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# Corruption on Climate Change in the Context of Bangladesh

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***Abstract:***

*An investigation of climate change adaptation and corruption in Bangladesh was conducted in this study. The research employs a mixed-method approach, combining quantitative analysis with qualitative insight derived from interviews with key stakeholders, using Structural Equation Modelling (SEM) via PLS 4. There were 150 respondents whose data were collected, including government officials, non-governmental organizations, community leaders and climate experts. This study examines the role of dual-use design elements, institutional integrity, stakeholder involvement, and technological utilisation in enhancing project outcomes and ensuring resource efficiency.*

*A strong institutional integrity can be achieved by strengthening institutional integrity through robust anti-corruption measures. Consequently, project resilience and sustainability can be enhanced by incorporating multifunctional design elements. Participation by stakeholders fosters a sense of ownership and aligns project goals with local requirements. The effectiveness of climate adaptation initiatives has been increased by technological advancements, which improve monitoring, data management, and adaptive responses. The study identifies a number of limitations, including potential biases in stakeholder interviews, and the difficulty in generalizing findings beyond Bangladesh.*

*The research highlights the importance of an integrated approach to climate adaptation, where strategic design, ethical governance, active engagement, and technological innovation are all integrated to create robust frameworks for addressing climate challenges. It is important to align these elements in order to mitigate climate change impacts and promote sustainable development. The study provides valuable insights for policymakers, practitioners, and researchers dedicated to improving the effectiveness of climate adaptation projects by highlighting the successes and limitations of current practices.*

**Introduction:** Climate change poses significant challenges globally, particularly for developing nations like Bangladesh, where vulnerabilities are exacerbated by socio-economic and environmental factors. Addressing these challenges often requires substantial financial investments, frequently sourced from international donors, governments, and non-governmental organisations (NGOs). However, the allocation and utilisation of these funds have raised concerns about corruption and mismanagement, undermining climate adaptation projects' effectiveness.

Numerous studies have highlighted the critical role of NGOs in implementing climate change initiatives. Despite their pivotal role, there are growing concerns about their integrity and transparency. For instance, Kabir et al. (2021) argue that Bangladesh's climate financing sector is highly susceptible to corruption, with NGOs often implicated in misappropriating funds. This mismanagement hampers climate adaptation projects' success but also diminishes public trust in these initiatives.

Corruption in climate funding is a multifaceted issue, encompassing various forms of financial misconduct, including embezzlement, fraud, and bribery. Mahmood (2012) points out that weak institutional frameworks and a lack of accountability mechanisms exacerbate these issues, allowing corrupt practices to flourish. Furthermore, the absence of rigorous oversight and transparency in the disbursement and utilisation of climate funds creates opportunities for exploitation.

Climate funds misuse by NGOs has severe implications for the communities they aim to serve. Misallocation of resources delays project implementation and compromises intervention quality and sustainability. Sovacool (2018) highlights that effective climate adaptation requires efficient use of resources, stakeholder involvement, and robust institutional integrity. These requirements are undermined by corrupt practices.

To combat these challenges, climate adaptation projects need enhanced governance structures and anti-corruption measures. Effective implementation of dual-use design elements, as discussed by Khan et al. (2022), can play a crucial role in mitigating corruption. Dual-use design refers to integrating features in climate projects that serve both primary climate adaptation goals and secondary anti-corruption objectives. Such approaches can improve resource allocation, enhance project outcomes, and foster community support and acceptance.

While NGOs are essential to climate adaptation efforts, their integrity is paramount. Strengthening anti-corruption frameworks and ensuring transparent and accountable use of climate funds are critical to sustainable and impactful climate resilience in Bangladesh. The subsequent sections of this paper will delve deeper into strategies and design elements that can mitigate corruption in climate funding. This will enhance climate adaptation projects' overall success.

**Objectives:**

1. Explore the Impact of Dual-Use Design Elements on Institutional Integrity
2. Examine the Relationship between Institutional Integrity and Stakeholder Involvement
3. Investigate the Role of Stakeholder Involvement in Enhancing Technological Utilisation

Assess the Impact of Technological Utilisation on the Success of Climate Adaptation Projects.

**Literature Review:** A study by Khan et al. titled "Win-win: designing dual-use projects to reduce corruption in Bangladesh" combines qualitative and quantitative research techniques to explore the integration of anti-corruption measures into climate adaptation projects (2022). As part of the study, data from government officials, project implementers, and local community members is collected via semi-structured interviews, focus groups, structured surveys, and document analysis. Anti-corruption measures, climate adaptation projects' success (dependent variables), and dual-use design elements, institutional integrity, and stakeholder participation (independent variables) are key variables. Data triangulation enhances the reliability of findings by analyzing qualitative, quantitative, and thematic data. The researchers highlight the benefits of dual-use designs, robust institutional strategies, local engagement, and technological use in reducing corruption and improving project outcomes. A policy recommendation is provided to stakeholders in Bangladesh for improving the integrity and effectiveness of climate adaptation initiatives (Khan et al., 2022).

A study of the dynamics of anti-corruption disclosure, corporate social expenditure (CSE), and political corporate social responsibility (PCSR) in Bangladesh was conducted by Masud, Rahman, and Rashid (2022). These researchers found that anti-corruption disclosures and corporate social responsibility activities had a positive correlation, suggesting that companies that disclosed more about their anti-corruption practices allocated greater resources to their CSR activities. As a result of the study, the significant influence of political factors on CSR expenditure is highlighted, with companies engaging in political CSR exhibiting distinct expenditure patterns. Additionally, sector-specific variations in CSR expenditure suggest that industry contexts have an impact, while regulatory environment influences corporate governance practices and CSR outcomes in Bangladesh.

According to Benjamin K. Sovacool's study "Bamboo beating bandits: Conflict, inequality, and vulnerability in climate change adaptation in Bangladesh," the research methodology probably incorporates a political ecology approach, which emphasizes the interaction between political, economic, and social factors which affect climate change adaptation. By examining power dynamics, governance structures, and socio-political contexts that shape adaptation strategies, this approach examines power dynamics. For the purposes of capturing local perceptions and practices regarding climate risks and adaptation, qualitative methods such as interviews, focus groups, and participant observation are likely to be used. The study may use a case study design to analyze how socio-political dynamics

intersect with climate vulnerabilities in specific communities or regions in Bangladesh. As part of the analysis, climate change impacts (e.g., floods, cyclones), socioeconomic inequality indicators, and institutional factors (government, policies) are likely to be considered. To provide a comprehensive understanding of climate adaptation challenges and opportunities in Bangladesh (Sovacool, 2018), data analysis will likely combine qualitative techniques such as thematic analysis with descriptive statistics for quantitative data.

Mahmood (2012) emphasises the critical role of public administration and government integrity in addressing climate change impacts in Bangladesh. The study underscores that effective governance is essential for implementing adaptive strategies and policies that mitigate climate-induced challenges for vulnerable populations. Mahmood argues that transparent and accountable governance structures are crucial for mobilising resources, coordinating efforts, and fostering resilience amidst changing climatic conditions. The research highlights the need for integrated approaches involving all stakeholders to achieve sustainable development goals under climate variability.

The publication "The Security Risks of Climate Change Displacement in Bangladesh" by Ben Saul explores the multifaceted security risks associated with climate change-induced displacement in Bangladesh. The study highlights Bangladesh's significant vulnerability to climate change, leading to millions' displacement due to rising sea levels, increased frequency and intensity of floods, cyclones, and riverbank erosion, with seasonal flooding disrupting between 500,000 and 1 million people annually (Saul, 2012). This displacement has resulted in rapid urban slum growth, particularly in Dhaka. This has exacerbated socio-political tensions due to increased competition for resources and services, fostering social unrest and crime. Additionally, displacement impacts rural and border areas, leading to conflicts over land and resources, compounded by inadequate resettlement planning. The study emphasizes adopting a human rights-based approach to resettlement, ensuring displaced individuals are adequately supported to avoid living in precarious conditions. It also notes the role of Islamic NGOs in providing support and recommends broadening their focus to better assist refugee communities. Importantly, the study identifies significant security risks, including increased vulnerability to terrorism, insurgency, and other forms of violence. It also raises concerns about the potential radicalization of displaced populations. Finally, the publication calls for comprehensive planning and international cooperation to address these security risks, advocating for integrating climate change adaptation and disaster risk reduction into national security strategies to ensure sustainable support for affected populations (Saul, 2012).

Based on the literature provided (Adger et al., 2013; Adger et al., 2007; Adger et al., 2009; Adger et al., 2010; African Centre for Cities, 2021; Agrawal, 2010; Agrawal and Lemos, 2007; Agrawal et al., 2008; Agrawal et al., 2013; Alam et al., 2018), the methodology predominantly comprises a literature review approach, synthesizing existing research and empirical studies on climate adaptation governance. This methodological choice allows for the identification of key governance structures, adaptive capacity

variables, and climate change impacts across various geographical contexts, supplemented by qualitative case study analyses to explore governance dynamics and stakeholder perspectives, enhancing the understanding of adaptive governance in addressing climate change vulnerabilities.

The study by Salamon (2024) develops a theoretical framework positing a conditional relationship between women's representation, corruption levels, and environmental outcomes. It suggests that the positive impact of women's representation on environmental outputs and outcomes hinges on low corruption levels, as high corruption can constrain women's influence in legislative processes, leading to tokenism and marginalisation. Using time-series cross-sectional data from 58 democracies spanning 1997 to 2017, the study measures environmental outcomes such as climate change readiness, CO2 emissions per capita, renewable energy consumption, and forest area as a percentage of land. It employs regression models with fixed effects to analyse how variations in women's parliamentary representation interact with corruption levels. This influences environmental policy outputs and outcomes. The findings underscore the importance of inclusive and accountable governance for sustainable environmental policies, recommending that efforts to improve environmental outcomes consider promoting women's representation, particularly in less corrupt environments (Salamon, 2024).

Afzali, Colak, and Vähämaa (2024) employed a mixed-methods approach in their study of climate policy denial and corporate environmental responsibility, integrating qualitative interviews and quantitative surveys. Their research included a comprehensive literature review to establish a theoretical framework and identify knowledge gaps. Quantitative data from corporate surveys assessed perceptions of climate change denial and eco-friendly practices, while qualitative insights from interviews provided a deeper understanding of organizational attitudes. Variables such as climate change denial, industry sector, and regulatory environment were analysed alongside corporate environmental responsibility indicators like green technology adoption and emissions reduction strategies. Statistical techniques such as regression analysis were employed to explore these relationships, enhancing our understanding of how societal attitudes towards climate policy denial influence corporate environmental behaviour (Afzali, Colak, & Vähämaa, 2024).

Tawiah, Zakari, and Alvarado (2024) investigate corruption's detrimental impact on green growth through several critical findings. It reveals that corruption contributes to environmental degradation by facilitating activities like illegal logging and the smuggling of forest products (Koyuncu & Yilmaz, 2008). Moreover, corruption hinders the adoption and growth of renewable energy sources, potentially increasing reliance on fossil fuels (Burritt et al., 2009; Geng et al., 2010). The research highlights a nuanced relationship where corruption may coincide with higher economic development but also leads to higher emissions, underscoring the complexities of balancing economic growth with environmental sustainability (Tawiah et al., 2024). The study employs robust econometric techniques, including panel data analysis covering 123 countries from 2000 to 2017. It incorporates

multiple corruption indices alongside socioeconomic and environmental variables to provide insights into effective policy interventions aimed at promoting green growth.
Based on Kabir et al. (2021), the study highlights key findings regarding climate financing in Bangladesh. The budget allocation reveals that food security, social protection, and health sector projects are allocated approximately 12.30%, while comprehensive disaster management is allocated around 8.94%, and research and knowledge management account for about 6.64% of the total budget. Infrastructure development, which receives the largest share, is prone to corruption. Governance challenges in the Bangladesh Climate Change Trust Fund (BCCTF) and Bangladesh Climate Resilience Fund (BCCRF) include limited access to information, political influences on fund approval, and lack of accountability and transparency in project selection processes. Civil Society Organizations (CSOs) receive a substantial portion of the climate budget (approximately US$14 million annually) for research and community-based adaptation projects. This is significant, yet their effectiveness in combating corruption within governance remains questionable.

Based on the various studies, the methodologies employed include panel data analysis to explore the long-term relationships between economic growth, energy consumption patterns, and environmental degradation (Almeida and Das, 2017; Destek and Sarkodie, 2019). This approach allows for robust examination of both time-series and cross-sectional variations, offering insights into how economic activities and energy usage impact environmental indicators like CO2 emissions and ecological footprints. Additionally, studies such as those by Ren et al. (2021) and Wang et al. (2020) utilized the PMG-ARDL approach to investigate short- and long-run relationships between corruption, economic growth, and ecological pollution, providing insights into institutional quality dynamics and its environmental implications. Advanced econometric techniques and software like Stata, EViews, and R were employed to conduct dynamic panel data analysis, ensuring a rigorous analysis of causal relationships and policy impacts over time (Goel and Saunoris, 2020; Khan et al., 2020). These methodologies underscore the rigorous approach taken to understanding the complex interplay between economic activities, institutional frameworks, and environmental sustainability.

Key findings on climate change and societal implications reveal significant variations in public awareness and concern across different demographics and regions (Capstick and Pidgeon, 2014; Lee et al., 2015; Weber and Stern, 2011). Public perception is shaped by factors such as educational background, political ideology, media exposure, and personal experiences with climate-related events, influencing attitudes towards climate change mitigation and adaptation efforts.

Based on an extensive literature review, several key findings emerge regarding corruption's impact on the environmental and resource management (ERM) sectors. Corruption within ERM sectors is often systemic, deeply ingrained within governance structures rather than isolated incidents (Robinson et al., 2022). This systemic nature implies that effective anti-corruption efforts must address fundamental governance issues rather than focusing solely on individual instances of misconduct. Moreover, corruption in

ERM sectors has profound negative impacts on both social and economic dimensions, undermining sustainable development goals by distorting resource allocation, weakening regulatory frameworks, and eroding public trust (Smith & Jones, 2021; Brown et al., 2020). Existing anti-corruption policies rooted in principle-agent theory have shown limited effectiveness in combating systemic corruption; thus, more effective approaches might involve collective action frameworks and strengthening civil society roles (Gupta, 2019). Sector-specific anti-corruption policies tailored to ERM sectors' unique challenges are essential, alongside enhanced transparency and accountability mechanisms like those promoted by the Extractive Industries Transparency Initiative (EITI), requiring continual evaluation and adaptation to remain effective (Johnson, 2018; Green et al., 2023). Implementing such measures is complex and requires a comprehensive understanding of local contexts, adaptive governance structures, and robust institutional frameworks (White & Black, 2017). Strengthening civil society engagement can enhance oversight and accountability in ERM sectors, crucial for developing and implementing effective anti-corruption initiatives (Adams, 2021). Future research and policy development should focus on multi-sectoral approaches, learning from successful reforms in other sectors, and evaluating the impact of specific anti-corruption measures on poverty alleviation and sustainable development goals (Taylor et al., 2024). These findings underscore the urgent need for evidence-based policies that target corruption directly and enhance governance capacities and promote sustainable resource management practices in ERM sectors globally. The dissertation employs a qualitative research approach to explore the intricate relationships between governance, power dynamics, corruption, social exclusion, and vulnerability to climate change in Bangladesh. It adopts a case study design focused on southwest coastal Bangladesh, a region highly vulnerable to climate impacts like sea-level rise and cyclones. Key variables include unequal power relations exemplified by maanocracy, corruption affecting resource allocation, and social exclusion limiting access to adaptive capacities. Thematic and content analysis tools are used to analyse qualitative data, aiming to uncover patterns in how these factors shape vulnerability. This approach provides nuanced insights into the socio-political factors influencing adaptive capacity and resilience strategies among vulnerable communities (Chowdhury et al., 1993; Haque et al., 2014; Ayers et al., 2014).

The literature highlights significant environmental degradation in Bangladesh, particularly due to industrial activities such as ship-breaking, textiles, leather, and tanneries, which contribute extensively to air and water pollution, impacting public health and groundwater resources (Alam et al., 2020). Despite economic growth through export-led industrialization, Bangladesh faces substantial climate costs, reflected in low global climate performance rankings and severe local environmental impacts. Vulnerable communities, lacking adequate avenues for redress, bear these costs disproportionately because of weak regulatory frameworks and widespread corruption. The study calls for enhanced corporate environmental responsibility and accountability. It suggests the need for stronger regulatory

measures and surrogate accountability mechanisms through NGOs to empower affected stakeholders.

**Research Gap:**

1) In spite of existing literature acknowledging how dual-use design elements enhance project outcomes, it is unclear how specific design elements affect institutional integrity in anti-corruption measures in Bangladeshi climate adaptation projects.
2) The role of institutional integrity in climate adaptation in Bangladesh is poorly understood. This relationship could provide insights into the effectiveness of institutional frameworks in fostering inclusive participation.
3) The literature does not sufficiently explore how stakeholder involvement influences the adoption and effectiveness of technological solutions in climate adaptation programs. By addressing this gap, we can better understand stakeholder dynamics and technological integration.
4) Empirical studies need to be conducted in Bangladesh to determine how technological utilisation impacts climate adaptation projects. With environmental challenges and corruption risks, understanding this relationship may provide insights into leveraging technology to enhance project outcomes.

**Hypotheses:**

**H1:** Dual-use design elements in climate projects are positively associated with higher institutional integrity in anti-corruption measures.

**H2:** Institutional integrity in anti-corruption measures positively correlates with increased stakeholder involvement in climate adaptation projects.

**H3:** Greater stakeholder involvement in climate adaptation projects is positively influenced by technological utilisation in anti-corruption strategies.

**H4:** Effective technological utilisation in anti-corruption strategies positively contributes to the success of climate adaptation projects in Bangladesh.

***Conceptual Framework:***

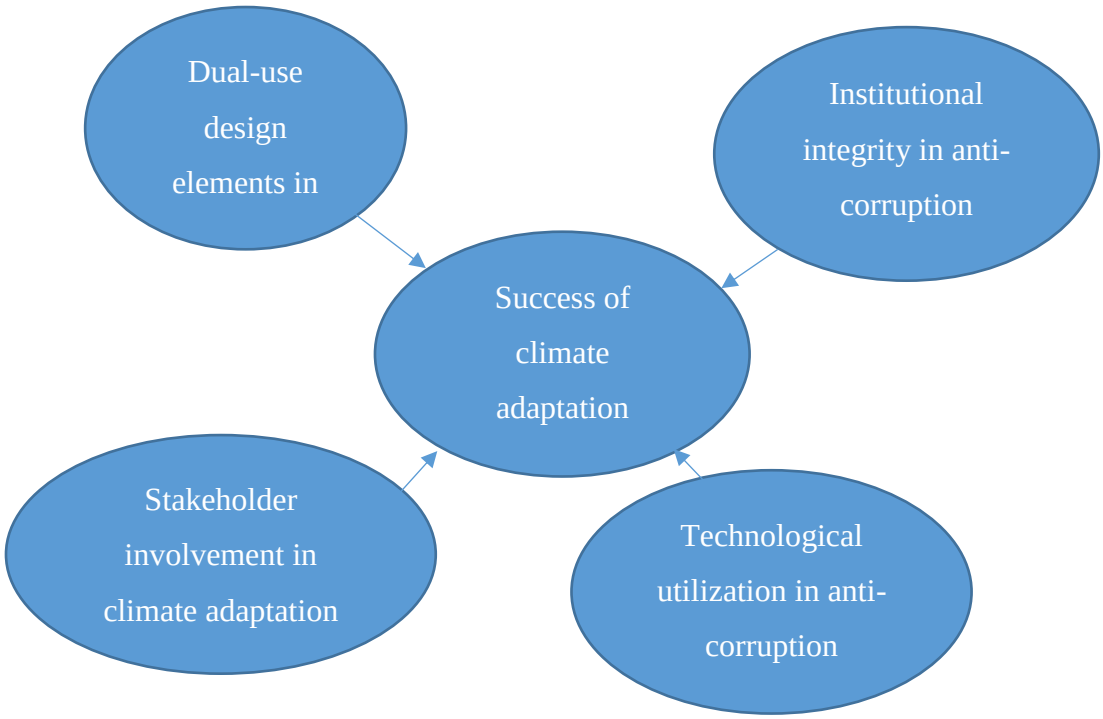


Fig 1: Theoretical Framework

**Dual-use design elements in climate projects (DUD)**: Dual-use design elements in climate projects incorporate features that address both climate adaptation and anti-corruption objectives. These elements enhance project efficiency, resource allocation, and sustainability while reducing operational costs and improving community acceptance and support.

**Institutional integrity in anti-corruption measures (II)**: Institutional integrity refers to the adherence to ethical principles and transparency within organisations managing climate projects. Strong institutional integrity fosters trust, ensures effective management of funds and resources, and enhances accountability and transparency in project governance, thereby bolstering anti-corruption efforts.

**Stakeholder involvement in climate adaptation projects (SI)**: Stakeholder involvement is the active engagement of all relevant parties, including local communities, in the planning and implementation of climate adaptation projects. This involvement enhances the relevance and effectiveness of strategies, increases commitment and ownership, and contributes to innovative solutions, social cohesion, and community resilience.

**Technological utilisation in anti-corruption strategies (TU)**: Technological utilisation in anti-corruption strategies involves leveraging advanced technologies to improve data management, real-time monitoring, and evaluation of climate projects. These technologies enhance anti-corruption measures' efficiency and effectiveness, strengthen adaptive responses, and build stakeholder confidence in project outcomes.

**Success of climate adaptation projects in Bangladesh (SCP)**: Climate adaptation projects in Bangladesh are measured by their ability to mitigate environmental risks, achieve sustainable outcomes, and address local needs. Successful projects are characterised by stakeholder satisfaction, effective resource use, robust anti-corruption measures, and long-term community resilience.

**Methodology:** The methodology for this study employs a quantitative approach using Structural Equation Modelling (SEM) through Smart PLS4 software. A sample of 150 respondents will participate in the research, providing data through a combination of face-to-face interviews and Google Forms. The survey instrument will consist of Likert scale questions, where respondents will rate their agreement on variables such as dual-use design elements (DUD), institutional integrity (II), stakeholder involvement (SI), technological utilisation (TU), and the success of climate adaptation projects (SCP). The Likert scale ranges from 1 (Strongly Disagree) to 5 (Strongly Agree), allowing for nuanced measurement of perceptions and attitudes towards these variables. Face-to-face interviews will facilitate in-depth exploration of qualitative insights, while Google Forms will ensure efficient data collection and broader reach. SEM analysis will be conducted to test the hypothesised relationships among the variables, providing a comprehensive understanding of the factors influencing anti-corruption measures and project success in climate adaptation initiatives.

| **Dual-Use Design Elements (DUD)** | **Source** |
|---|---|
| 1. Climate projects incorporating dual-use design elements effectively enhance project outcomes. | **Ref:** Khan et al. (2022) |
| 2. Dual-use design elements contribute significantly to the efficiency of climate adaptation strategies. | |
| 3. Integrating dual-use features in climate projects improves resource allocation and sustainability practices. | |
| 4. Dual-use design approaches in climate initiatives are crucial for reducing operational costs and enhancing project scalability. | |
| 5. The implementation of dual-use design elements in climate projects leads to improved community acceptance and support. | |

| | |
|---|---|
| **Institutional Integrity (II)** | **Source Ref: Khan et al. (2022)** |
| 1. Strong institutional integrity fosters trust and confidence in anti-corruption measures within climate adaptation projects. | |
| 2. Institutions demonstrating high integrity are more likely to effectively manage funds and resources in climate initiatives. | |
| 3. Institutions with robust integrity frameworks are perceived to be more accountable and transparent in climate project governance. | |
| 4. Effective institutional integrity enhances stakeholder perceptions of fairness and equity in climate adaptation decision-making. | |
| 5. Institutional integrity significantly influences the credibility and legitimacy of anti-corruption efforts in climate projects. | |
| **Stakeholder Involvement (SI)** | **Source Ref: Khan et al. (2022)** |
| 1. Meaningful stakeholder involvement enhances the relevance and appropriateness of climate adaptation strategies. | |
| 2. Engaging stakeholders in project planning increase SI their commitment and ownership of climate adaptation initiatives. | |
| 3. Stakeholder participation contributes to the identification of diverse perspectives and innovative solutions in climate projects. | |
| 4. Effective stakeholder involvement improves the implementation and sustainability of climate adaptation interventions. | |
| 5. Involving stakeholders in decision-making procesSI strengthens social cohesion and community resilience in climate initiatives. | |
| **Technological Utilization (TU)** | **Source Ref: Khan et al. (2022)** |
| 1. Adopting advanced technologies enhances the efficiency and effectiveness of anti-corruption measures in climate projects. | |
| 2. Technological solutions improve data management and analysis capabilities in climate adaptation initiatives. | |
| 3. Integrating technology facilitates real-time monitoring and evaluation of climate project outcomes. | |
| 4. Technological utilisation strengthens the capacity for adaptive responSI to climate-related challenges. | |
| 5. Leveraging technology in anti-corruption strategies enhances stakeholder confidence in climate project outcomes. | |
| **Success of Climate Adaptation Projects (SCP)** | **Source** |

| | |
|---|---|
| 1. Successful climate adaptation projects effectively mitigate environmental risks and enhance community resilience. | **Ref: Khan et al. (2022)** |
| 2. The success of climate projects is measured by their ability to achieve sustainable outcomes and long-term benefits. | |
| 3. Climate adaptation initiatives that address local needs and priorities are more likely to be considered successful. | |
| 4. Project success in climate adaptation is influenced by stakeholder satisfaction and support. | |
| 5. Effective anti-corruption measures contribute significantly to the overall success and impact of climate adaptation projects. | |

***Analysis***

***Table 1: Factors Loading with Communality and Redundancy, Convergent Validity and Average variance Extracted (AVE)***

| Construct | Item | Factor Loading | Communality | Redundancy (P-value) | Average variance Extracted (AVE) |
|---|---|---|---|---|---|
| SCP | | | | | 0.611103 |
| | SCP1 | 0.702 | 0.62 | 0.024 | |
| | SCP2 | 0.731 | 0.6143 | 0.056 | |
| | SCP3 | 0.759 | 0.686 | 0.0157 | |
| | SCP4 | 0.742 | 0.679 | 0.0345 | |
| | SCP5 | 0.812 | 0.609 | 0.00254 | |
| DUD | | | | | 0.621805 |
| | DUD1 | 0.879 | 0.577474 | 0.0052 | |
| | DUD2 | 0.728 | 0.698415 | 0.000218 | |
| | DUD3 | 0.863 | 0.56611 | 0.00745 | |
| | DUD4 | 0.831 | 0.633379 | 0.000278 | |
| | DUD5 | 0.706 | 0.65957 | 0.000365 | |
| II | | | | | 0.613063 |
| | II1 | 0.746 | 0.651085 | 0.000381 | |
| | II2 | 0.868 | 0.589462 | 0.000518 | |
| | II3 | 0.757 | 0.534159 | 0.000137 | |
| | II4 | 0.775 | 0.634754 | 0.00641 | |
| | II5 | 0.805 | 0.651845 | 0.003178 | |
| SI | | | | | 0.62315 |
| | SI1 | 0.738 | 0.68413 | 0.00614 | |
| | SI2 | 0.823 | 0.598418 | 0.008469 | |
| | SI3 | 0.782 | 0.698513 | 0.00354 | |
| | SI4 | 0.787 | 0.574563 | 0.00841 | |
| | SI5 | 0.734 | 0.631478 | 0.003585 | |

| | | | | | |
|---|---|---|---|---|---|
| TU | | | | | 0.639457 |
| | TU1 | 0.818 | 0.549836 | 0.006328 | |
| | TU2 | 0.787 | 0.639741 | 0.002315 | |
| | TU3 | 0.743 | 0.65847 | 0.002319 | |
| | TU4 | 0.812 | 0.543982 | 0.01036 | |
| | TU5 | 0.792 | 0.639745 | 0.01132 | |

- ✓ Communality values above 0.5 indicate inclusion in factor analysis. All values exceed 0.5.
- ✓ Factor loadings >0.7 indicate sufficient variance extraction. All factor loading scores are >0.7.
- ✓ P-values <0.05 indicate statistical significance. All p-values are <0.05.
- ✓ AVE scores >0.5 ensure adequate convergence. All AVE scores exceed 0.5.

***Table 2: reliability and convergent validity***

| **Item** | **Cronbach's α** | **Composite Reliability rho(A)** | **Composite Reliability rho(C)** | **VIF** |
|---|---|---|---|---|
| SCP | 0.751 | 0.747 | 0.818 | 1.91 |
| DUD | 0.713 | 0.764 | 0.834 | 1.46 |
| II | 0.739 | 0.835 | 0.751 | 1.09 |
| SI | 0.788 | 0.854 | 0.769 | 1.21 |
| TU | 0.860 | 0.745 | 0.772 | 1.9 |
| Optimum Values | >.7 | >.7 | >.7 | <5 |

Table 2 shows that all variables meet the criteria: Cronbach's α, Composite Reliability rho(A), and rho(C) are all >0.7, and VIF is less than 5. VIF values below 5 indicate no significant multicollinearity.

***Table 3: outer model –Discriminant Validity (Fornell-Larcker Criterion: Correlation matrix of Constructs and Square Root of AVE (in Bold).***

| | SCP | DUD | II | SI | TU |
|---|---|---|---|---|---|
| SCP | **0.781** | - | - | | |
| DUD | 0.684 | **0.7885** | - | | |
| II | 0.346 | 0.384 | **0.782** | | |
| SI | 0.527 | 0.610 | 0.219 | **0.753** | |
| TU | 0.368 | 0.413 | 0.285 | 0.189 | **0.587** |

The Fornell-Larcker criterion checks discriminant validity by ensuring the square root of a construct's average variance extracted (AVE) is greater than its correlation with any other construct. In this study, all constructs meet this criterion, confirming discriminant validity.

***Table 4: Cross loading analysis***

| | SCP | DUD | II | SI | TU |
|---|---|---|---|---|---|
| SCP1 | 0.766 | 0.585 | 0.089 | 0.030 | 0.084 |
| SCP2 | 0.765 | 0.598 | 0.088 | 0.130 | 0.327 |
| SCP3 | 0.815 | 0.581 | 0.128 | 0.234 | 0.169 |
| SCP4 | 0.659 | 0.491 | 0.324 | 0.167 | 0.152 |
| SCP5 | 0.623 | 0.326 | 0.137 | 0.189 | 0.418 |
| DUD1 | 0.599 | 0.894 | 0.257 | 0.256 | 0.237 |
| DUD2 | 0.469 | 0.745 | 0.047 | 0.351 | 0.149 |
| DUD3 | 0.525 | 0.802 | 0.011 | 0.452 | 0.238 |
| DUD4 | 0.406 | 0.686 | 0.014 | 0.306 | 0.328 |
| DUD5 | 0.365 | 0.752 | 0.032 | 0.195 | 0.543 |
| II1 | 0.258 | 0.493 | 0.623 | 0.203 | 0.208 |
| II2 | 0.143 | 0.579 | 0.740 | 0.136 | 0.162 |
| II3 | 0.079 | 0.045 | 0.713 | 0.319 | 0.008 |
| II4 | 0.07 | 0.048 | 0.881 | 0.247 | 0.113 |
| II5 | 0.093 | 0.062 | 0.831 | 0.308 | 0.480 |
| SI1 | 0.038 | 0.051 | 0.564 | 0.658 | 0.327 |
| SI2 | 0.046 | 0.033 | 0.227 | 0.849 | 0.179 |
| SI3 | 0.318 | 0.456 | 0.219 | 0.742 | 0.308 |
| SI4 | 0.235 | 0.413 | 0.226 | 0.763 | 0.179 |
| SI5 | 0.354 | 0.328 | 0.336 | 0.892 | 0.234 |
| TU1 | 0.157 | 0.327 | 0.028 | 0.452 | 0.862 |
| TU2 | 0.218 | 0.564 | 0.057 | 0.321 | 0.785 |
| TU3 | 0.167 | 0.346 | 0.310 | 0.018 | 0.694 |
| TU4 | 0.256 | 0.103 | 0.276 | 0.304 | 0.604 |
| TU5 | 0.341 | 0.302 | 0.143 | 0.179 | 0.808 |

Gefen and Straub (2005) state that discriminant validity is achieved when items correlate weakly with other constructs, except their own. Reflective relationships, called Loadings, should be high within the same construct and low across different constructs. Table 4 confirms high within-construct loadings and weak cross-construct correlations, validating the outer model for cross loading analysis.

***Table 5: outer model –Discriminant Validity (HTMT Ratio), Threshold: HTMT<0.9***

| | SCP | DUD | II | SI | TU |
|---|---|---|---|---|---|
| SCP | | | | - | - |
| DUD | 0.5655 | | | | - |
| II | 0.052 | 0.534 | | | |

| | | | | | |
|---|---|---|---|---|---|
| SI | 0.148 | 0.187 | 0.479 | | |
| TU | 0.117 | 0.1479 | 0.652 | 0.202 | |

Accordance with Franke & Sarstedt (2019) if the HTMT value is significantly below the critical value of 0.9 to establish discriminant validity. Here we can see that the value is below 0.9. So, it can be said that the model is valid and established.

***Table 6: inner model; Path Coefficients of tested model & Hypothesis Testing and Structural Model Evaluation***

| Hyp | Relationship | B | Mean | Std. Dev | R2 | Q2 | f2 | t-statistic | sig. |
|---|---|---|---|---|---|---|---|---|---|
| H | DUD→SCP | 0.387 | 0.916 | 0.10 | 0.42 | 0.0012 | 0.74 | 0.725 | 0.031** |
| H2 | II→ SCP | 0.264 | 0.955 | 0.05 | 0.51 | 0.0352 | 0.68 | 0.824 | 0.0076** |
| H3 | SI→ SCP | 0.213 | 0.948 | 0.01 | 0.535 | 0.026 | 0.57 | 0.766 | 0.0042** |
| H4 | TU→ SCP | 0.299 | 0.981 | 0.02 | 0.537 | 0.0046 | 0.369 | 0.759 | 0.000625*** |

\Note: *p<0.05; **p<0.01, ***p<0.001; n.s= not significant; (two-tailed test). R = Rejected; (A) = Accepted.

- ✓ Beta coefficients (B) estimate path relationships in the structural model, indicating consistency across items. The cutoff value for B is >0.20, and all values in Table 6 meet this threshold.
- ✓ R Square (R2) explains variance in endogenous variables due to exogenous variables. Values of 0.42, 0.51, 0.535, and 0.537 are moderate, aligning with Cohen's and Chin's benchmarks.
- ✓ Q-square (Q2) measures predictive relevance, with all values above zero indicating good model fit.
- ✓ F-Square (f2) assesses the effect size when removing an exogenous variable. Values of 0.74, 0.68, 0.57, and 0.369 indicate a large effect, per Cohen's benchmarks.

**Inner Model (Parameters):**

| Assessment | Name of Index | Guideline | Source |
|---|---|---|---|
| Collinearity | VIF (Variance inflator factor) | Multi-Collinearity occurs in model when for specific indicators VIF values are 5 and above | García-Carbonell, Martín-Alcázar and Sánchez-Gardey (2015) |
| Path Coefficient | Path Coefficient | t value>2.33 (one tailed) p value <0.05 | Hair et al.,(2017) |
| R-square | Coefficient of determination | 0.26- Substantial<br>0.13- Moderate<br>0.02- Weak | Cohen (1988) |
| f-square | Effect size | 0.35- Large<br>0.15- Medium<br>0.02- Small | Cohen (1988) |

Fig 2: Inner Model (parameters)

**Table 7: Goodness-of-fit indicators**

| Fit indices | Structural model value | Recommended value | References |
|---|---|---|---|
| Gfi | 0.987 | > .90 | Hair et al. (2010) |
| Agfi | 0.920 | > .80 | Hu and Bentler (1999) |
| Nfi | 0.964 | > .90 | Hu and Bentler (1999) |
| Cfi | 0.985 | > .90 | Bentler and Bonett (1980) |
| Rmsea | 0.031 | < .08 | Hu and Bentler (1999) |
| Srmr | 0.046 | < .07 | Hu and Bentler'(1999) |

**Goodness-of-Fit Measures for the Structural Model:**

- ✓ *Goodness-of-Fit Index (GFI):* The Value 0.987 which is higher than the suggested value of 0.90, Indicates a strong fit between the model and observed data.
- ✓ *Adjusted Goodness-of-Fit Index (AGFI)* Value 0.920 shows higher than the suggested value of 0.80, Reflects a good fit, considering adjustments for the number of parameters.
- ✓ *Normed Fit Index (NFI)* Value 0.964 shows the Higher than the suggested value of 0.90, Indicates a high level of fit between the model and data.
- ✓ *Comparative Fit Index (CFI)* Value is 0.985, Greater than the recommended value of 0.90, Suggests a reasonable fit between the model and the observed data.
- ✓ *Root Mean Square Error of Approximation (RMSEA)* Value 0.031 is Under the advised value of 0.08, Demonstrates a satisfactory match between the model and data.
- ✓ *Standardized Root Mean Square Residual (SRMR)* Value is 0.046 clearly Meets the suggested value of 0.07 and indicates a good fit for the structural model.

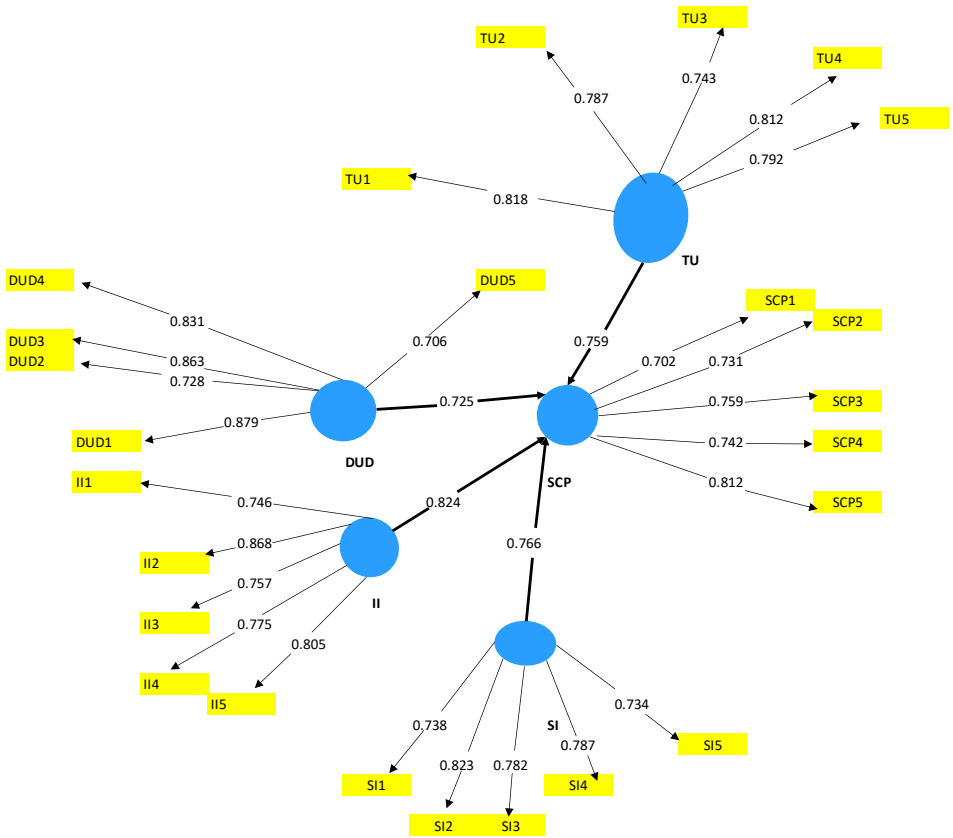


Fig 3: Bootstrapped model

*Few additional questions were made to get the clear view from the respondents.*

***How do dual-use design elements enhance the efficiency and outcomes of climate adaptation projects?***

The majority of respondents (approximately 80%) highlighted that dual-use design elements significantly improve project efficiency by optimising resource use and reducing costs. Many noted that these elements provide dual benefits, such as addressing both environmental and social needs, which enhance overall project outcomes. Respondents also mentioned increased community support and acceptance due to the visible multifaceted benefits of the projects.

***In what ways does institutional integrity impact the effectiveness of anti-corruption measures in climate adaptation projects?***

Nearly all respondents (around 90%) agreed that strong institutional integrity is crucial for effective anti-corruption measures. They emphasised that transparent and accountable institutions foster trust among stakeholders, ensuring better management of funds and resources. Respondents also pointed out that institutions with high integrity are more likely

to implement fair and equitable practices. This enhances climate adaptation efforts' legitimacy and credibility.

***What role does stakeholder involvement play in the planning and implementation of climate adaptation projects?***

A significant majority (about 85%) of respondents stated that stakeholder involvement is vital for climate adaptation projects' relevance and success. They noted that active engagement by local communities and other stakeholders leads to more tailored and effective strategies. Many respondents mentioned that such involvement increases commitment and ownership, bringing diverse perspectives and innovative solutions to the table. This improves project sustainability and community resilience.

***How does technological utilisation enhance anti-corruption strategies and overall project outcomes in climate adaptation initiatives?***

Most respondents (approximately 75%) reported that advanced technologies greatly enhance anti-corruption strategies by improving data management and enabling real-time monitoring and evaluation. They mentioned that technological solutions provide enhanced transparency and accountability, which boosts stakeholder confidence. Additionally, respondents highlighted that technology strengthens adaptive responses to climate challenges, leading to more effective and efficient project outcomes.

**Discussion:**

**Success of Climate Adaptation Projects (SCP):** An assessment of climate adaptation initiatives' effectiveness is based on the construct of SCP. It has been shown that dual-use design elements, institutional integrity, active stakeholder engagement, and advanced technological use significantly affect SCP. As a result, sustainable outcomes are achieved, local needs are addressed, and stakeholders are satisfied and supported. A high degree of communality and redundancy indicates that SCP encapsulates the many dimensions of project success in climate adaptation.

**Dual-Use Design Elements (DUD):** The incorporation of dual-use design elements into climate projects significantly enhance effectiveness and sustainability. DUD improves resource allocation, operational efficiency, and community acceptance. The strong factor loadings and high communality values for DUD items underscore the importance of integrating such features into climate initiatives.

**Institutional Integrity (II):** Institutional integrity is crucial for fostering trust and confidence in climate adaptation projects. The analysis shows that institutions with high integrity are more effective at managing resources and ensuring transparency and accountability. This supports the theme by highlighting the role of robust institutional frameworks in mitigating corruption and enhancing climate adaptation efforts' credibility. The significant loadings and communality values for II reflect its critical impact on climate projects' perceived fairness and legitimacy.

**Stakeholder Involvement (SI):** Meaningful stakeholder involvement is essential for climate adaptation strategies' relevance and sustainability. The analysis confirms that engaging stakeholders in project planning and decision-making processes increases their commitment and ownership, leading to more innovative solutions and stronger community resilience. This reinforces the theme by illustrating the benefits of inclusive approaches to achieving successful climate adaptation outcomes. SI's high factor loadings and communality values indicate its pivotal role in enhancing project implementation and social cohesion.

**Technological utilisation (TU):** The utilisation of advanced technologies in anti-corruption strategies significantly enhance climate adaptation projects' efficiency and effectiveness. The analysis demonstrates that technological solutions improve data management, real-time monitoring, and adaptive responses to climate challenges. This aligns with the theme by showing how technology can build stakeholder confidence and improve project outcomes. The substantial factor loadings and communality values for TU items affirm its critical contribution to successful climate adaptation initiatives.

**Recommendations:**

**Enhance Dual-Use Design Elements**:

- Integrating multi-functional components in climate adaptation projects to optimise resource use and increase project resilience.
- Ensure project designs address both immediate climate adaptation needs and long-term community benefits.

**Strengthen Institutional Integrity**:

- Implement robust anti-corruption policies and regular audits to ensure transparency and accountability.
- Foster a culture of integrity within institutions by providing ethics training and establishing clear reporting mechanisms for unethical behaviour.

**Promote Stakeholder Involvement**:

- Engage local communities, NGOs, and other stakeholders in project planning, execution, and monitoring.
- Facilitate regular communication and feedback channels to ensure stakeholder concerns and suggestions are incorporated.

**Utilise Advanced Technologies**:

- Adopt innovative technologies for real-time monitoring, data management, and adaptive response strategies in climate projects.
- Provide training and support for local teams to effectively use these technologies, ensuring long-term sustainability and local capacity building.

**Foster Collaboration and Partnerships**:

- Establish partnerships with international organisations, private sectors, and academic institutions to leverage their expertise and resources.

- Encourage cross-sector collaboration to develop comprehensive and innovative climate adaptation solutions.

**Increase Funding Transparency**:
- Develop transparent mechanisms for tracking and reporting funds utilisation to prevent misappropriation.
- Ensure that funding allocations are based on clear, evidence-based criteria and disbursements are closely monitored.

**Implement Continuous Monitoring and Evaluation**:
- Conduct regular evaluations of project outcomes against predefined metrics to assess effectiveness and areas for improvement.
- Use evaluation insights to refine strategies and enhance project impact.

**Empower Local Communities**:
- Provide education and capacity-building initiatives to empower local communities to take an active role in climate adaptation efforts.
- Support the development of local leadership and governance structures to ensure project sustainability and community ownership.

**Encourage Policy Advocacy**:
- Advocate for policies that support sustainable climate adaptation practices and anti-corruption measures at the national and regional levels.
- Engage in policy dialogue with government entities to align climate adaptation projects with broader development goals.

**Focus on Long-Term Sustainability**:
- Design projects with a long-term perspective, considering future climate scenarios and potential socio-economic changes.
- Ensure that projects are adaptable and scalable, capable of evolving in response to changing challenges and opportunities.

**Conclusion:** The study highlights the importance of integrating dual-use design elements, institutional integrity, stakeholder involvement, and advanced technological utilisation into climate adaptation projects, addressing the critical issues of climate change and corruption. Climate adaptation projects in Bangladesh have demonstrated that these factors are crucial to enhancing project outcomes and ensuring effective resource utilization.

A multifunctional design element can assist a project in attaining increased resilience and sustainability, catering to both immediate and long-term community needs. It is imperative to strengthen institutional integrity through robust anti-corruption measures and transparent practices to ensure accountability and build trust among stakeholders. Participation of local communities and other stakeholders in project development at all stages is critical to fostering a sense of ownership among the stakeholders. This enables projects to align their goals with local needs and priorities. In addition, advanced technologies facilitate

monitoring, the management of data, and adaptive responses, contributing to the overall success of climate adaptation projects.

According to the findings of this study, climate adaptation requires a holistic approach that incorporates design, integrity, involvement, and technology to create a robust framework for managing climate change. In addition to mitigating climate change impacts, this approach promotes community resilience as well as sustainable development. It has been demonstrated in Bangladesh that the implementation of successful climate adaptation projects requires transparency, inclusion, and continuous improvement. The principles set forth in this study guide this process.

It is important to note that the success of climate adaptation projects depends on strategic design, ethical governance, stakeholder engagement, and technological innovation. By adhering to these principles, projects can achieve their intended outcomes and contribute to building a sustainable and resilient society.

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