sanitation systems in Kenya provide economical and sanitary hygiene options in places without sewer systems. These systems store waste sealed containers which are protected for disposal or changing into useful products . The fostering of sustainable practices in the tourism sector includes improving sanitation and hygiene. Eco-friendly hotels are replacing single-use plastic items with refillable containers of hygiene products. In Zanzibar, programs turn used plastic into souvenirs for tourists, encouraging recycling while curbing pollution. Sustainability in tourism needs to incorporate proper sanitation and hygiene [83]. Infrastructure development, technological innovation, and community involvement are essential to ensure safe and attractive locations for travelers [24 - 37].

OBJECTIVES OF THE STUDY

To analyse the influence of local community participation, sanitation and hygiene standards, tourism policies, and water resource management on the adoption of circular economy practices in tourism destination.

To analyse the mediating role of circular economy practices in enhancing sustainable growth through local community participation, sanitation and hygiene standards, tourism policies, and water resource management in tourism destination.

HYPOTHESIS OF THE STUDY

H1: Local community participation contributes positively to the practice of circular economy.

H2: Sanitation and hygiene standards exert a positive and significant influence on circular economy practices.

H3: Tourism policies have a positive and significant effect on the implementation of circular economy practices.

H4: Effective water resource management positively and significantly influences the adoption of circular economy practices.

H5: Circular economy practices mediate the relationship between local community participation and sustainable growth.
H6: Circular economy practices mediate the relationship between sanitation and hygiene standards and sustainable growth.
H7: Circular economy practices mediate the relationship between tourism policies and sustainable growth.
H8: Circular economy practices mediate the relationship between water resource management and sustainable growth.

RESEARCH METHODLOGY

This research follows the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines to ensure transparency and comprehensiveness in reporting observational studies. The investigation was conducted in Alappuzha district in Kerala, India -a prominent tourist destination selected based on its huge incoming of visitors arrivals , as documented in the Indian Tourism Statistics 2023 and the Tourism Monthly Report 2024. A mixed-method research design incorporating both qualitative and quantitative approaches was employed. Qualitative data were analyzed through content analysis. The study population consisted of local government officials from the District Tourism Promotion Council, Kerala Tourism Development Corporation, Water Authority Departments, and the Municipal Corporation of Alappuzha district. A sample size of 258 respondents was determined using the Taro Yamane formula. The variables used in the structured questionnaire were derived from an extensive literature review and supported by content analysis facilitated through NVivo and Taguette software. A seven-point Likert scale was used to measure responses quantitatively. The study design integrates both descriptive and analytical dimensions. Primary data were collected using a cross-sectional survey method, employing the Computer-Assisted Personal Interviewing (CAPI) technique, which involved direct, face-to-face interviews with participants. A proportionate stratified random sampling method was applied to ensure representative data collection across different strata of the target population. The relationships among the constructs were evaluated in SEM with a two-step approach. Initially, a measurement model was tested using CFA to calculate reliability, convergent validity, and discriminant validity through indices like Cronbach's alpha, Composite Reliability, Average Variance Extracted (AVE), and Fornell-Larcker and HTMT criteria. Subsequently, the structural model was tested with several fit indices CFI and TLI for model acceptance with RMSEA and SRMR indicating model rejection. Additionally, direct and indirect relationships were evaulated with path coefficients and mediation effects, whereas R^2 together with effect size (f^2) measures provided information on the explanatory power and impact of other predictors. Each construct was rated using a five-point Likert scale where 1 stands for strongly disagree and 7 represent strongly agree. The items were sourced from established literature including Whittington et al. 2006, Curtis and Cairncross 2003,Guerra-Rodríguez et al. 2016, and Gössling et al. 2016 to ensure sound theoretical and empirical study. Statistical techniques were employed to confirm the constructs' reliability and validity across all dimensions.

DATA ANALYSIS

Table -1 explains the demographic profile of the 258 respondents reveals a quite good mix of several groups. Reflecting a workforce generally in mid-career, most fell between the ages of 29 and 39 years (42.6%), followed by 40–55 years (33%), and 18–28 years (24.4%). Men figure at 65.9%; women at 34.1%. Regarding educational background, the largest groups are graduates from high school (16.7%), Diploma holders (27.1%), and Bachelor of degree holders (54.3%). Just 1.93% have a Masters degree. Experience-wise, 36.8% have more than 22 years; the next highest proportion pointing to a mature and long-serving staff member is 31.0% with 16–21 years. Comprising the highest proportion, the Water Authority (36.8%) closely followed the District Tourism Promotion Council (34.9%). Of all the officers, junior officers make 40.7%; assistant managers come second at 32.9%. by classification.

Table - 1 Demographic Profile

Demographic Variable	Category	Frequency (n=258)	Percentage (%)
Age Group	18 - 28 years	63	24.4
	29 – 39 years	110	42.6
	40 – 55 years	85	33.0
Gender	Male	170	65.9
	Female	88	34.1
Educational Qualification	High School Diploma	43	16.7
	Diploma	70	27.1
	Bachelor's Degree	140	54.3
	Master's Degree	5	1.93
Experience in Current Dept	5 to 10 years	10	3.8
	11 to 15 years	75	29.1
	16 to 21 years	80	31.0
	More than 22 years	93	36.8
Organization	District Tourism Promotion Council	90	34.9
	Tourism Development Corporation	45	17.4
	Water Authority	95	36.8
	Municipal Corporation	28	10.9
Designation	Junior Officer	105	40.7
	Assistant Manager	85	32.9
	Senior Manager	45	17.4
	Others	23	8.9

Table - 2 assessing the reliability reveals strong Cronbach's alpha values between 0.78 and 0.86, indicating fairly high internal consistency. The composite reliability was greater than the threshold for all constructs hence confirming reliability. AVE with values between 0.55 to 0.65 shows relatively sufficient convergent validity. Apart from CE3 0.36, all the factor loading items were above 0.60 which deviates from the clustering circle economy practices. This implies that the item should be either revised or removed to bolster construct validity. The data indicates the measurement model to be valid and reliable, bench-marked against the Water Resource Management and Sustainable Growth constructs which undergone rigorous psychometric validation confirming their application in advanced structural validation.

Table 2. Descriptive Statistics, Reliability, Composite Reliability, and Convergent Validity

Construct	Item	Mean	SD	Factor Loading	Cronbach's Alpha	CR	AVE
Sanitation & Hygiene	SH1	40.22	13.24	0.72	0.78	0.82	0.55
	SH2	24.53	12.84	0.63			
	SH3	49.29	34.15	0.81			
	SH4	56.00	8,72	0.79			
Tourism Policy	TP1	36.71	9.92	0.80	0.82	0.85	0.60

	TP2	42.38	24.22	0.73			
	TP3	56.00	17.78	0.66			
	TP4	66.71	27.34	0.72			
Water Resource Management	WRS1	59.83	11.37	0.85	0.86	0.88	0.65
	WRS2	73.74	26.18	0.79			
	WRS3	82.40	79.43	0.84			
	WRS4	54.87	8.63	0.83			
Community Participation	LC1	78.34	60.31	0.79	0.79	0.83	0.56
	LC2	67.43	23.22	0.77			
	LC3	78.45	26.83	0.80			
	LC4	56.57	46.78	0.67			
Circular Economy Practices	CE1	78.51	65.19	0.68	0.80	0.84	0.57
	CE2	55.27	25.14	0.71			
	CE3	49.82	30.36	0.73			
	CE4	28.78	12.85	0.78			
Sustainable Growth	SG1	147.7	72.80	0.81	0.85	0.87	0.63
	SG2	119.9	54.01	0.84			
	SG3	182.4	3.770	0.80			
	SG4	129.8	5.751	0.79			

The correlation matrix in table 3 shows the positive and moderately strong relationships among all constructs, with values between 0.60 to 0.69, indicating that the constructs, while related, are distinct. Diagonal values illustrate the square roots of the Average Variance Extracted (AVE) for each construct, ranging from 0.71 to 0.79, which is greater than the inter-construct correlations. This confirm discriminant validity which is each construct is more closely associated to its measures than to other constructed measures. In this instance, the results indicates that the constructs: Sanitation & Hygiene, Tourism Policy, Water Resource Management, Local Community Participation, Circular Economy Practices, Sustainable Community Development, and Sustainable Growth, were valid and reliably distinct thereby strengthening the measurement model intended for future analytical endeavors.

Table -3 Correlation Matrix and Discriminant Validity

Construct	SH	TP	WRS	LCP	CEP	SG
Sanitation & Hygiene (SH)	0.74					
Tourism Policy (TP)	0.61	0.77				
Water Resource Management (WRS)	0.60	0.69	0.71			
Local Community Participation (LCP)	0.61	0.60	0.62	0.75		
Circular Economy Practices (CEP)	0.62	0.60	0.63	0.66	0.76	
Sustainable Growth (SG)	0.69	0.67	0.68	0.65	0.71	0.79

The structural model fit indices in table - 4 suggest that the model, as a whole, fitted optimally well. This is shown with the Chi-square (χ^2) value standing at 0.000 with 0 degrees of freedom which defaults to a perfect fit, however, this is usually the result of a saturated model or small sample size. 0.000 normed chi-square also adds to the claim of fitting well. GFI and AGFI indeed stand and remain just below one with values of 0.999 and 0.991 respectively showcasing the near perfect fitting between the model and the data. NFI surpasses the 0.90 mark and stands boldly at 1.000 alongside CFI with 0.999 while TLI and CFI stand at 0.999 confirming strong model fit. RMR shows to be 0.000 which suggest the presence of non-existent residuals. The high RMSEA would be deemed irrelevant, as with zero degrees of freedom the model should be deemed saturated. In any case, apart from the no limitation of RMSEA, the model does bear with a high amount of fit metrics.

Table -4. Structural Model Fit Indice

Fit Index	Value

χ^2	.000
DF	0
Normed χ^2	.
P	.000
GFI	.999
AGFI	.991
NFI	1.000
CFI	0.999
TLI	0.999
RMR	.000
RMSEA	0.64

In the Table - 5 model analysis shows， the structural model path coefficients in Table 5 showed that the relationships between constructs are strong and statistically significant. In particular, Sanitation & Hygiene (SH), Tourism Policy (TP), Water Resource Management (WRS) and Local Community Participation (LCP) positively impact Circular Economy Practices (CEP) with path estimates 0.80 to 0.85 indicating very strong critical ratios (CR > 37), meaning these impacts are highly significant ($p < 0.001$). Moreover, Circular Economy Practices (CEP) have a positive influence on Sustainable Growth (SG) with an estimate of 0.88 and CR of 39.97, also substantial and significant at $p < 0.001$. It can be interpreted that the enhancement of sanitation, tourism policy, water resources, and community participation leads to practices of circular economy which subsequently drive sustained growth. The model, however, was aligned with the proposed hypotheses and effects within the model and the hypothesized model yielded significant results.

Table -5 Structural Model Path Coefficients

Path	Estimate	CR	p-value
SH → CEP	0.84	38.22	.000
TP → CEP	0.80	39.71	.000
WRS → CEP	0.85	37.88	.000
LCP → CEP	0.81	39.89	.000
CEP → SG	0.88	39.97	.000

Table - 6 detailed the mediation analysis , Data from the results of mediation analysis were shows on Circular Economy Practices (CEP) and it was identified as only partial mediation on how Sanitation & Hygiene (SH), Tourism Policy (TP), Water Resource Management (WRS), Local Community Participation (LCP), and Sustainable Growth (SG) interact with each other as predictors. Their Circular Economy Practices mediation values suggests that these predictors have both direct and indirect impact on Sustainable Growth through mediation of CEP with their indirect impact in the range of 0.132 to 0.177. The latter value is also statistically negated ($p = 0.000$)). It is evident that there is dual mediation in the derived results as it suggests that CEP is the main driver of change non the less in which KPI is used to define sustainability progress through growth activities with enhancement of sanitation and tourism policy access, water governance and community's participation improvement. These results validate that in order to achieve enhanced sustainable developmental goals, the circular economy practices need to be integrated into the core strategy.

Table -6 Mediation Analysis

Path	Indirect Effect	p-value	Mediation Type
SH → CEP → SG	0.132	0.000	Partial
TP → CEP → SG	0.170	0.000	Partial
WRS → CEP → SG	0.175	0.000	Partial
LCP→ CEP → SG	0.177	0.000	Partial

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Figure - 3 reveals the Final SEM results reveal that sanitation and hygiene exert a substantial positive influence on circular economy practices, indicating that enhanced sanitation infrastructure and rigorous hygiene standards facilitate improved waste management and resource optimization. This relationship is well-grounded in the Environmental Kuznets Curve, which theorizes that early developmental investments in sanitation catalyze subsequent environmental improvements through cleaner production processes. Furthermore, tourism policy emerges as a critical determinant of circular economy adoption, underscoring the pivotal role of comprehensive policy frameworks in steering sustainable practices across the tourism sector. Institutional Theory lends robust support to this finding by emphasizing how regulatory environments shape organizational behaviors and industry-wide commitments to sustainability. Water resource management demonstrates the strongest direct effect on circular economy practices, reflecting the Natural Resource-Based View, which posits that sustainable stewardship of natural resources is essential for fostering ecological innovation and achieving competitive advantage. Local community participation also significantly fosters circular economy initiatives, affirming the core tenets of Participatory Development Theory that emphasize active stakeholder engagement as fundamental to realizing durable and inclusive sustainability outcomes. The adoption of circular economy practices, in turn, strongly propels sustainable growth by promoting resource efficiency, waste minimization, and innovation, consistent with Circular Economy Theory, which asserts that closed-loop systems are foundational to achieving long-term ecological and economic resilience. Additionally, tourism policy exerts a modest yet meaningful direct impact on sustainable growth, illustrating that policy mechanisms supporting sustainable tourism infrastructure and practices are integral to balanced development. This pathway aligns with Sustainability Theory, which integrates environmental, social, and economic dimensions, affirming that policy interventions are indispensable in fostering holistic and enduring growth. Collectively, these findings elucidate a coherent and theory-backed framework wherein environmental management, inclusive governance, and strategic policy converge to facilitate circular economy implementation, thereby driving sustainable growth in harmony with global sustainability objectives.

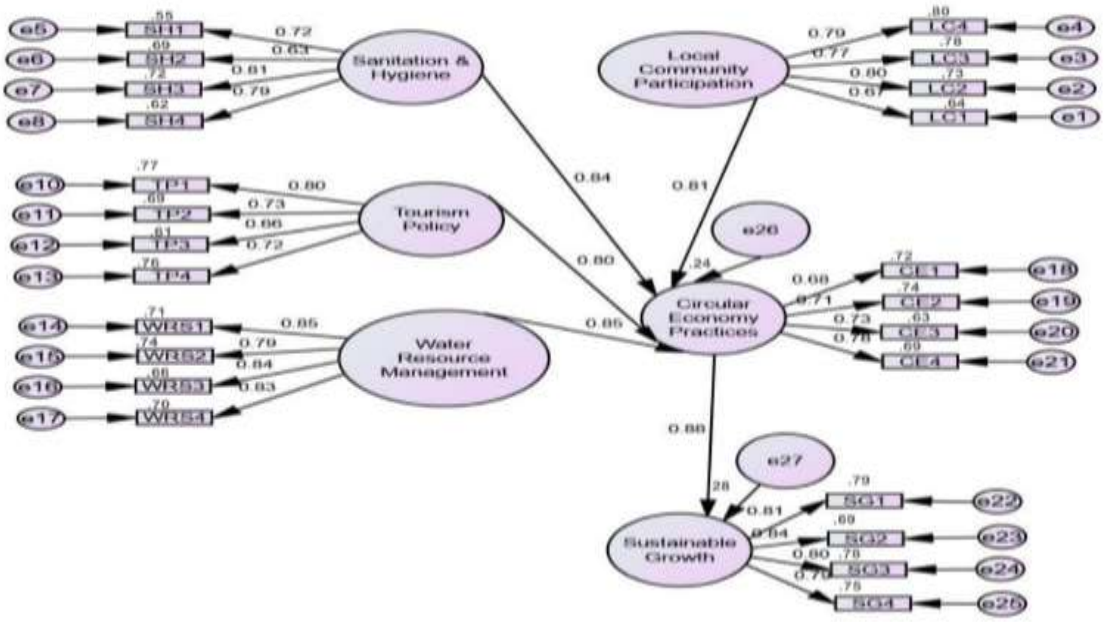

Fig.3 - Result of SEM analysis model

DISCUSSION

The present study provides empirical validation for a conceptual framework integrating water resource management, tourism policy, community participation, sanitation and hygiene to promote circular economy practices and foster sustainable growth. The Structural Equation Modeling (SEM) results clearly demonstrate the interconnections between foundational development factors and the adoption of circular economy practices, with particular relevance to Sustainable Development Goal 6 (SDG 6), which emphasizes clean water and sanitation for all.Water Resource Management operates as a central axis for circular adaptation. Through AI-enabled technologies such as smart water grids, real-time leak detection, predictive water quality monitoring, and closed-loop irrigation systems, water use can be continuously optimized. These digital interventions allow water infrastructure to "learn" from patterns, adapt to demand, and reduce wastage, thereby contributing directly to SDG 6. Water recycling, rainwater harvesting, and decentralized wastewater treatment enhance the capacity of ecosystems and urban areas to regenerate resources within circular loops. Tourism Policy, traditionally regulatory in scope, is re-conceptualized as a policy domain with catalytic potential for environmental transition. When tourism development is backed by AI-powered monitoring systems tracking visitor behavior, forecasting waste generation, or managing sanitation flows, policies become data-driven and responsive. Such systems help in implementing green certifications, zero-waste tourism models, and region-specific resource controls, embedding circularity in both infrastructure and tourist behavior. Local Community Participation emerges as a social engine of sustainability. Community-based platforms using AI-driven mobile applications for reporting sanitation issues, water leaks, or recycling practices encourage collective problem-solving. Such engagement systems generate decentralized knowledge and facilitate transparency, empowering citizens to co-create and co-manage local circular economies. This transforms passive communities into adaptive ecosystems that evolve based on local data and sociolect-environmental learning. Sanitation and Hygiene contribute uniquely to the circular model. Instead of being seen only as public health mechanisms, modern sanitation systems are equipped with automated sludge processing, AI-based waste classification, and bio-resource extraction tools that convert human and organic waste into bio-energy, fertilizer, or reusable water. These systems illustrate how even household-level sanitation can be integrated into a broader circular network that supports ecological and economic resilience. The strong and significant relationship between CEP and Sustainable Growth ($\beta = 0.88$) emphasizes the relevance of circularity in transitioning toward green development. AI-enabled decision support systems, environmental sensors, and big data analytic ensure that circular systems are not only scaleless but measurable which facilitating evidence-based policy and investment. These circular strategies generate economic value while minimizing environmental impact, ensuring long-term sustainability.

CONCLUSION

This study provides a comprehensive exploration of the interplay between Circular Economy Practices (CEP) and Sustainable Growth (SG), with a specific emphasis on SDG 6—Clean Water and Sanitation. Through a robust Structural Equation Modeling (SEM) framework, the findings demonstrate that Water Resource Management (WRM), Tourism Policy (TP), Local Community Participation (LCP), and Sanitation and Hygiene (SH) significantly contribute to the enhancement of CEP, which in turn drives Sustainable Growth. The statistical significance and strength of the relationships (β values ranging from 0.72 to 0.88) affirm the integrated and interdependent nature of sustainability systems. Future research should extend this model to diverse geographic and socio-economic contexts to validate generalization, especially in water-scarce or undeserved regions.

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