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# Sustainable development goal 11.1 in the Caribbean: assessing informal settlement upgrading in Trinidad and Tobago

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The study had the purpose of holistically assessing informal settlement upgrading in the Caribbean, due to Trinidad and Tobago's high prevalence of housing informality. Reports highlight that many cities in the region do not achieve the sustainable development goal of United Nations' SDG 11.1, "adequate, safe, and affordable housing, basic services, and upgrading slums." Furthermore, upgrading projects are rarely evaluated in relation to SDG 11.1. Therefore, the study investigated, "To what extent has the upgrading of Bamboo Settlement #3 met the United Nations' five (5) key dimensions of informal settlement upgrading?" It focused on a single case, Bamboo Settlement #3 in Trinidad and Tobago. This informal community well exemplifies the government's strategy in upgrading, comprising 379 residential lots. A mixed-methods approach and a sample that included 31 households were used to collect the primary data. The used metrics aligned with the United Nations' five key dimensions: improved water, improved sanitation, sufficient living area, structural quality, and security of tenure. The findings show that the upgrading possessed moderate access to the five key dimensions due to the inferred average access to four of the five key dimensions. The study results indicate that the government's three-pillar strategy of affordable housing grants, regularization, and regeneration and revitalization is partially effective. However, the government's dependency on international funding, the limited access to limited financial resources for the poorest households and the slow speed of upgrading result in a national situation with high and growing informal settlement.

### KEYWORDS

Caribbean, informal settlement, informal settlement upgrading, SDG 11, urban planning

## 1 Introduction

From a global perspective, the number of people living in informal settlements is on the rise, and the trend toward Sustainable Development Goal SDG 11: "Make Cities and Human Settlements Inclusive, Safe, Resilient, and Sustainable" is decreasing. The goal's target SDG11.1, "By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums," seems hard to achieve for many cities worldwide (UN, 2025; UNHabitat, 2023). More scholars recognize this global challenge and some argue that informality is rather a generalized form of urbanization (Harris, 2018; Roy, 2005; Shrestha, 2025). Given that the boundaries between informal and formal settlements

are often blurred, it raises the question as to what extent informal settlement development programs are oriented toward SDG11.1.

Although the research on informal settlement is increasing, few studies focus on Caribbean Small Island Developing States (CSIDS) despite the high percentage of informal and coastal settlement. Estimates indicate that CSIDS, particularly Trinidad and Tobago, has one of the highest percentages of its population living in informal settlements, 24.7%, after Haiti (74.4%) and Jamaica (60.5%) (UNHabitat, 2020). The development of informal settlement in the Caribbean must be considered in the historical context. After emancipation, where often formerly enslaved people were allowed to settle in houses and estates, planters ejected workers who rejected high rents, forcing them to occupy land without rights or secure tenure (Verrest, 2007; Mintz, 2017). Additionally, the lack of updated planning legislation, the non-enforcement of legal frameworks and zoning policies, the shortage of affordable housing in the market, the prevalence of social family structures such as a high percentage of female-headed single households, and the high crime rates all contribute to the growth of informal settlements (Mycoo, 2024; Goffe, 2023).

Due to this uncontrolled development, some CSIDS, like Trinidad and Tobago, are experiencing a low population growth, combined with a rapid urbanization, resulting in a disproportionate increase in urbanized land and dispersed urban sprawl. This has led to a higher built-up area per capita compared to other CSIDS (ECLAC, 2024). Additionally, many urban areas, including Bamboo Settlement #3 in CSIDS are flood vulnerable due to climate change. Roopnarine et al. (2018) identified that the majority of representatives of both formal and informal settlements within Trinidad and Tobago were “very susceptible” to flooding, with a further 40% of areas being “highly susceptible.” However, climate change adaptation (SDG 13) has weakly been systematically incorporated into policies and measures for informal settlements in the Caribbean (Atkinson, 2024; Middelbeek et al., 2014; Sandoval and Sarmiento, 2020).

Bamboo Settlement #3 is one of Trinidad and Tobago’s approximately 396 informal settlements, which well exemplifies this phenomenon (GovTT, 2016). The settlement is located in the Tunapuna/Piarco region, which is part of the wider urban area of the capital, Port-of-Spain (Figure 1). Due to its rapid growth, the land use illegally changed from agriculture to an informal residential settlement (GOVTT, 2010). This settlement was identified and registered as a “Designated Area” to receive funding for the purpose of upgrading and regularization under the Ministry of Housing and Settlements’ Squatter Regularization Program. The project primarily focused on the provision of infrastructure and land title (GovTT, 1996). The formal status, its central and optimal location to major infrastructure, as well as its historical significance, make it an ideal case study for a holistic assessment with the United Nations’ five (5) key dimensions of informal settlement upgrading.

Upgrading in the Caribbean mainly involves legalization, social housing provision, support for self-help initiatives, and regularization. Nevertheless, the measures are often project-based, not holistic, and overlook the housing conditions in the long term (Cuesta Tabares et al., 2025). Trinidad and Tobago has no comprehensive informal settlement planning or strategy in force

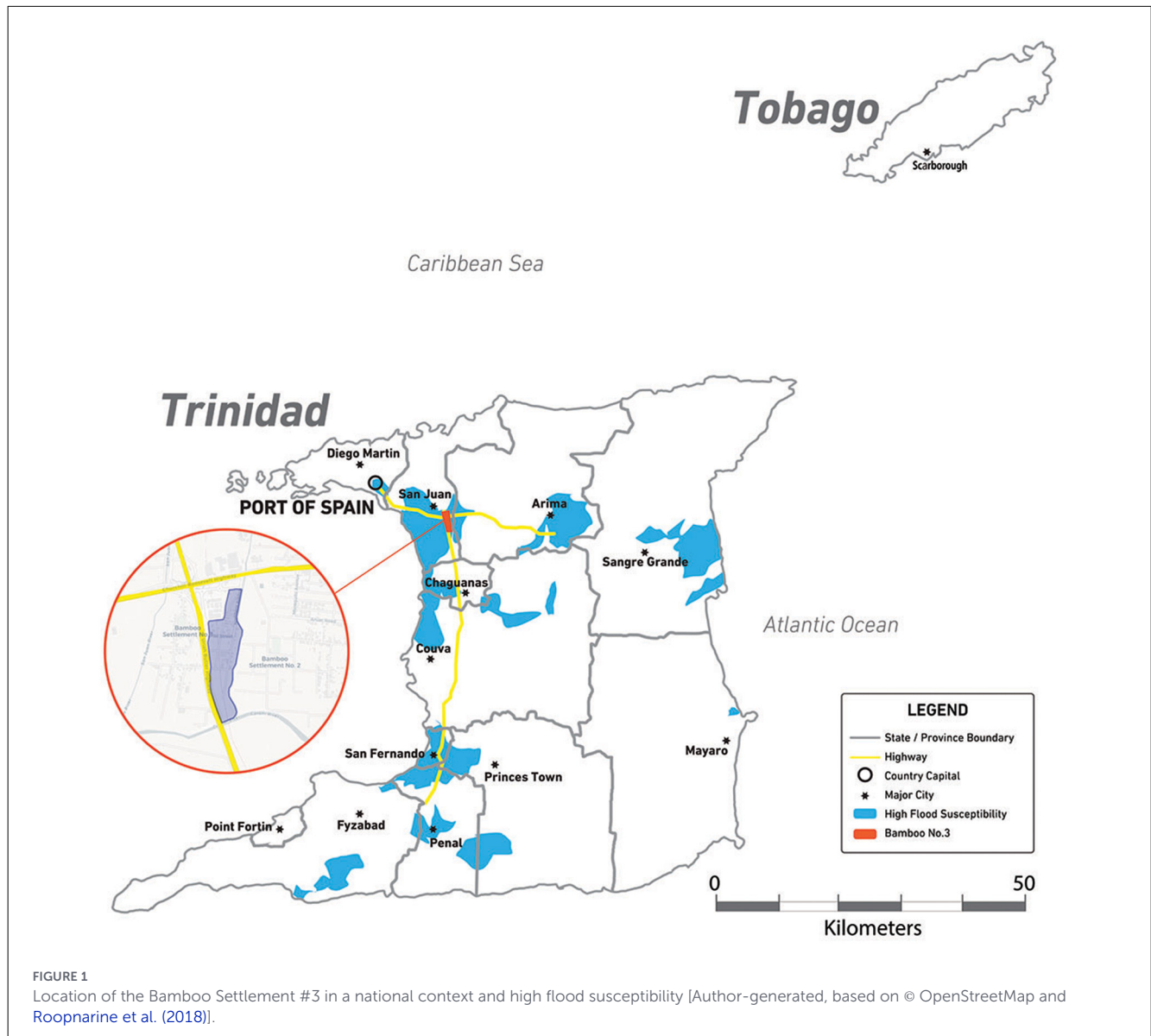
that considers aspects like lack of affordable housing for the poorest (SDG 1), healthy environments (SDG 3), gender equality (SDG 5), the systematic reduction of inequalities (SDG 10), crime reduction (SDG 16), and flood-resilient housing (SDG 13), although these are main contributors to informal settlement. Nor has the government a typology or classification for informal settlement, but it merely addresses squatter settlements and state land occupation in its legal framework and policy (GovTT, 1996, 2025b). Generally, there is a lack of consistent typologies and characteristics that allow a clear categorization of informal settlements (Cuesta Tabares et al., 2025; Henson et al., 2020). Accordingly, Trinidad and Tobago, like other Caribbean island states, are challenged by the data-based identification of housing inadequacies that have been improved and those that are still perpetuated within informal settlements.

The UN defined five core characteristics to enhance operationalizing, evaluating, and comparing interventions, which were used for the holistic assessment in this study (UNHabitat, 2018). Generally, they are rarely comprehensively used for assessing and evaluating. Scholars argue that impact evaluations are poor or lacking worldwide due to methodological challenges and poor resources after project implementation (Corburn and Sverdluk, 2017; Wainaina, 2023). Additionally, upgrading projects are often treated as an end in themselves, but even after upgrading projects, the areas develop fast and often informally.

The study’s objective was to examine to what extent the upgrading of Bamboo Settlement #3 met the United Nations’ five (5) key dimensions of informal settlement upgrading. To address the research objective, the paper first introduces the theoretical framework, followed by the methodology and a brief introduction to the study area, Bamboo Settlement #3. Subsequently, the paper will present the findings and then discuss their implications for the informal settlement upgrading policy in Trinidad and Tobago and beyond.

## 2 Informal settlements and their evaluation metrics

Informal settlement is a complex spatial-social phenomenon, and despite attempts to develop typologies, characteristics, and determinants, there are no universal conceptualizations and evaluation metrics (Cuesta Tabares et al., 2025). The so-called slum concept has metamorphosed into an umbrella term that broadly refers to and is often interchangeably used with informal or lower-quality housing (UNHabitat, 2003). However, the use of this stigmatized and colonial language poses problems for assessment and development planning. The assumption that informal housing always means lack of basic services and poverty is problematic, because it is a type of housing that develops in the absence of formal planning, regulation, implementation, and enforcement (Roy, 2005). A frequently made assumption is that upgrading of these areas is a government response to a problematic settlement structure. It can be argued that many housing and settlement improvements are self-built by the residents or community-based, which demonstrates that they respond fast and efficiently to changing personal and environmental changes (Manalang et al.,



2002; Satterthwaite, 2012). This implies that governmental-led upgrading does not prevent re-informalization (Dovey and Recio, 2023).

Because of the dynamic and the complexity of these social systems, an ongoing assessment is needed to monitor development and plan for future strategies. The value of an ongoing assessment, however, depends on the indicators used. Scholars criticize that the term “slum” is a normalized stigmatization that contributes to its complexity. This has impacted nations’ ability to collectively measure, monitor, and plan the unplanned, because such a paradigm might lead to unachievable standards and biased indicators (Ezeh et al., 2017; De Castro Mazarro, 2023). Worldwide, there is a data deficit to monitor the status quo and the development of informal settlements toward SDG, and the data collected does often not capture the needs of people (UNESCAP, 2023).

Due to the challenges, some scholars argue to merely focus on the physical characteristics (Cuesta Tabares et al., 2025). A major tool, geospatial information is increasing to monitor the

morphological and physical characteristics of informal settlement areas (Tjia and Coetzee, 2022; Kuffer et al., 2016). However, such a narrow focus might not give a comprehensive perspective that is needed for a transition toward SDG 11.1 because it neglects social realities and relationships (Abbott, 2002). Holistic evaluations are rare, as the literature review shows. The research employed Google Scholar. Although the engine has limitations, e.g., the need for individual searches, systematic studies demonstrated that it is comparable to traditional databases and includes the relevant literature with high accuracy (Winn et al., 2025; Martín-Martín et al., 2018). The search included the terms “SDG 11.1” and “informal settlement”, which resulted in 103 publications. The second round of searches replaced the search term “informal” with “slum”, which resulted in 184 publications. This search was refined with the search terms “assessment” (132 publications), “model” (111 publications), and “GIS” (50 publications). The literature revealed that the use of stigmatizing language is common. It shows a bias toward assessment of physical characteristics. And

systematic holistic evaluations of the long-term effect of measures as well as the inclusion of SDGs like climate change, health and green infrastructure are rare (Henson et al., 2020; Wicaksono and Suprapti, 2023). Additionally, the search indicated studies in large continental countries are more common than in small Caribbean island states. Especially Trinidad and Tobago is underinvestigated (Middelbeek et al., 2014).

The complexity and context dependency of informal settlement developments make them almost incomparable. An understanding of the spatial and social context is needed, as well as empirical data to avoid an oversimplification (Nuissl and Heinrichs, 2013). Hence, this study followed a holistic approach by assessing the five core characteristics to understand whether data is available and accessible, whether the method is applicable, and therefore whether it is a contribution to SDG 11.1. The next section briefly describes the past informal settlement upgrading approaches in Trinidad and Tobago.

### 3 Informal settlement upgrading approaches in Trinidad and Tobago

Upgrading policy is often a mixture of approaches, and since the 80's the use of "in-situ" and "rolling" approaches has been in use. *In situ* attempts to move the minimal number of occupants possible while attempting to facilitate the required infrastructural development. Rolling refers to the removal of most informal settlement occupants to facilitate formal infrastructural and residential development (Cirolia et al., 2017).

The upgrading in Trinidad and Tobago is linked to the colonial legacy. The "Slum Clearance and Housing Ordinances of 1935" defined slums, based on the British Housing Acts, as overcrowded areas with poor hygienic conditions and minimal roads, drains, or other services. The ordinance granted authorities the power to implement radical measures, including replanning and redevelopment, which resulted in standardized workers' homes and, frequently, the displacement of poor and low-income earners (Home, 2013). The so-called slum clearance policy changed from piecemeal so-called slum demolition, with the provision of flats and cottages in suburban areas up to 1975, to state-constructed low- and middle-income single-family units up to 1986 during the oil boom period. After that, the government introduced comprehensive development, including regulations for informal settlements and community revitalization (GovTT, 1996).

Currently, the upgrading approach is characterized by a combination of time-bound and area-based projects from external funding institutions, like the International Development Bank (IDB), and government-funded measures. These measures include three major components: affordable housing grants, regularization of state-owned lands, and regeneration and revitalization (UNHabitat, 2020). In collaboration with IDB, the government introduced a program to improve housing for lower-income groups in 2002 that is still in place (Scanlon, 2011). The Ministry of Housing offers a home improvement grant program that allows very low-income groups to repair and improve their homes (GovTT, 2025a). It also provides home improvement and home construction subsidies to low- to middle-income groups. However,

the program's effectiveness can be debated because only the poorest households, which possessed little or no savings of their own, were eligible. The cost of repairing or constructing a house often exceeds the amount of aid to such an extent that the households could not afford it. Another hurdle is to prove ownership of the dwellings. This results in a minority receiving funding (Scanlon, 2011).

Regarding the regularization of state-owned lands, the Regularization of Tenure (State Lands) Act of 1998, Chapter 57:03, represented legislation that was specifically developed to address the so-called squatting situation. The major purpose is to: (1). Facilitate physical infrastructure upgrading, which included the provision of potable water, electricity, drainage, and sewage infrastructure. (2). Facilitate security of tenure for eligible squatters who occupied state lands prior to 1998 (GovTT, 1998). The first process of improving tenure security would be the issuance of a Certificate of Comfort (COC), which provides squatters with a personal right to protection from ejection from state land but prohibits the transfer to any other person or entity, nor does it provide a legal interest in the parcel a squatter occupies. Home and Lim (2004) posit that ejection can be done by the state if necessary; however, in this event, another plot of land is identified for the squatter and made available to them.

Regeneration and revitalization are a third major component of the current informal settlement upgrading strategy, which forms a notable component of Trinidad's budget. The policy focuses on infrastructure upgrades in addition to the development of lands for resettlement projects. Mycoo and Bharath (2021) argue that especially Trinidad and Tobago's policy and its laws regarding adverse possession influence the informal settlement development. The law states that if someone occupies a parcel of state land for more than 30 years, they can claim title to that parcel in association with the established squatter regularization policies under the State Land (Regularization of Tenure) Act. The community of Bamboo Settlement #3 well exemplifies the strategy. Under the Squatter Regularization Program, Bamboo Settlement upgrading primarily focused on the provision of infrastructure and land title (GovTT, 1996).

The status quo of informal settlements, such as Bamboo Settlement #3, is the result of the interplay between legal frameworks, policies, government projects, non-governmental initiatives, private sector efforts, and self-made upgrades. Given the fast dynamic in informal settlements and without an integrated strategy and transparent governance, it is hard to determine the real contribution of specific measures and projects to the upgrading (Wainaina, 2023). The next section therefore investigates to what extent the upgrading resulted in fulfilling the five core characteristics.

### 4 Methodology

To respond to the research question, the study focuses on the results of upgrading Bamboo Settlement #3 and emphasizes the upgrades' outcomes at the local resident level. The study area is centrally located close to Port of Spain. This region represents an area of expansive and continuous rapid urban development (Figure 1). Geographically situated between two major roads, the

Churchill Roosevelt Highway and east of the Uriah Butler Highway and adjacent to the Caroni River, the largest river of the island. The settlement comprises approximately 300,021 m<sup>2</sup> and contains 379 residential lots. Historically, the area was a swamp that was altered in 1920 under the Cipriani Reclamation Scheme for rice cultivation. However, the area was considered unsuitable, and the scheme was abandoned (Juman and Ramsewak, 2013). The land was leased out in small patches for agricultural use. Due to the central location, the land use has been informally changed to self-made housing and informal infrastructure. The larger parcels are formally planned areas, developed between 1950 and 1970 primarily for use as upper-class residential housing, but also attracted so-called squatters (De Verteuil, 2000). Little has been documented about informal development in that area.

Regarding the research design, primary data was derived from the mixed research method of quantitative and qualitative research. In response to the research question, “To what extent do the current living conditions of residencies reflect the five key dimensions?”, an evaluation framework was developed that aligns with the key dimensions. Subsequently, a questionnaire with 35 questions was designed conforming to the dimensions and indicators of the framework as stated in Table 1. The types of questions that were used for each dimension are multiple-choice, closed, open-ended, and yes-no questions. The open-ended questions allowed participants to add qualitative data like specifications or descriptions of the situation. A single case study was chosen due to the purpose of the study to illustrate an issue in a bounded setting by time and location (Coombs, 2022).

Given the holistic nature of the assessment and the data shortage, the integration of multiple data sources as well as the comprehensive understanding were vital to the study (Dawadi et al., 2021). On the one hand, there exist critiques of the use of such pragmatism as a justification for the use of a mixed-methods approach due to pragmatism’s lack of definitions surrounding the phrase “what works best” (Hall, 2013). On the other hand, Feilzer (2010), Kaushik and Walsh (2019) posit that pragmatism aims to select the best available method to answer the research questions.

The data were collected with the electronic data capture tool, Kobo Toolbox. The software is designed for field data collection in challenging environments (Poloju et al., 2022). The study’s inclusion criteria specified that participants must be residents of Bamboo Settlement #3, over the age of 18, and either the head of household or a representative of the head of household. Furthermore, residents must occupy the originally identified lots of the settlement, as indicated by the registered cadastral plan of 1994, because of the requirements of the State Land (Regularization of Tenure) Act 57.05, as described earlier.

UNICEF (2006) recommends that a rule of thumb of 10% should be added to the estimated sample size to anticipate potential losses while conducting field surveys or interviews. This research project sought to derive a sample of 60 households with a 10% allowance for loss of participants, which represented a sample size of 66 households. Through the use of the probability sampling method of simple random sampling, 66 households were selected from computer-generated lots for examination. Each lot represented a potential individual household to be evaluated. To test the significance, the One Sample Student *t* (*t*-test) Confidence

Interval method was used (Stutely, 2003). The one-sample *t*-test is utilized to determine if the mean of the sample is similar to that of the sample population when the sample size is  $\geq 30$  if the population standard deviation is unknown (Mishra et al., 2019).

For the qualitative analysis, it employed Braun and Clarke’s reflexive thematic analysis approach. The method has been widely used and can represent a systematic six-step process. Accordingly, the data analysis process was as follows: to familiarize oneself with the data and its core concepts, to generate initial codes, to identify themes from collected data, to review the themes, to define and name themes, and finally to report on the themes (Braun and Clarke, 2006; Byrne, 2022).

## 4.1 Limitations

Due to participant hesitancy, the research project achieved only 47% participation from the expected 66 households, resulting in 31 households actually participating in the survey. The non-response is a well-known phenomenon in informal development research. For instance, people refuse to answer for fear of harassment, sanctions, or a lack of trust in authorities (Carr-Hill, 2013). It reduces the sample size and can introduce a bias, which can compromise the survey conclusions. However, Bailey (1994) argues that without exact knowledge of the population size and distribution, like in informal settlements, a minimum sample size of 30 is required for data analysis. Stutely (2003) confirms that a sample size of 30 can be adequate when conducting statistical analysis due to the assumption that the sampling distribution is close to a normal distribution at or above 30. Therefore, the study mainly has an exploratory value that can guide future assessments, due to its limited statistical power. The focus solely on the UN’s five key dimensions is also a simplification. Hence, the key dimensions are a minimum standard for self-made, private, or government-initiated upgrading development. SDG 11 is a complex goal, and evaluations show significant inconsistencies due to a lack of standardized frameworks. For instance, Michalina et al. (2021) identified 160 different frameworks used globally.

## 5 Results

The presentation of results follows the methodological approach established by the evaluation framework, starting with identification of the sample populations’ access to an improved water supply and finishing with secure tenure. All ( $n = 31$ ) households indicated that they possessed access to an improved supply of water and that the cost of accessing an improved water supply does not exceed 10% of household income. Water supply was direct on-lot/into-dwelling water delivery with 30 households. Merely one household stated that they utilized a public tap as their improved source of water. Regarding the costs of water supply, they are very low, as shown in Table 2.

Regarding the access to improved sanitation, the majority of households ( $n = 30$ ) secured the service through the upgrading. One household indicated that the lack of improved sanitation

TABLE 1 Evaluation framework for informal settlement upgrading.

Key dimension	Indicator	Requirements of indicator	
Access to improve water services	Households with access to 20 liters of water per person per day At an affordable rate—less than 10% of total household income Does not require more than 1 h of a 24-hourday to obtain the 20 liters of water per person per day	Direct on lot/into dwelling water delivery Public tap Rainwater harvesting Boreholes Protected springs/dug holes	
Access to improved sanitation	If a household has access to a public or private excretion disposal system.	Flush/pour toilets connected to a sewer Septic tank/pit Ventilated pit latrine Pit latrine with slab that covers the pit entirely Composting toilets/latrine	
Sufficient living area/overcrowding	Households that provide adequate living space for its members	3 persons per bedroom with a minimum bedroom size of 4 m <sup>2</sup>	
Structural quality/durability of dwelling	If a household is not located within a hazard prone environment and the structure does not lack permanency	Hazard prone environment	Building permanency
		Near toxic waste Flood plain Steep slope Dangerous right of way	Permanent wall material Permanent roof material Permanent floor material
Secure tenure	Proportion of households with protection against eviction from the State	Formal title deeds to both land and residence Formal title deeds to either one of land or residence Agreements or any documentary proof of a tenure arrangement	

Compiled by author based on Data from UNhabitat (2018, p. 8).

TABLE 2 Average cost of water supply as a percentage of total quarterly household income.

Type of water supply	County of St. George avg. quarterly income (\$)	Bamboo #3 avg. quarterly cost (\$) of water consumption	Avg. cost of quarterly household water consumption as a % of income
Internally serviced	21,271.00	219.99	1.034
Standpipe	21,271.00	33.75	0.1586

Compiled by author.

Inference of the average cost of water on a quarterly basis for Bamboo #3 utilized general income data derived from the Trinidad and Tobago National Population and Housing Census at the administrative level of a county.

TABLE 3 Mean, mode and median number of persons that occupy a dwelling unit and the number of livable rooms within a participating household (n = 31).

Overcrowding data point	Mean	Mode	Median	Standard deviation
Persons that occupy a dwelling unit	4.48	6	4	1.87
Habitable rooms per dwelling unit in Bamboo #3	5.16	5	5	1.77

Compiled by author.

is hampered due to the high financial costs associated with the implementation. This data signals that the household was likely unable to repair and maintain the facilities that had been installed.

Despite the general access, 27 households use a septic tank/pit as their improved sanitation method. Alternatively, 3 households utilized flush/pour toilets connected to a sewer.

Data collection on the structural quality and durability of dwellings indicated, on the one hand, that all households used permanent materials for their walls, roofs and floors. A minority (n = 9) require one or more major repairs to their homes. On the other hand, 22 households reported no need for major repairs. The majority (n = 22) of homes were made of permanent materials and needed no major repairs. They were in compliance with this metric. Three households required major maintenance repair for their floor. Two households needed to make major repairs to their septic tank/pit system. However, the second factor of the dimension, location, requires that a dwelling must not be near hazardous locations like toxic waste or floodplains, and this requirement is not met. Given that this dimension requires households to possess

TABLE 4 Reflexive thematic analysis—the quantification of codes and themes ( $n = 15$ ).

Themes	Tenure arrangements with HDC		No identified tenure arrangements with HDC	
No. households per theme	10		5	
Codes	Titling arrangement	HDC engagement	Lacked engagement	No identified obstacles
No. of households per code	3	7	3	2

Compiled by author.

Each code possesses their own description. Titling Arrangement refers to Household Payments Being Made Toward Deed of Title from HDC. HDC Engagement refer to Engagement with the HDC to Begin Formal Arrangement toward Land Titling. Lacked Engagement refers to No Formal Engagement by HDC to Begin Regularization. No Identified Obstacles refers to No Identified Hurdles.

access to building permanency and location in order to satisfy its criteria.

Considering the indicator of sufficient living area/overcrowding, the highest, average, and lowest number of persons per habitable room were identified to be 1.87, 0.86, and 0.37, respectively (Table 3). The highest average number of persons per habitable room in the evaluation component of “No more than 3 persons per habitable room with a minimum room size of 4 m<sup>2</sup>” would reveal that no household within the sample reflected the occurrence of overcrowding, thereby suggesting that the entirety of the sample possesses sufficient living space.

The assessment of security of tenure revealed that 14 households possessed formal title, and 2 owned a Certificate of Comfort. Through the use of reflexive thematic analysis, it was identified that an additional 10 households possessed an agreement with the landowner, which constituted tenure security (Table 4). This resulted in 25 households possessing tenure security, with a relatively small number, 5 households having no clear tenure security. In summary, the majority of households had total access to all five key dimensions of upgrading. Twenty five of households possessed access to four of the five key dimensions, with 6 households only possessing access to 3 key dimensions.

## 6 Discussion

The article sought to apply the UN 5 key dimensions of settlement upgrading to the local level of settlement evaluation as a means of the applicability of the metric. Additionally, this study investigated whether the informal settlement upgrading moved informal settlements toward the SDG 11.1. The study showed that the majority of households possess access to four key dimensions, with a minority accessing less than four. The evaluated population of Bamboo Settlement #3 possessed 30 households access to the key dimension of “Improved Form of Sanitation”. The rate of access for this dimension can be explained by the fact that the state’s policy focuses on the provision of infrastructure (Rajack and Barhate, 2004). However, the high rate of households that use septic tanks and soakaways as compared to a traditional sewer system (10%) was noteworthy. While the assessment result of this metric is positive, the effectiveness of septic systems depends on local environmental conditions (Richards et al., 2016). Through the study area’s proximity to the Caroni and St. Joseph River, as shown in Figure 1, the community is at greater risk of exposure to

nutrient-rich and strengthen and its associated consequences, as its location is within a floodplain (Maraj et al., 2022). This vulnerability does not only limit development toward SDG 11.1 but also toward SDG 3 to ensure healthy lives and promote well-being for all at all ages as well as strengthen the resilience of communities to climate-related hazards (SDG 13). Another aspect is the maintenance of infrastructure, as studies indicate that residents need the capability to maintain and sustain infrastructure upgrades (Wainaina and Truffer, 2024).

Similarly, all evaluated households possessed access to “Improved Water.” Existing literature on this topic indicates that affordability is often merely considered through access and income based on national surveys, but that connection fees and housing adaptations are often burdens in informal settlements, which affect SDG 1 the reduction of poverty (Fagundes et al., 2023; Smith, 2006). However, this does not apply to Trinidad and Tobago, given the government possesses one of the lowest costs for water in the Caribbean region (Ekwue, 2010). This can be a major contributing factor to the significant level of access to this dimension.

Considering “Sufficient Living Space,” the study showed no overcrowding. Comparatively, the national average for household size has been steadily decreasing from 4.0 persons per dwelling unit in 1990 to its current value of 3.3 persons per dwelling unit in 2011. This contrasts significantly with the 4.5 persons per dwelling unit average based on the sample from Bamboo Settlement #3. The value exceeds the estimated household size of 4 persons per household within squatting communities as identified by the Parliament of the Republic of Trinidad and Tobago (GovTT, 2016). The result relates to SDG11 in general, as the study shows that the informal city contributes to compactness but might compromise spatial justice (Soja, 2009). Nevertheless, the positive result of the assessment must be considered in the context of Trinidad and Tobago’s housing shortage and affordability crisis. Chadee shows that applicants to public-sector social housing programs increased by 5% in the last 10 years. For those who have no access to housing, it leads to informal settlement (Chadee, 2025).

Conversely, no household has access to the dimension of “Structural Quality/Durability of Dwelling”. This is due to its component of building location, which cannot be within a hazardous environment. During high rainfall events, the St. Joseph River possesses the potential to over run its banks and flood the areas within its catchment, including Bamboo Settlement #3 (Figure 1) (Maraj et al., 2022). Despite this, the component of building permanency was 22 households possessed access to permanent material for floors, walls and roofs and

did not require major repairs as per the requirements of this component. This is noteworthy due to the dwelling units being constructed by their occupants. Moreover, the provision of trunk infrastructure such as water and sewerage lines, also representative of key dimensions being evaluated, makes incremental household development associated with self-help projects more feasible given that it increases the resources that can be placed into shelter improvements over time (Bah et al., 2018).

Finally, the study indicated that 26 possessed access to the dimensions of “Secure Tenure”. The result was not unexpected given that the primary focus of the State’s settlement upgrading strategy contained a major component of title regularization that was embedded through legislation. However, there existed 25 households that possessed no clear form of tenure security. The condition affects SDGs 10 and 1, as low-income groups have less access to secure tenure. One such assertion can be the potential disadvantages associated with titling cost and the associated taxation that accompanies formal land ownership which can be burdensome for the urban poor (Payne et al., 2009). Problematic is also that residents who had not applied for a Certificate of Comfort prior to the year 2000 would not be eligible to apply currently.

Generally, it can be stated that the settlement upgrading of Bamboo Settlement #3 has resulted in a development toward SDGG 11.1 given that most of the evaluated households possessed access to 4 of the 5 dimensions of settlement upgrading. However, the assessment alone does not clarify the factors and measures that contribute to this development. Although the study did not investigate these single factors, the area is located close to major highways, and it was formally connected. Additionally, the area has a social and economical infrastructure, including its own governmental primary school, shopping malls and supermarkets that provide jobs and attract customers from outside the area, which might positively contribute to the overall upgrading outcome (Winarso, 2022; Halvorsen, 2024; Julkarnain et al., 2024).

## 7 Conclusion

In answering the overarching research question of “To what extent has the upgrading of Bamboo Settlement #3 met the United Nations’ five (5) key dimensions of informal settlement upgrading?”, it can be stated that the informal settlement of Bamboo Settlement #3 possessed moderate access to the five key dimensions of upgrading. Moderate, based on the inferred average access to four of the five key dimensions, with the lacking dimension, location, being outside the remit of settlement upgrading due to the community’s natural susceptibility to the hazard of flooding. The finding indicates that this assessment metric is not fully applicable to CSIDS given that the majority of urban and rural settlements are located in flood areas. The metrics are applicable and holistically assess the settlement. Nonetheless, a limitation is that the metric is little context-sensitive and partly neglects social realities. The metric used does not fully represent the aspects necessary for improving deprived informal communities. Socioeconomic factors and the legitimacy of the upgrading process, for instance, whether the participatory and transparent strategies

had been used, are critical for sustainable cities and communities under SDG 11 in general. Currently, there is a lack of formal and holistic strategic planning for informal settlements. So, there is no systematic implementation and evaluation of plans. The evaluation of informal settlements within the Caribbean, and in Trinidad and Tobago, would require increased sampling of a sufficient number of informal settlements to make statistical inferences about the general state of informal settlement upgrading utilizing the 5 key dimensions of settlement upgrading. This would enable the countries to effectively report on the status of SDG Goal 11.1.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Ethics statement

The studies involving humans were approved by Prof. Rahul Naidu Chair Campus Research Ethics Committee the UWI, St. Augustine Email: [STA-researchethics@sta.uwi.edu](mailto:STA-researchethics@sta.uwi.edu). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

## Author contributions

JJ: Conceptualization, Investigation, Methodology, Visualization, Writing – original draft. JK: Conceptualization, Supervision, Visualization, Writing – original draft.

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## Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/frsc.2026.1731817/full#supplementary-material>

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