# A Comprehensive Approach to Sustainable Technology Integration: Achieving Functional Compatibility through the Sustainability Acceptance Model in South Africa's Energy Grid


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# DECLARATION

I, Malcolm Weaich, declare that this thesis is my own, unaided work. It is submitted for the Degree of Master of Science in Quantity Surveying at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other university.

Malcolm Weaich

__10th__ day of __December__ year __2024__.

# DEDICATION

In memory of my grand father

Louis Beyers

This work is dedicated to my brother, Sherwyn Weaich, whose support and encouragement have been a constant source of strength. To my mother, Nola Weaich, and my father, Malcolm Weaich, whose unwavering belief in me has been my guiding light. To my grandmother, Zora Bibi (Sandra) Beyers, whose wisdom and love have shaped who I am today. I am deeply grateful to my supervisors, Dr. Prisca Simbanegavi, Dr. Pride Ndlovu, and Prof David Root, for their invaluable guidance and mentorship. Above all, I dedicate this work to God, whose grace and blessings have made all things possible.

# ABSTRACT

South Africa's energy grid, primarily dependent on coal and aging infrastructure, faces significant challenges transitioning toward sustainable energy solutions. Despite governmental initiatives, such as the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), the adoption of green technologies remains constrained. This study introduces the Sustainability Acceptance Model (SAM), designed to identify and address barriers to sustainable technology adoption. Through cross-sectional surveys and rigorous statistical analyses (Spearman's correlation, regression models, and variance inflation factor assessments), significant correlations were identified, including perceived economic stability ($\rho$ = 0.157, p = 0.0114), functional compatibility of technology ($\rho$ = 0.187, p = 0.0026), and public awareness campaigns ($\rho$ = 0.188, p = 0.0024). A notable paradox emerged wherein heightened environmental awareness correlated negatively with perceptions of institutional effectiveness ($\rho$ = -0.126, p = 0.0429), indicating a perceived gap between public expectations and institutional action.

The study recommends specific policy interventions, such as amendments to the Electricity Regulation Act (No. 4 of 2006) to facilitate decentralised renewable energy generation, expansion of the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) to include smaller-scale end-user projects and enhanced financial incentives including subsidies and tax benefits. Additionally, public engagement strategies must be culturally aligned and supported by educational initiatives to bridge identified gaps in sustainable knowledge perception.

This study contributes significantly to academia, policymakers, and industry stakeholders by providing an actionable, multidimensional Sustainability Acceptance Model (SAM) framework. It aids policymakers and industry practitioners in formulating effective strategies that facilitate an equitable transition towards sustainable energy solutions, fostering greater end-user acceptance and supporting South Africa's sustainable development goals.

# HIGHLIGHTS

1. Introduces the Sustainability Acceptance Model (SAM) for energy transitions.
2. Develops new Sustainability Coefficients and the Economic Stability Threshold.
3. Identifies key socio-economic barriers to adopting green energy technologies.
4. Extends TAM and TPB with economic and functional compatibility dimensions.
5. Proposes actionable strategies for grid modernisation and public engagement through a Framework.

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# PRESENTATIONS

**Presentations Arising from this Research Project**

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| **DOI:** http://dx.doi.org/10.13140/RG.2.2.16034.61122 |
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| **Theme:** The research highlights the pivotal role of construction project managers in balancing carbon tax demands with sustainable development but reveals gaps in their understanding of environmental protection and compliance. |
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| **Theme:** The research finds a moderate correlation between green technology investments and youth unemployment, suggesting targeted investments could enhance employment while supporting broader economic strategies for sustainability. |

# FIRST AUTHOR JOURNAL PUBLICATIONS

**First Author Publications Arising from this Research Project**

| **Publication No. 1** |
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# CO-AUTHORED PUBLICATIONS

**Publications Co-Authored in Support of this Research Report**

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| **General Abbreviations** |
| --- |
| GDP: Gross Domestic Product |
| GW: Gigawatt |
| NPV: Net Present Value |
| UK: United Kingdom |
| UN: United Nations |
| **Research and Analytical Models** |
| PBC: Perceived Behavioural Control |
| PEI: Perceived Environmental Impact |
| SAM: Sustainability Acceptance Model |
| SAT: Sustainability Acceptance Test |
| SDG: Sustainable Development Goals |
| SEM: Structural Equation Modelling |
| SIN: Social Influence and Norms |
| STA: Sustainable Technology Acceptance |
| TAM: Technology Acceptance Model |
| TPB: Theory of Planned Behaviour |
| TRA: Theory of Reasoned Action |
| UTAUT: Unified Theory of Acceptance and Use of Technology |
| **Statistical and Computational Tools** |
| SPSS: Statistical Package for the Social Sciences |
| VIF: Variance Inflation Factor |
| **Industry-Specific Terms** |
| IPP: Independent Power Producer |
| REIPPPP: Renewable Energy Independent Power Producer Procurement Programme |
| **Empirical Variables (Survey-Based)** |
| GPC: General Perception of Sustainable Living |
| PAA: Perceived Awareness |
| PECC: Perceived Economic Barriers |
| PFCG: Perceived Government Subsidies |
| PFCU: Perceived High Upfront Costs |
| POSC: Perceived Cultural Values |
| PVII: Perceived Institutional Involvement |
| PVRG: Perceived Government Policies |
| PVSHP: Perceived Community Participation |
| PVSHI: Perceived Well-Being Improvements |
| PTAT: Perceived Technological Reliability |

# LIST OF EQUATIONS

# NOMENCLATURE

## General Terms

**Carbon Footprint:** The total greenhouse gas emissions caused directly and indirectly by an individual, organisation, or product.

**Economic Stability Threshold (EST):** A model-specific threshold used to identify statistically significant correlations, establishing their influence on perceptions of economic stability.

**Functional Compatibility:** The degree to which a sustainable technology aligns with existing systems, practices, and cultural norms.

**Green Grid:** A power grid incorporating renewable energy sources and sustainable technologies to minimise environmental impact.

**Kruskal-Wallis H Test:** A non-parametric test used to evaluate differences in median rankings of variables across multiple acceptance groups.

**Net Present Value (NPV):** A financial metric that assesses the profitability of an investment or project by calculating the difference between present values of cash inflows and outflows.

**Perceived Environmental Impact (PEIs):** A theoretical construct measuring individuals' perceptions of the ecological benefits of adopting a sustainable technology.

**Spearman's Rank Correlation:** A non-parametric method to assess monotonic relationships between variables, adapted in the study for the Sustainability Acceptance Model (SAM).

**Sustainability Acceptance Model (SAM):** A theoretical framework developed to evaluate the factors influencing the acceptance of sustainable technologies.

**Sustainability Acceptance Threshold (SAT):** A model-specific threshold used to identify statistically significant correlations, establishing their influence on perceptions of sustainability acceptance.

**Sustainability Coefficients:** Quantitative measures used to evaluate the dimensions of sustainability, including environmental, economic, social, and functional factors.

**Sustainable Economic Viability (SEV):** The capacity of a sustainable system, product, or technology to be found to be economically and financially feasible.

**Variance Inflation Factor (VIF):** A measure of multicollinearity in regression analysis.

## Redefined General Terms

### Sustainability

**Accepted:** The practice of meeting the needs of the present without compromising the ability of future generations to meet their own needs, typically encompassing economic, environmental, and social dimensions.

**Expansion:** Traditionally encompassing the three foundational pillars—economic, environmental, and social dimensions—this study introduces a fourth pillar: Functional Compatibility (FC). This expanded definition emphasises that sustainability must account for the 'seamless integration' of sustainable technologies and processes into existing systems, infrastructures, and cultural practices.

# CHAPTER 1: INTRODUCTION

*“There’s no such thing as a free lunch.” - Milton Friedman*

This phrase encapsulates the notion that all costs—whether hidden or apparent—are ultimately borne by the public, regardless of how governments or organisations may frame them. It reflects the reality that, at the end of the day, society pays for every policy, service, or resource, often in unseen ways.

## 1.1 Synopsis of the Opening Chapter

The opening chapter provides essential background information for the study, covering South Africa's constitutional commitment to sustainability and the challenges of transitioning to a sustainable energy grid. It discusses the current state of Eskom’s coal-dependent infrastructure, the inefficiencies within the energy grid, and the role of policy frameworks like the Electricity Regulation Act and REIPPPP. The chapter highlights socio-economic disparities, high infrastructure costs, and barriers to renewable energy adoption. Additionally, it identifies research gaps in existing sustainability models, such as TAM and TPB, and introduces the need for a comprehensive framework (SAM) that includes economic viability and functional compatibility. This sets the stage for analysing public perceptions, resource allocation, and policy recommendations to achieve an equitable and sustainable energy transition.

## 1.2 Background

The Constitution of South Africa, adopted in 1996, is among the few constitutions globally that explicitly establishes sustainability as a core principle of governance (Cooper, 2019). Section 24 of the Constitution guarantees everyone the right to an environment that is not detrimental to their health or well-being. It further obligates the state to take reasonable legislative and other measures to ensure ecologically sustainable development and the judicious use of natural resources (Diedericks et al., 2023; Theil, 2019). This innovative constitutional inclusion highlights South

Africa’s leadership in embedding environmental stewardship at the highest level of national policy, making it one of the first nations to recognise sustainability as a constitutional imperative (Cooper, 2019).

### 1.2.1 The Current State of South Africa’s Energy Grid

South Africa's energy grid, owned and operated by Eskom, a publicly funded state-owned enterprise governed under the *Electricity Regulation Act, 2006*, (2006) faces significant challenges in achieving sustainability due to increasing demand and aging infrastructure (Nhleko and Inambao, 2020; Reboredo and Carmody, 2024; Walwyn, 2021). The publicly funded state-owned utility generates approximately 90% of the country's electricity, and has inherent inefficiencies that manifests across infrastructure, generation capacity, policy frameworks, renewable energy integration, and socio-economic impacts (Agbenyo Folly, 2021; Bowman, 2020; Hanto et al., 2022; Kruger et al., 2023; Kumba et al., 2024; Longe et al., 2019; Mutumbi et al., 2024).

Eskom's generation infrastructure, dominated by coal-fired power plants that account for 65% of the energy mix, is environmentally unsustainable and technically outdated (Dippenaar, 2018). Designed for centralised energy production, the system is incompatible with modern bidirectional energy flows (Eskom Holdings SOC Ltd, 2021). The average age of Eskom's coal-fired power plants is approximately 40 years, posing significant challenges to reliability and sustainability (Green Economy Journal, 2021).

Frequent equipment failures lead to regular power outages, colloquially known as ‘load shedding’ (Kumba et al., 2024). Although Eskom’s installed capacity is approximately 52 GW, actual availability is often significantly reduced due to maintenance delays and unplanned outages—a challenge known as the ‘energy availability factor’ (Pram et al., 2022). These disruptions not only compromise economic productivity but exacerbate socio-economic inequalities, disproportionately impacting underprivileged communities (Longe et al., 2019).

### 1.2.2 The Current State of Renewable Energy Transformation in South Africa

Acknowledging the urgency for reform, the South African government initiated measures to transition from fossil-fuel dependence to a more sustainable energy grid (Papacostantis, 2021). Central to this strategy is the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), designed to attract private investment in renewable energy projects through competitive bidding (South African Government, 2006).

Complementing the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) are fiscal incentives under the Income Tax Act. Sections 12L and 12B offer a single annual tax deduction for energy-efficient technologies and accelerated capital allowances for renewable energy investments, respectively (South African Government, 2015, 2013, 2009, 1962). However, a closer analysis of these clauses reveals that, while these incentives are a step in the right direction, they are restricted to a one-time tax deduction. As a result, subsequent upgrades and the use of second-hand solar panels are ineligible under the current legislation (Dippenaar, 2018; Engelbrecht and Hassan, 2024; Tomaschek et al., 2009).

An important development has been the removal of restrictions on self-generation capacity for businesses, significantly empowering industries to invest in renewable energy solutions (Dippenaar, 2018). However, long term cost savings were swiftly diminished when local municipalities imposed tariffs on businesses with solar generation capacity to offset revenue losses at the local government level (Sewchurran and Davidson, 2021). While these incentives foster a more sustainable business environment, constant policy shifts supporting renewable energy continue to be a significant bottleneck. These shifts transfer the burden of costly energy storage and imposed tariffs onto businesses, which hinders sustainability progress and economic growth (Apata, 2024; Ratshitanga et al., 2023; Sewchurran and Davidson, 2021). Additionally, socio-economic inequalities, such as limited job creation and inadequate energy security, are emerging as significant barriers to a successful energy transition (McKay and Hendricks, 2022; Okbandrias, 2022).

According to the *Income Tax Act, 1962*, (2023), initiatives such as the solar photovoltaic rebate program have provided financial assistance to homeowners adopting renewable technologies. This tax incentive allows for a deduction of 25% of the cost of solar panels, up to a maximum of 15,000 rand per financial year, for installations using new equipment (South African Government, 2008). However, the introduction of additional duties on imported solar panels in July 2024 has undermined this incentive by increasing costs and reducing the affordability and accessibility of these technologies (Brederode, 2024).

While these measures aim to lower upfront costs and facilitate adoption, the average expense of such installations remains prohibitively high for many South African citizens (Kgopana and Popoola, 2023). Consequently, these initiatives have not yet achieved their broader objectives of significantly reducing the nation's carbon footprint or advancing environmental stewardship at the homeowner level due to constant shifts in policy in relation to sustainable development (Simbanegavi et al., 2024; M. R. Weaich et al., 2024)

#### 1.2.3 End-Users Stake in South Africa's Energy Transformation Strategy

Transforming South Africa's energy grid requires a multifaceted approach that transitions from a reliance on coal-based, centralised power generation to a diversified, renewable-based, and decentralised energy system. This transformation necessitates robust policy reform, strategic infrastructure investments, and active engagement with end-users to ensure sustainability and resilience. Currently, South African citizens bear the full financial burden of this transformation, highlighting the urgent need for equitable cost-sharing mechanisms to support this transition (O'Connell, 2024). While businesses benefit from targeted incentives and complete equipment write-offs, individual end-users such as homeowners, face limited financial support, which hinders widespread adoption of sustainable alternatives. Addressing this disparity is crucial to unlocking the full potential of renewable energy solutions, ensuring equitable socio-economic development, and fostering long-term sustainability (Msimango et al., 2023; Naidoo et al., 2020; Ramalho et al., 2023; Reboredo and Carmody, 2024; Wright et al., 2019).

## 1.3 Justification for the Study and the Research Gap

Existing research on the acceptance of sustainable technologies within South Africa's renewable energy sector has predominantly addressed environmental and social dimensions, often through theoretical models such as the Technology Acceptance Model (TAM), the Theory of Planned Behaviour (TPB), and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Ajzen, 1985; Davis, 1989; Wang et al., 2021). However, these models primarily focus on behavioural and social factors, neglecting the nuanced interplay of economic viability, financial feasibility, and policy development, which are crucial to understanding acceptance at both individual and community levels (Belletier et al., 2018; Malatji et al., 2020).

While existing extended models such as UTAUT and various TAM adaptations primarily incorporate additional social influences and facilitating conditions, they typically neglect comprehensive economic factors and the critical construct of functional compatibility, essential in sustainability contexts. The Sustainability Acceptance Model (SAM) uniquely bridges this gap by incorporating economic factors and the construct of functional compatibility, ensuring financial feasibility and operational alignment within existing infrastructures and cultural practices. By explicitly addressing these dimensions, SAM offers a more comprehensive and contextually relevant framework for investigating sustainable technology acceptance, particularly within the complex socio-economic environment of South Africa's energy transition.

The Justification for the Sustainability Acceptance Model (SAM) explicitly details the deficiencies of existing models such as the Technology Acceptance Model (TAM), the Theory of Planned Behaviour (TPB), and the Unified Theory of Acceptance and Use of Technology (UTAUT). These models primarily emphasise behavioural and technological acceptance factors while overlooking the economic and infrastructural constraints that shape adoption within South Africa's energy grid.

SAM addresses this gap by introducing Economic Feasibility (EF) and Functional Compatibility (FC) as core determinants, ensuring a comprehensive approach to sustainability adoption. This distinction can be represented mathematically as:

**Equation 1.1: Justification for the Development of a Novel Model**

$$SAM = f(TAM, TBP, UTAUT) + \Delta(EF, FC)$$

Where:

SAM represents the Sustainability Acceptance Model, $f(TAM, TBP, UTAUT)$ denotes the foundational structure of prior models incorporating perceived ease of use (PEOU), perceived usefulness (PU), social influence (SI), and perceived behavioural control (PBC), $\Delta(EF, FC)$ represents the additional economic feasibility and functional compatibility factors introduced by SAM. If $\Delta(EF, FC) = 0$, then SAM reduces to the traditional TAM/TPB/UTAUT models, which fail to adequately explain sustainability adoption in South Africa. Conversely, if $\Delta(EF, FC) > 0$, SAM expands upon prior models, explicitly addressing real-world economic and infrastructural barriers to sustainable technology adoption, thereby providing a more contextually relevant framework.

## 1.4 Problem Statement

Despite governmental initiatives such as the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), the transition to a sustainable energy grid in South Africa is hindered by inconsistent public acceptance of sustainable technologies. This inconsistency primarily arises due to significant economic barriers, including prohibitive upfront costs, inadequate financial incentives, aging infrastructure, policy instability, and socio-economic disparities. Consequently, the lack of coherent, economically viable policy frameworks and strategic interventions has resulted in limited adoption and integration of sustainable technologies, thereby impeding South Africa's efforts to achieve equitable and widespread participation in its energy transformation.

## 1.5 Aim of the Study

### 1.5.1 Enhancing Green Grid Acceptance in South Africa

The primary aim of this research is to advance the understanding of ‘sustainability as a form of technology acceptance.’ By developing a comprehensive framework that identifies the key factors influencing public perceptions and acceptance, this study seeks to facilitate the transition to a sustainable energy grid in South Africa through the formulation of a guide. The research emphasises bridging theoretical insights with practical applications to ensure sustainable technologies are not only feasible but also effectively integrated and functionally compatible within society.

### 1.5.2 Developing a Sustainable Technology Acceptance Model

The dual challenges of aging infrastructure and escalating environmental concerns underscore the urgency of sustainable development in South Africa (Bowman, 2020; Reboredo and Carmody, 2024). Sustainable technologies are central to addressing these challenges; however, their acceptance hinges on a complex interplay of public perception, cost considerations, and socio-economic factors.

This study aims to develop a framework to enhance the acceptance of sustainable technologies. By developing sustainability modelling through the development of sustainability coefficients, used to examine factors such as economic feasibility, end-user acceptance, and broader socio-economic impacts. The outcome is intended to guide the strategic transition toward a sustainable and economically viable energy grid in South Africa.

To address this challenge, the following research question is presented:

## 1.6 Main Research Question (MRQ)

*How can the acceptance of sustainable technologies in South Africa's energy sector be optimised by enhancing public perception, strategically allocating resources, and effectively integrating empirical models to achieve a robust and economically* *viable transition towards a sustainable national electrical grid at the end-user level in South Africa?*

This research question is grounded in its potential to bridge theoretical insights with actionable strategies. By addressing the pressing energy challenges facing South Africa, it facilitates a transition to sustainability while contributing significantly to scholarly discourse on sustainable development. The outcome will serve as a guide for policymakers and stakeholders, advocating for sustainable technologies that are seamlessly integrated into society to meet both contemporary and future energy demands.

## 1.7 Research Sub-Questions

To ensure comprehensive explanation of the research question, it has been divided into three sub-questions, aligning with the study's objectives:

**$RSQ_1$:** *How do public perceptions influence the acceptance of sustainable technologies within South Africa's energy grid?*

**$RSQ_2$:** *How can economic stability and policy frameworks be strategically aligned to enhance end-user acceptance of sustainable technologies within South Africa's energy grid?*

**$RSQ_3$:** *How can empirical models effectively incorporate end-user perspectives to enhance the functional compatibility and acceptance of sustainable technologies in South Africa's energy grid?*

## 1.8 Research Objectives

### 1.8.1 Developing a Guideline for Sustainable Technology Acceptance

#### *1.8.1.1 Ranking End-User Acceptance: Determinants of Sustainability Acceptance*

**$RO_1$:** *To develop a Sustainability Acceptance Model (SAM) that measures the influence of environmental, social, economic, and functional compatibility factors* *on end-user acceptance of sustainable technologies within South Africa's energy grid.*

***1.8.1.2 Analysis of Sustainable Technologies: Addressing Unfavourable Cost Systems***

**$RO_2$:** *To examine how economic stability and strategic policy frameworks influence end-user acceptance of sustainable technologies within South Africa's energy grid.*

***1.8.1.3 Development of a Guideline: The Sustainability Acceptance Model (SAM)***

**$RO_3$:** *To develop practical guidelines based on end-user opinions, emphasising factors that significantly impact the functional compatibility and adoption of sustainable technologies within South Africa's energy grid.*

## 1.9 Research Assumptions

### 1.9.1 Foundational Assumptions for Limitation Mitigation of the SAM

The following assumptions form a foundational basis for the investigation. These assumptions are critical as they underpin the research design, methodology, and interpretation of findings:

***1.9.1.1 Assumption 1 ($RA_1$): Assumption of Rational End-User Decision-Making***

**$RA_1$:** *Assumption of Rational End-User Decision-Making.*

End-users are assumed to make decisions based on personal motivation, favouring technologies that provide clear economic or tangible advantages.

***1.9.1.2 Assumption 2 ($RA_2$): Assumption of Data Representativeness, Generalisability, and Reliability***

**$RA_2$:** *The data collected is assumed to be representative of the broader population, with random sampling acting as a countermeasure to mitigate population bias.*

#### *1.9.1.3 Assumption 3 ($RA_3$): Assumption of Stability in Policy and Market Conditions*

**$RA_3$:** *It is assumed that the policy environment and market conditions will remain stable throughout the research period, ensuring the applicability of findings.*

These assumptions frame the study while acknowledging its limitations, ensuring valid interpretations of the results.

## 1.10 Research Hypotheses

### 1.10.1 Empirical Hypotheses for Sustainable Technology Acceptance

The study investigates the acceptance of sustainable technologies through empirical models and analyses, guided by the following hypotheses:

#### *1.10.1.1 Hypothesis 1 ($RH_1$): Ranking End-User Acceptance*

**$RH_1$:** There is a significant positive correlation between end-user perceptions of sustainable technology factors (environmental, social, economic, and functional compatibility) and their acceptance within South Africa's energy grid.

**$RH1_0$ – Null Hypothesis:** No significant correlation is observed between end-user perceptions of sustainable technology factors and their acceptance levels.

The null hypothesis is rejected based on the results in this study, which demonstrates a statistically significant sustainability coefficients (quantitative measures used to evaluate the dimensions of sustainability, including environmental, economic, social, and functional factors), with a p-value less than 0.05 ($p < 0.05$). This supports the alternate hypothesis, emphasising the importance of perceived benefits in sustainable technology adoption.

**Hypothesis 2 ($RH_2$):** Economic stability and strategic policy frameworks significantly influence end-user acceptance and the adoption of sustainable technologies within South Africa's energy grid.

**$RH2_0$ – Null Hypothesis:** Economic stability derived through strategic policy does not significantly influence acceptance, regardless of perceived benefits or social factors.

The null hypothesis is rejected based on the results of this study, which demonstrate a statistically significant relationship between economic stability and acceptance ($p < 0.05$). The analysis further indicates that strategic policy additions play a pivotal role in enhancing financial viability, contributing significantly to acceptance. These findings support the alternate hypothesis and underscore the critical influence of economic conditions in fostering the acceptance of sustainable technologies.

The study supports the alternate hypothesis ($RH_2$), indicating that economic stability, in combination with perceived benefits and social factors as influenced by policy, significantly influences the acceptance of sustainable technologies.

## 1.11 Research Syllogisms

### 1.11.1 First Syllogism: End-User Perception as a Determinant of Sustainable Technology Acceptance

**Premise 1:** *If end-users perceive sustainable technologies positively, they are more likely to adopt these technologies.*

**Premise 2:** *Positive perceptions are primarily determined by the perceived benefits associated with these technologies.*

**Counter-Premise:** *However, systemic barriers, such as infrastructural limitations, prohibitive upfront costs, or lack of supportive policies, prevent adoption despite positive perceptions.*

**Conclusion:** *Therefore, while positive end-user perceptions significantly enhance the likelihood of sustainable technology adoption, systemic barriers must be addressed to enable successful implementation.*

### 1.11.2 Second Syllogism: Economic Stability and Resource Allocation as Catalysts for Sustainable Technology Adoption

**Premise 1:** *If economic stability is supported by targeted strategic policy interventions, the financial viability of adopting sustainable technologies increases.*

**Premise 2:** *Increased financial viability, supported by effective policy interventions, enhances end-user acceptance of sustainable technologies.*

**Conclusion:** *Therefore, economic stability, supported by clear and strategic policy interventions such as financial incentives and subsidies, significantly influences end-user acceptance of sustainable technologies.*

### 1.11.3 Third Syllogism: Functional Compatibility as a Critical Component of Sustainability

**Premise 1:** *If a sustainable technology is functionally compatible with existing infrastructure and cultural practices, resistance to adoption decreases.*

**Premise 2:** *Reduced resistance leads to higher levels of acceptance among end-users.*

**Conclusion:** *Therefore, ensuring functional compatibility is critical to the successful adoption of sustainable technologies.*

### 1.11.4 Fourth Syllogism: Development of a Comprehensive Sustainability Acceptance Model (SAM)

**Premise 1:** *A comprehensive model integrating environmental, economic, social, and functional compatibility factors can accurately predict acceptance patterns.*

**Premise 2:** *Accurate predictions enable stakeholders to design effective strategies for sustainable technology adoption.*

**Conclusion:** *Therefore, developing a multidimensional framework, such as the Sustainability Acceptance Model (SAM), is essential for improving the acceptance and practical implementation of sustainable technologies.*

## 1.12 Organisation of the Research

This research is systematically structured to address its core objectives and research questions, ensuring a comprehensive analysis of the topic. The organisation is outlined as follows:

### 1.12.1 Chapter 1: Introduction and Contextual Framework

**Background:** Examines South Africa's energy grid challenges, including its heavy reliance on coal and the critical need for transitioning to sustainable energy solutions.

**Problem Statement:** Highlights the persistent failure to achieve widespread acceptance of sustainable technologies despite their essential role in addressing energy and environmental crises.

**Research Gap:** Identifies limitations in existing models, such as the Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB), in adequately addressing economic, social, and functional compatibility dimensions.

**Aim and Objectives:** Defines the study's aim to improve sustainable technology acceptance while outlining specific objectives, including perception analysis, resource allocation strategies, and empirical modelling.

### 1.12.2 Chapter 2: Literature Review

**Theoretical Review:** Critically evaluates traditional acceptance models (TAM, TPB) and introduces the Sustainability Acceptance Model (SAM) as a comprehensive alternative, incorporating constructs such as functional compatibility, economic viability, and perceived environmental impact.

**Empirical Review:** Synthesises prior studies to highlight gaps in economic stability, social equity, and technological adoption within the context of South Africa's energy challenges.

### 1.12.3 Conceptual Framework

**Sustainability Acceptance Model (SAM):** Proposes a novel framework integrating environmental, economic, social, and functional compatibility dimensions to address limitations in existing models.

**Key Constructs:** Establishes five foundational components—Perceived Environmental Impact, Economic Viability, Social Influence and Norms, Perceived Behavioural Control, and Functional Compatibility—to comprehensively evaluate technology acceptance.

### 1.12.4 Chapter 3: Methodology

**Philosophical Standpoint:** Adopts a positivist approach to enable empirical validation.

**Research Strategy:** Utilises a deductive approach supported by cross-sectional data collection to test theoretical constructs.

**Analytical Framework:** Survey's primary data (survey-based perceptions) and employs adapted statistical tools to assess relationships between variables.

### 1.12.5 Chapter 4: Data Sources & Handling Protocols

**Primary Data:** Collects surveys to capture public perceptions, preferences, and barriers to adopting sustainable technologies.

**Validation:** Ensures robust analysis through data cleaning, consistency checks, and statistical validation techniques.

### 1.12.6 Chapter 5: Data Analysis and Discussion

**End-User Perception Analysis:** Investigates the relationship between public attitudes and sustainable technology acceptance.

**Economic Stability Analysis:** Explores how economic stability and policy interventions impact adoption rates from an end-user's perspective.

**Functional Compatibility Assessment:** Evaluates how well sustainable technologies align with existing systems and cultural norms.

#### 1.12.7 Chapter 6: Conclusion and Recommendations

**Summary of Key Findings:** Highlights the study's main outcomes and their implications for policy and practice.

**Actionable Guidelines:** Proposes strategies based on the Sustainability Acceptance Model to promote the adoption of sustainable technologies in South Africa.

#### 1.12.8 Limitations and Future Research

**Study Limitations:** Acknowledges constraints, such as the scope of empirical validation and potential biases in end-user perceptions.

**Future Directions:** Recommends longitudinal studies and expanded modelling efforts across other developing nations to strengthen the generalisability of findings.

This structured approach ensures that the research addresses its objectives comprehensively while delivering actionable insights for policymakers, stakeholders, and scholars in the field of sustainable development.

## 1.13 Summary of the Opening Chapter

The introduction underscores South Africa's urgent need for sustainable energy solutions, highlighting key contextual challenges and the foundational principles guiding the research:

- Reliance on coal, aging infrastructure, and socio-economic challenges underscore the critical need for sustainable energy solutions.
- South Africa's constitutional commitment to sustainability, particularly Section 24 of the Constitution, provides a foundation for ecological governance.

- The inefficiencies of Eskom's coal-dominated energy grid and the government's Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) are explored.
- Constant policy flux hinders sustainable development, with policies across sectors of South African governmental institution being in misalignment, resulting in redacted gains on any progress made.
- Existing models, such as the Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB), are identified as insufficient due to their failure to address economic viability and functional compatibility.
- The chapter highlights the role of the end-user as a critical stakeholder, emphasising the importance of public perception, financial burden, and functional compatibility in sustainable technology adoption.
- The study aims to empower end-users by addressing these factors, ensuring equitable participation in the energy transition.

This sets the foundation for the development of the Sustainability Acceptance Model (SAM), a comprehensive framework incorporating environmental, economic, social, and functional dimensions to optimise South Africa's transition to a sustainable energy grid.

# CHAPTER 2: LITERATURE REVIEW

## 2.1 Chapter 2 Synopsis

This chapter reviews theoretical and empirical literature on sustainable technology adoption. It critiques traditional theoretical frameworks like the Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB) for neglecting key factors such as economic viability and functional compatibility. The chapter further introduces its theoretical and conceptual framework, the Sustainability Acceptance Model (SAM), incorporating constructs like perceived environmental impact, social influence, and functional compatibility to address these gaps. It emphasises the importance of aligning sustainable technologies with existing systems and cultural norms, especially in South Africa's energy sector, advocating that the SAM offers a holistic framework to foster public acceptance and guide the transition to a sustainable energy grid.

## 2.2 Theoretical Literature Review

### 2.2.1 Introduction

The concept of sustainability has traditionally been anchored in its three foundational pillars, economic, environmental, and social dimensions, as popularised by John Elkington's Triple Bottom Line framework in 'Cannibals with Forks: The Triple Bottom Line of 21st Century Business' (1999), and grounded in the Brundtland Report (World Commission on Environment and Development, 1987).

While these pillars advocate a balanced approach to pursuing economic development, environmental protection, and social equity concurrently, critical analyses have highlighted their limitations, particularly in contexts marked by rapid technological advancements and systemic complexities. This study addresses such limitations by proposing the inclusion of a fourth pillar, functional compatibility, which emphasises the seamless integration of sustainable technologies within existing infrastructures and cultural frameworks. By incorporating this additional dimension, the research seeks to provide a more comprehensive understanding of sustainable technology acceptance, particularly relevant to South Africa's energy transition.

Functional compatibility emerges as an interdisciplinary adaptation, drawing from two distinct fields: computer science, where technologies are evaluated for their ability to integrate seamlessly with existing infrastructure, and management sciences, where operational alignment and strategic fit are emphasised (Bornemann and Wenzel, 2006; Rodrigues and Grossi, 2007; M. Weaich et al., 2024). This concept acknowledges that achieving sustainability requires more than balancing economic, environmental, and social goals; it demands an assessment of whether solutions are technically, operationally, environmentally, socially, and culturally compatible (M. Weaich et al., 2024). The development of compatibility indicators, akin to performance indicators or environmental indicators as described by Condori-Fernandez and Lago, (2018), and Rodrigues and Grossi, (2007), allows for a structured evaluation of these dimensions. These indicators provide a systematic approach to ensuring that sustainable solutions are adaptable across diverse criteria, facilitating their practical implementation.

In this conceptual framework, functional compatibility decomposes the complex notion of sustainability further into observable or measurable parameters, ensuring that solutions operate harmoniously within existing infrastructures, align with cultural norms, and complement technological ecosystems. In the context of this study, in South Africa’s energy grid transformation, functional compatibility is particularly critical. Renewable energy systems and efficiency measures must integrate effectively with the operational dynamics of the national grid, adapt to consumer behaviour patterns, and adhere to existing policy frameworks (Chakraborty et al., 2020; De Vries and Verzijlbergh, 2018; Stute and Klobasa, 2024; Tantau et al., 2021). Without functional compatibility, otherwise beneficial technologies may encounter inefficiencies, public resistance, or outright rejection, undermining their potential contributions to economic, environmental, and social objectives (Ježek and Brada, 2011; Proykov and Simeonova, 2023; Vasin et al., 2020).

By emphasising functional compatibility, this study extends the traditional sustainability paradigm, offering a phenomenological lens for evaluating the feasibility and long-term viability of sustainable solutions. This focus ensures that theoretical advancements are aligned with real-world complexities, ultimately fostering the successful integration of sustainable technologies in diverse and challenging contexts.

### 2.2.2 Observing the Phenomenon: Tenets and Theoretical Frameworks

Observing phenomena through the lenses of theoretical frameworks in technology acceptance studies are critical for understanding the underlying principles that shape user adoption of innovations (Husserl, 2012). Recent research highlights diverse applications of these frameworks across technological contexts. For instance, studies by Alshkeili and Ghosh, (2023), Perju-Mitran et al., (2020) and Ahn and Park, (2022), delve into user acceptance of autonomous vehicles in private and public transportation. Similarly, Bouaguel and Alsulimani, (2022) explore residential consumer acceptance of solar panels, while Mutambik, (2024), investigates cultural reforms influencing consumer behaviour toward renewable energy in smart and sustainable cities. Broader evaluations, such as those by Khalid et al., (2021) and Wang et al., (2021), examine trends in renewable energy acceptance and the Unified Theory of Acceptance and Use of Technology (UTAUT), offering valuable insights into societal integration of advanced technologies.

Key models, particularly the Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB), have played pivotal roles in shaping the discourse on technology acceptance. TAM, introduced by Davis, (1989), emphasises perceived usefulness and perceived ease of use as the primary determinants of acceptance. TPB, developed by Ajzen, (1985), extends this understanding by incorporating perceived behavioural control alongside attitudes and subjective norms to predict intentions (Anisman and Kusnecov, 2022). While these models provide foundational insights, their application to sustainable technologies reveals limitations, particularly in addressing economic dimensions critical to sustainable development (Chen and Yen, 2023; Han et al., 2024; Pilipczuk, 2021).

#### *2.2.2.1 Towards Developing a Sustainability Acceptance Model (SAM)*

To address these gaps, the Sustainability Acceptance Model (SAM) extends traditional frameworks by integrating constructs such as perceived environmental impact and economic viability. This evolution bridges the gap between theoretical knowledge and practical applications, offering a comprehensive framework for sustainable technology acceptance.

### 2.2.3 Critiquing the Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM), introduced by Davis, (1989), has been a cornerstone in predicting user acceptance of technology, particularly through its foundational components: perceived usefulness and perceived ease of use. These constructs measure, respectively, the belief that a system enhances job performance, and the anticipated effort required to engage with the system. TAM's simplicity and versatility have enabled its application across diverse technological contexts, such as information systems, healthcare, and education, where it has consistently demonstrated robust explanatory power (Aburbeian et al., 2022; Granić, 2022; Ho et al., 2020; Naidoo, 2022; Wang et al., 2023).

#### *2.2.3.1 Strengths of TAM*

The Technology Acceptance Model (TAM) demonstrates significant strengths, including its simplicity and clarity, as its straightforward constructs allow for ease of application and interpretation (Malatji et al., 2020). It also boasts wide applicability, having been successfully employed to understand user behaviour across various domains (Ahmed Alnagrat et al., 2023; Othman et al., 2019; Ratna and Mehra, 2015). Additionally, TAM benefits from extensive empirical validation, making it a reliable and robust framework for studying technology adoption (Sugiantoro and Kurniawan, 2023).

### *2.2.3.2 Limitations in the Context of Sustainability*

Despite its widespread application, the Technology Acceptance Model (TAM) has notable limitations when applied to the adoption of sustainable technologies. One significant limitation is its neglect of financial determinants. TAM does not explicitly address financial constraints, which are often critical in sustainability contexts. For example, Aboalsamh et al., (2023) identified financial policy barriers that limit the promotion of green fintech in smart cities, while Warsono et al., (2023) highlighted economic challenges hindering collaborative governance in public administration.

In agriculture, Hannus and Sauer, (2021) revealed that financial constraints deter farmers from adopting sustainability standards, and Vyas and Jain, (2021) discussed how financial exclusion impedes rural populations from embracing digital technologies. Similarly, Hamza et al., (2023) noted resistance to prefabricated construction technologies due to high costs. These instances underscore TAM's inadequacy in addressing cost-related barriers essential for sustainable technology adoption.

Additionally, TAM excludes broader socio-environmental dimensions critical for sustainability. While focusing on individual user perceptions, it fails to incorporate drivers such as long-term environmental benefits, like carbon footprint reduction, as highlighted by (Addai et al., 2023; Garcia et al., 2023; Gillon et al., 2024; Marina Lorena et al., 2024; Pratt, 2022; Slatter, 2023). Ethical imperatives, including motivations to adopt environmentally friendly practices, are also overlooked (Gillon et al., 2024; Marina Lorena et al., 2024; Pratt, 2022; Slatter, 2023). Furthermore, TAM's limited consideration of economic viability is a concern.

### *2.2.3.3 Towards Developing a Sustainability Acceptance Model (SAM)*

Key economic factors, such as energy efficiency cost savings or financial incentives like subsidies and tax benefits, are absent from the model, despite being pivotal for sustainable technology adoption. These gaps suggest that TAM requires significant adaptation to address the unique challenges posed by sustainable technologies.

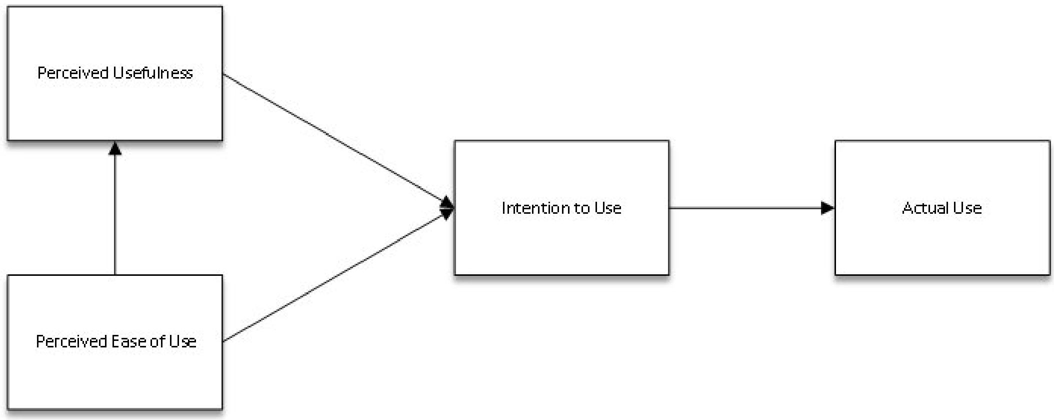


**Figure 2.1: Theoretical Framework for the Technology Acceptance Model**
Source: (Bidin and Saad, 2012)

### 2.2.4 Critiquing the Theory of Planned Behaviour (TPB)

The Theory of Planned Behaviour (TPB), introduced by Ajzen, (1985), is a robust framework designed to predict behavioural intentions by incorporating perceived behavioural control alongside attitude towards behaviour and subjective norms. TPB built upon a well-established conceptualised theory by Fishbein, (1976), commonly referred to as the Theory of Reasoned Action (TRA) by addressing its limitations (Ajzen and Fishbein, 2002). To enhance the predictive power of TRA, Ajzen introduced the concept of perceived behavioural control as a third determinant of both intention and behaviour. This addition reflects the extent to which individuals believe they can successfully perform a behaviour, integrating internal factors such as skills and abilities, and external factors such as resources and obstacles. By accounting for non-volitional elements, TPB extends TRA to predict behaviours that require significant effort or face external barriers (Ajzen, 1985; Ajzen and Cote, 2008; Ajzen and Fishbein, 2002).

TPB has been widely applied to understand a variety of actions, ranging from health behaviours to technology acceptance, with its emphasis on individual perceptions of control and the influence of social pressures proving particularly valuable. These constructs collectively influence behavioural intentions, offering a reliable basis for understanding and predicting behaviour across diverse contexts (Ajzen, 2020; Lee et al., 2021; Mak et al., 2020; Widianto et al., 2021).

#### *2.2.4.1 Limitations in the Context of Sustainability*

While TPB effectively accounts for social influences and perceived ease or difficulty in performing a behaviour, it exhibits significant limitations when applied to the acceptance of sustainable technologies (Islam et al., 2023). The model fails to address the economic and environmental dimensions critical to sustainability (Elkington and Rowlands, 1999). Specifically, TPB overlooks long-term environmental benefits and ethical considerations, which are often pivotal motivators for sustainable behaviour (Pollard, 2015; Rex et al., 2015). These gaps highlight the need for an evolved framework that can better accommodate the unique drivers of sustainability. While TPB provides a foundational framework, its effective application to sustainable technology acceptance remains limited.

#### *2.2.4.2 Towards Developing a Sustainability Acceptance Model (SAM)*

The Sustainability Acceptance Model (SAM) responds to these limitations by incorporating constructs such as perceived environmental impact and economic viability, which are essential to understanding sustainable technology adoption (Popper, 2008; Saunders et al., 2023). By extending TPB to include these dimensions, SAM offers a more comprehensive framework that captures the complexities of sustainable technology acceptance. This integration ensures a nuanced understanding of the multifaceted drivers behind the adoption of sustainable practices and technologies, addressing the shortcomings of traditional models and aligning theoretical insights with observed barriers identified in the phenomenon.

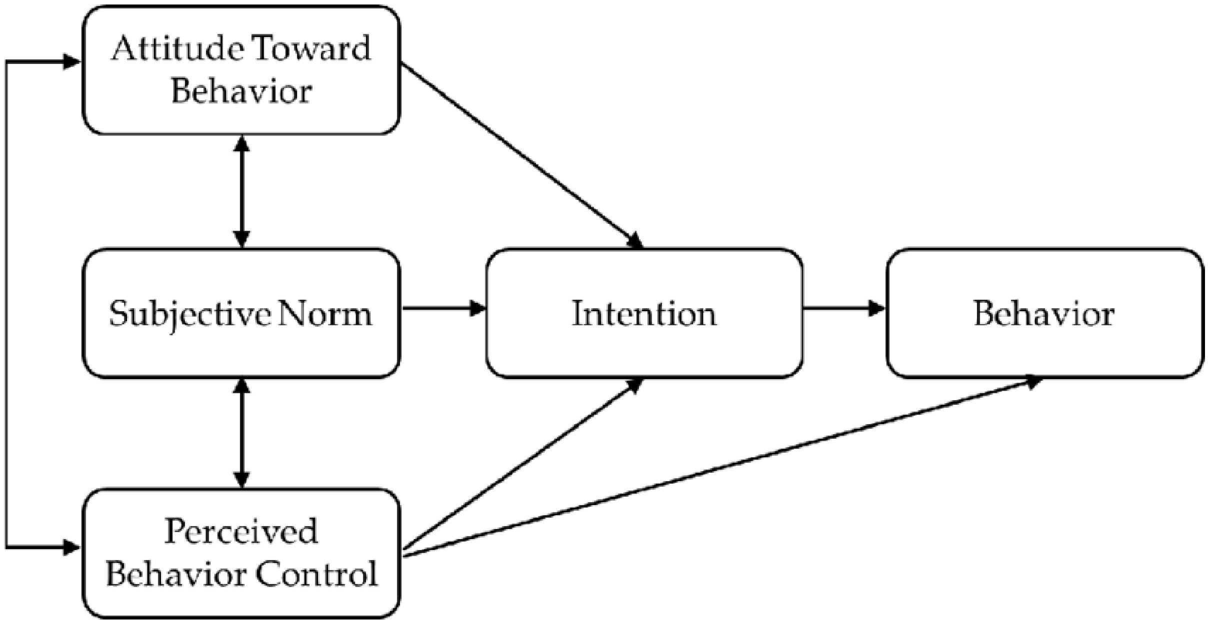


**Figure 2.2: Theoretical Framework for the Theory of Planned Behaviour (TPB)**
Source: (Prayoga et al., 2021)

### 2.2.5 Previous Attempts at Merging Theory to Decipher the Sustainability Phenomenon

Efforts to integrate the Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB) have aimed to develop more comprehensive frameworks for understanding technology acceptance (Karsh et al., 2009). Sustainability, with its foundational triple bottom line—encompassing environmental, social, and economic dimensions—necessitates theoretical models that effectively capture these multifaceted aspects. Models such as TAM and TPB, along with modern adaptations like the Unified Theory of Acceptance and Use of Technology (UTAUT), provide valuable foundational insights into user acceptance (Ajzen, 1985; Davis, 1989; Elkington and Rowlands, 1999; Kemple, 2023; Lau et al., 2020; Narang and Bhardwaj, 2020; Prasetyo and Santiago, 2021; Syamil and Kharisma, 2023; Wang and Huang, 2024). These models primarily focus on constructs such as perceived usefulness, ease of use, attitudes, subjective norms, and perceived behavioural control, offering a solid base for predicting technology adoption behaviours.

However, these theoretical frameworks fail to adequately address the economic dimensions critical to sustainability. For instance, while TAM and TPB consider individual attitudes and perceptions, they do not incorporate broader economic factors, such as financial feasibility, financial viability, financial incentives, or market dynamics, that significantly influence sustainable technology adoption. Similarly, UTAUT, which attempts to enhance predictive power by including constructs like social influence and facilitating conditions, overlooks the economic complexities essential to the sustainability discourse (Malatji et al., 2020).

These limitations highlight the need to retool existing models to better align with the principles of sustainability. Integrating economic considerations into the theoretical frameworks is vital for capturing the interdependence of environmental, social, and economic dimensions. Addressing these gaps is necessary for developing a cohesive understanding of the sustainability phenomenon, where theoretical advancements align with the practical realities of adopting and implementing sustainable technologies. This critique underscores the importance of advancing frameworks that reflect the intricate variables underpinning the sustainability paradigm, ensuring that they not only predict user acceptance but also facilitate the integration of sustainability principles across diverse contexts.

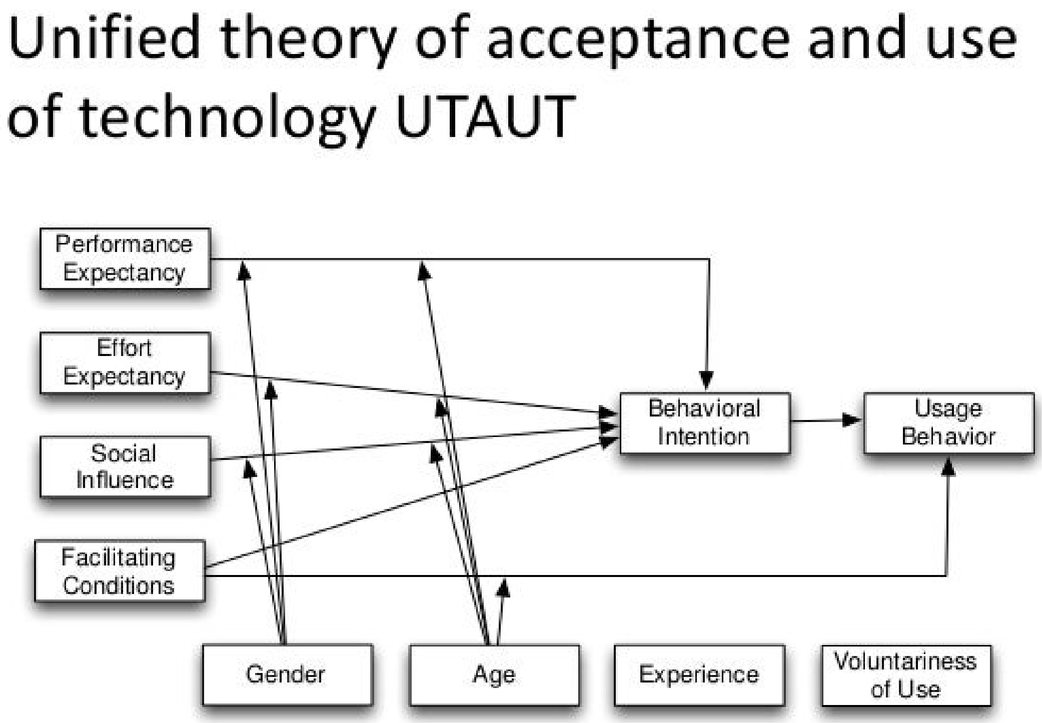


**Figure 2.3: Theoretical Framework for the Unified Theory of Acceptance and Use of Technology (UTAUT)**
Source: (Venkatesh et al., 2003)

### 2.2.6 Developing the Tenets of the Sustainability Acceptance Model (SAM)

In line with the principles of theory development articulated by Popper, (2008) and Saunders et al., (2023), the Sustainability Acceptance Model (SAM) has been designed to incorporate a comprehensive and integrative approach that addresses the multifaceted nature of sustainable technology acceptance. This framework rests on five foundational tenets, each offering critical insights into the factors that influence the acceptance and seamless integration of sustainable technologies within society. These tenets collectively form the theoretical underpinning of SAM and ensure a holistic evaluation of sustainability-related decisions:

#### *2.2.6.1 Tenet 1 (T1): Perceived Environmental Impact (PEI)*

**T1:** This tenet captures the extent to which individuals perceive the ecological benefits of adopting a technology, including reductions in carbon footprints, conservation of natural resources, and contributions to environmental sustainability. It emphasises the ethical and ecological dimensions critical to influencing acceptance behaviours.

#### *2.2.6.2 Tenet 2 (T2): Economic Viability (EV)*

**T2:** Reflecting the financial aspects of technology adoption, this tenet assesses both immediate costs and long-term financial benefits, such as energy savings, tax incentives, or subsidies. Economic viability plays a pivotal role in determining whether sustainable solutions are feasible and attractive to end-users.

#### *2.2.6.3 Tenet 3 (T3): Social Influence and Norms (SIN)*

**T3:** Building on the social dimensions of sustainability, this tenet examines how societal expectations, peer pressures, and community endorsements affect the adoption of sustainable technologies. It highlights the role of collective attitudes and norms in shaping individual and organisational behaviours.

#### *2.2.6.4 Tenet 4 (T4): Perceived Behavioural Control (PBC)*

**T4:** Adapted from the Theory of Planned Behaviour, this tenet evaluates an individual's perceived ability to successfully adopt and use a sustainable technology. It includes factors such as the availability of resources, technical support, and infrastructure, as well as personal competencies.

#### *2.2.6.5 Tenet 5 (T5): Functional Compatibility (FC)*

**T5:** A novel addition to the sustainability framework, this tenet assesses how well a sustainable technology aligns with existing systems, practices, and cultural norms. It ensures that new solutions can be integrated into current infrastructures without significant disruption, minimising resistance and maximising adoption potential.

These tenets collectively address the diverse dimensions of newly adapted definition for sustainability, adding a fourth pillar to its complex, offering a robust theoretical foundation for understanding the drivers and barriers to sustainable technology acceptance. By integrating these tenets, SAM provides actionable insights for policymakers, developers, and stakeholders, ensuring that sustainable solutions are not only desirable in principle but also feasible and effective in practice.

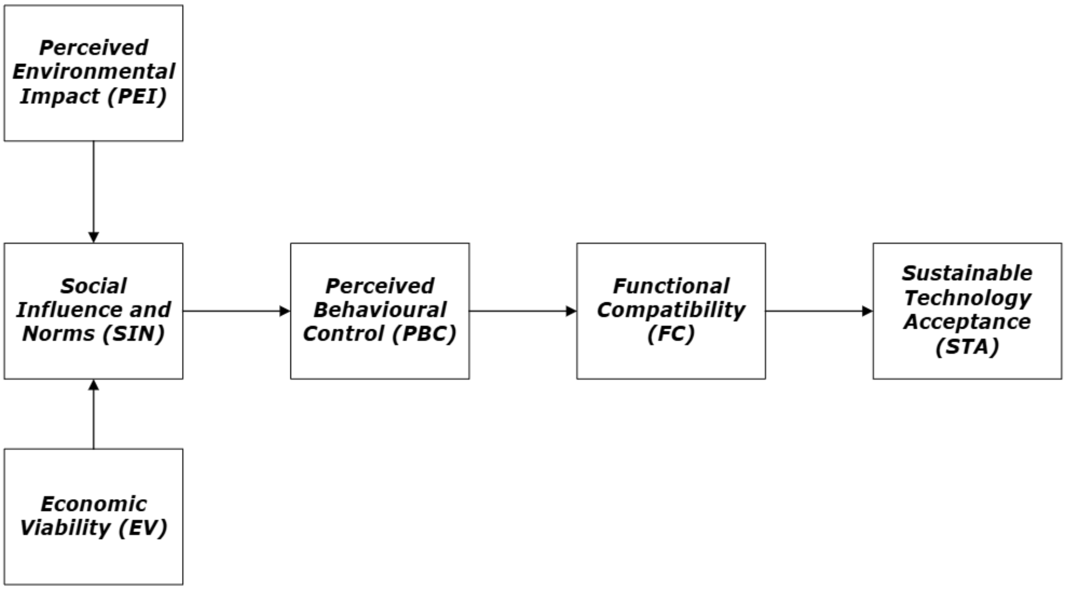


**Figure 2.4: Theoretical Framework for the Sustainability Acceptance Model**
Source: Author

## 2.3 Empirical Literature Review

### 2.3.1 Introduction: Establishing Empirical Evidence for a Distinct Phenomenon

The Sustainability Acceptance Model (SAM) introduced in the theoretical literature review builds upon and extends traditional frameworks, such as the Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB), by incorporating additional constructs essential for evaluating sustainable technology adoption. These constructs—perceived usefulness, perceived ease of use, perceived environmental impact, economic viability, social influence, and functional compatibility—address critical dimensions that earlier models inadequately captured. By doing so, SAM provides a more comprehensive lens through which the multifaceted factors influencing sustainable technology acceptance can be understood and empirically validated.

Empirical studies have highlighted the need for such a holistic framework. For instance, while TAM has demonstrated the importance of perceived usefulness and ease of use in user acceptance, these studies often neglect environmental and financial aspects that are central to sustainable technologies. Similarly, TPB's focus on attitudes, subjective norms, and perceived behavioural control provides valuable insights but does not account for the systemic alignment required for sustainable solutions to be effective. SAM bridges these gaps by integrating functional compatibility—a construct that ensures technologies are assessed for their ability to align with existing systems, infrastructures, and cultural norms.

### 2.3.2 South Africa's Carbon Production and Global Ranking as a $CO_2$ Emitter

South Africa is the largest $CO_2$ emitter in Africa and consistently ranks among the top 20 $CO_2$ emitters globally. The country's total $CO_2$ emissions are overwhelmingly driven by its reliance on coal-fired power stations, which account for approximately 80-90% of its electricity production. This reliance has made South Africa's energy production one of the most carbon-intensive globally (International Monetary Fund. African Dept., 2023). In terms of per capita $CO_2$ emissions, South Africa produces approximately 6-7 metric tons per person annually, placing it significantly higher than many other nations with similar population sizes (Global Carbon Atlas, 2022; International Energy Agency, 2024).

For context, the global average for per capita $CO_2$ emissions stands at approximately 4.66 metric tons, making South Africa's emissions nearly double the world average. Despite ranking around 25th globally in population size with roughly 60 million people, South Africa's per capita emissions position it within the top 50 countries globally, highlighting the disproportionate impact of its energy sector on carbon emissions (Global Carbon Atlas, 2022; International Energy Agency, 2024). Notably, South Africa's per capita emissions are comparable to or even higher than some developed countries with larger populations but more diversified and less carbon-intensive energy mixes (International Monetary Fund. African Dept., 2023).

This disparity underscores the carbon-intensive nature of South Africa's energy mix, particularly when compared to nations with larger populations but more diversified and less carbon-intensive energy systems (International Monetary Fund. African Dept., 2023).

Notably, South Africa's per capita emissions are comparable to, or even exceed, those of some developed countries that have adopted diversified energy portfolios with lower reliance on coal. This statistic further emphasises the challenges South Africa faces in transitioning to sustainable energy systems. The heavy dependence on coal, one of the most carbon-intensive fossil fuels, is the primary driver of these high emissions, both in total and per capita terms. The reliance on coal not only exacerbates South Africa's environmental footprint but also poses significant obstacles to meeting global climate targets and transitioning toward renewable and sustainable energy solutions (International Energy Agency, 2024; International Monetary Fund. African Dept., 2023).

The disproportionate carbon emissions per capita highlight the urgent need for systemic reform within South Africa's energy sector. Transitioning to cleaner and more diversified energy sources is critical not only for reducing the country's contribution to global $CO_2$ levels but also for aligning with international commitments to combat climate change. Addressing this challenge requires concerted efforts to invest in renewable energy technologies, enhance energy efficiency, and reduce dependence on coal to mitigate the environmental and economic consequences of its carbon-intensive energy production.

### 2.3.3 Key Links between 'IPP Housing' and a 'Sustainable Energy Grid for South Africa'

The relationship between housing and South Africa's energy grid is pivotal in the nation's transition to a sustainable energy system. Housing serves not only as a major consumer of energy but also, potentially, as a contributor to the energy grid. This dual role is emphasised within the Sustainability Acceptance Model (SAM) developed in this research, which highlights the importance of end-users, particularly homeowners, in adopting and integrating sustainable energy practices.

Empirical evidence consistently demonstrates the significant impact of housing on energy consumption patterns. Energy-efficient housing, incorporating technologies such as solar panels, energy-efficient appliances, and advanced insulation, can substantially lower the energy required per household. Such reductions directly alleviate the strain on the national grid, particularly during periods of peak demand, contributing to greater grid stability and reliability (Brounen et al., 2012; Cho, 2019; Escandón et al., 2017; Estiri, 2015). However, much of the existing literature conceptualises households solely as energy consumers rather than as independent power producers (IPPs) capable of contributing energy to the grid.

This traditional perspective is particularly restrictive in the South African context. South Africa's urban sprawl and the comparatively large land footprint of suburban households present a unique opportunity for decentralised energy production. For instance, the average suburban household in Johannesburg, Durban, and Cape Town occupies a full-title stand of approximately 807 square meters, compared to an average urban living space of just 47 square meters in European cities (Businesstech, 2017; Eurostat, 2016). This substantial land area enables South African households to adopt not only energy-efficient technologies but also renewable energy generation systems, such as rooftop solar panels or small-scale wind turbines. By doing so, these households can transition from being mere energy consumers to active contributors to the national grid.

This potential aligns closely with the goals of a sustainable energy grid, as decentralised energy production reduces the burden on centralised infrastructure, mitigates transmission losses, and supports a more resilient and flexible energy system (Berrie et al., 2011; Talari et al., 2020). Additionally, empowering households as IPPs creates socio-economic benefits, including cost savings for homeowners, reduced energy inequality, and the stimulation of local renewable energy markets (Akinyele et al., 2014; Elms, 2009; Nieminen et al., 2023).

In the South African context, where reliance on a coal-dominated energy grid exacerbates $CO_2$ emissions and undermines sustainability goals, enabling households to serve as energy producers is a transformative strategy. By leveraging the unique spatial characteristics of South African housing and encouraging the adoption of decentralised energy technologies, this research demonstrates that IPP housing can play a critical role in achieving a sustainable energy grid (Daniel et al., 2024; Mulongo et al., 2018; Skosana et al., 2023). This integration not only aligns with the SAM framework but also highlights the importance of functional compatibility, economic viability, and social acceptance in driving the nation's energy transition.

### 2.3.4 The Role of Social and Cultural Factors in Sustainable Housing Adoption

Social and cultural factors are pivotal in shaping the adoption of sustainable housing practices, particularly in communities where societal norms and collective values significantly influence individual decision-making. Adopting sustainable housing extends beyond technical or economic considerations; it is a social process deeply embedded in the cultural fabric of a community (Alwah et al., 2023; Okitasari et al., 2022; Rogers, 2003; Zhang and Khachatryan, 2023). Cultural norms and social equity considerations can either promote or impede the acceptance of green technologies in housing, depending on their alignment with community values and expectations (Gan et al., 2022; Seyfang and Smith, 2007; Yoon, 2018).

Empirical studies demonstrate that communities with strong social cohesion and shared environmental values are more likely to embrace sustainable housing practices. Social capital—defined as the networks and relationships among individuals in a society—emerges as a significant predictor of sustainable housing adoption (Putnam, 1995, 2001). In regions where environmental sustainability is a communal goal, individuals are more inclined to adopt green technologies, driven by peer influence and a desire to conform to collective norms (Dietz et al., 2003; Khurshid et al., 2024; Shehawy et al., 2024). Social cohesion fosters collective reinforcement of sustainable behaviours, creating an environment where green technologies are viewed not only as desirable but also as socially expected (Löhr et al., 2021; McMichael et al., 2006; Passaro et al., 2015; Tamasiga et al., 2024).

Cultural traditions also play a crucial role in determining the acceptability of sustainable housing technologies. Societies that place a high value on environmental stewardship and intergenerational equity are more likely to accept innovations that align with these principles (Schwartz, 1999; Shehawy et al., 2024). Conversely, resistance may arise in cultures where traditional building methods and materials are deeply embedded, as new technologies might be perceived as incompatible with established norms (Burroughs and Růžička, 2019; Golden, 2017; Janda, 2011; Weaich et al., 2023).

Social equity further influences the uptake of sustainable housing by addressing disparities in access to green technologies. Policies promoting equitable access, such as subsidies for low-income households, have proven effective in enhancing the acceptance of sustainable housing by reducing financial barriers (Bramley and Power, 2009; Carter and Fortune, 2007; Masram et al., 2020; Simbanegavi et al., 2021, 2020; Simbanegavi and Ijasan, 2022; Simbanegavi and Ndlovu, 2021). Ensuring that all societal groups, including marginalised and low-income communities, benefit from sustainable housing initiatives is essential for fostering widespread acceptance (Agyeman, 2005; Alaie et al., 2022; Carter and Fortune, 2007; Dean et al., 2017; Oyebanji et al., 2017; Santosa et al., 2020).

However, the influence of social and cultural factors is highly context-dependent, varying significantly based on the socio-economic and cultural characteristics of the community. As a result, strategies to promote sustainable housing adoption must be culturally sensitive and tailored to local contexts. Addressing unique social dynamics and cultural values is critical for ensuring that sustainability initiatives resonate with the targeted communities and achieve long-term success (Oyetunji et al., 2022; Qtaishat et al., 2020; Shama and Motlak, 2019; Wilson and Dowlatabadi, 2007).

### 2.3.5 Economic Stability and its Influence on Sustainable Housing Choices

Economic stability is a critical determinant in the decision-making process for sustainable housing choices, shaping both the capacity and willingness of individuals to invest in energy-efficient homes and green technologies. Factors such as stable income, job security, and overall financial well-being directly influence households' ability to consider sustainable housing options (Liu et al., 2024; Oyetunji et al., 2022; Ozili and Iorember, 2024; Rehman, 2018; Shooshtarian et al., 2021; Weaich et al., 2023). Households with stable economic conditions are more likely to absorb the higher upfront costs associated with sustainable technologies, including solar panels, energy-efficient appliances, and eco-friendly building materials. These investments, although initially costly, promise long-term financial and environmental benefits, making them more accessible to economically secure households (Average Chigwenya and Prisca Simbanegavi, 2020; Dananjoyo et al., 2020; Gillingham and Palmer, 2014; He et al., 2020; Maclennan and Long, 2024; Mushanga et al., 2024).

Empirical research establishes a positive correlation between economic stability and the adoption of sustainable housing practices. Higher and more consistent household incomes facilitate access to credit and capital, enabling individuals to finance the initial costs of green technologies (He et al., 2020; Khan and Fang, 2020). Furthermore, financial stability lowers the perceived risks associated with adopting innovative but unfamiliar technologies, which increases the likelihood of their acceptance (Dadoukis et al., 2021; Pierri and Timmer, 2022; Roe et al., 2001). In contrast, households experiencing financial instability often redirect their resources toward immediate necessities, deprioritising investments in sustainable housing (Ahiadu and Abidoye, 2023; Dai and Sheng, 2021; Gomez-Gonzalez et al., 2024; Heinonen and Junnila, 2011; Huang, 2024).

The influence of economic stability also extends to the broader housing market. Regions experiencing robust economic growth and stable employment typically see higher demand for sustainable housing, driven by consumer preferences and developers' ability to invest in eco-friendly construction methods (Al Harazi et al., 2022; Alaloul et al., 2022; Baronin et al., 2023; Myers and Myers, 2008; Pourrahimian et al., 2022; Sutantio et al., 2022). Moreover, economic policies fostering financial stability—such as low-interest rates, housing subsidies, and tax incentives—reduce financial barriers and encourage sustainable investments by both consumers and developers (Bhanye et al., 2024; Duca et al., 2021; Nemet et al., 2010; Zhang et al., 2020).

However, the impact of economic stability is not uniformly distributed across socio-economic groups. While wealthier households often have the means to invest in sustainable housing, lower-income groups face significant barriers, including limited access to credit and reduced disposable income (Aarland and Reid, 2019; Aliu, 2022; Chiu et al., 2019; Eastin et al., 2011; Maclennan and Long, 2024). Addressing these disparities requires targeted policy interventions that include subsidies, tax breaks, and affordable financing mechanisms to ensure equitable access to sustainable housing for all income levels (Adabre and Chan, 2019; Berry, 2012; Díaz-López et al., 2021; Tovar, 2012).

Given the importance of economic stability in driving sustainable housing adoption, prioritising financial security and equity is essential for fostering widespread acceptance and implementation of green technologies in the housing sector. Policymakers must develop inclusive strategies that address financial barriers, ensuring that sustainable housing options are accessible to diverse socio-economic groups. For South Africa, integrating these considerations is vital to transitioning toward a sustainable green energy grid, where housing becomes a cornerstone of both energy efficiency and decentralised energy production.

#### 2.3.6 Advocating Financial Analysis as a Core Component of Sustainability Research

Financial feasibility studies, often used by Quantity Surveyors, a vital tool for evaluating the economic viability of sustainable housing investments, offers a systematic approach to comparing costs and incomes over a specified timeframe (Terblanche and Root, 2024). This method provides stakeholders with a framework for determining whether the financial returns from sustainable technologies justify the initial and ongoing expenses, thereby aiding decision-making in both public and private sectors (Boardman, 2018; Fan et al., 2018; Mao and Yang, 2011; Zhang et al., 2018). By quantifying costs and assigning monetary values to returns, a financial feasibility study enables the comprehensive assessment of the economic impacts of sustainable housing projects. It evaluates financial sustainability of the project lifecycle, making it a valuable tool for the construction and residential sectors (Arkhangelskaya and Arkhangelskaya, 2020; Babos et al., 2023; Karji et al., 2019; Pearce et al., 2006; Tupenaite et al., 2017).

Empirical studies consistently reveal that while the upfront costs of sustainable housing investments, such as energy-efficient systems and green building materials, are often higher than conventional alternatives, the long-term benefits frequently outweigh these expenses (Arkhangelskaya and Arkhangelskaya, 2020; Dwaikat and Ali, 2016; Gabay et al., 2014; Marja C. Hoek-Smit et al., 2021; Olanrewaju et al., 2018; Ries et al., 2006; Tupenaite et al., 2017; Yassin et al., 2024). Benefits such as reduced energy consumption, lower utility costs, and increased property values contribute to the overall financial viability of these projects. For example, households that invest in solar panels or energy-efficient appliances typically realise significant savings on energy bills, often resulting in a positive Net Present Value (NPV) over time (Heiskanen and Matschoss, 2017; Klingler, 2017; Lee, 2020; Masotya et al., 2024; Mushanga et al., 2024; Olanrewaju et al., 2018; Oyetunji et al., 2022; Randolph et al., 2016; Vijayan and Kumar, 2005). These savings, coupled with potential incentives like subsidies or tax breaks, underscore the economic case for sustainable investments (Oyetunji et al., 2022; Randolph et al., 2016).

The effectiveness of a financial feasibility, however, is influenced by several contextual factors. The choice of discount rate, the expected lifespan of the technologies, and the regulatory environment all play critical roles in determining outcomes. A lower discount rate, for instance, emphasises future benefits, making long-term investments more attractive (Arrow et al., 2012; Buła and Foltyn-Zarychta, 2022). Likewise, supportive government policies, such as subsidies and tax incentives, can significantly improve the financial feasibility of sustainable housing projects by reducing initial costs for investors (D'Alpaos, 2021; Díaz-López et al., 2021; Nemet et al., 2010).

Despite its strengths, financial feasibilities are not without limitations. Critics argue that it may undervalue non-monetary benefits or overlook broader social and environmental impacts (Ackerman and Heinzerling, 2004; Carolus et al., 2018; Massiani, 2024). Additionally, financial modelling methods lack stakeholder insights and fail to reflect localised socio-economic dynamics as they are purely a financial tool to confirm investment returns. To address these shortcomings, a financial feasibility should be supplemented with complementary analytical tools, such as multivariate approaches, to ensure a more holistic evaluation of sustainable investments (Carolus et al., 2018; Mátrai, 2013; Phelps and Madhavan, 2018; Womer et al., 2006).

When tailored to specific conditions, this wholistic approach to financial feasibility studies has the potential to serve as a mandatory step in evaluating sustainable housing investments and green grid transformations. By carefully balancing monetary and non-monetary considerations, financial feasibilities can help stakeholders make informed decisions that promote long-term sustainability. Integrating localised factors, such as community needs and regional environmental priorities, into existing models can further enhance their utility, ensuring that green retrofits and energy systems align with broader sustainability objectives.

### 2.3.7 Technological Comfort and Acceptance of Green Grid Technologies

Technological comfort, defined as the ease with which individuals adapt to and use new technologies, is a critical determinant in the acceptance and integration of green grid technologies. As sustainable energy solutions increasingly depend on advanced systems—such as smart grids, solar power installations, and energy management devices—the extent to which end-users feel comfortable using these technologies significantly influences their adoption (Aklin et al., 2018; Archana, 2022; Bugden and Stedman, 2021; Venkatesh et al., 2003). Technological comfort not only impacts the initial decision to adopt green grid solutions but also affects their continued use and integration into daily practices (Offermann-van Heek and Ziefle, 2018; Raymundo and Da Silva Santana, 2014; Rogers, 2003; Shoheib et al., 2022).

Empirical research demonstrates that individuals with higher levels of technological literacy and confidence are more likely to adopt green grid solutions. For instance, those with prior experience using smart home devices or energy management systems often perceive green grid technologies as logical extensions of familiar systems rather than as disruptive innovations (Obafemi et al., 2023; Rochat and Ragot, 2022). Perceived ease of use—a core element of technological comfort—has been consistently shown to influence user attitudes toward adopting new energy technologies (Davis, 1989). When these technologies are user-friendly and their benefits are clear, end-users are more willing to invest in and utilise them (Arfina et al., 2023; Chen et al., 2019; Ku and Wang, 2022).

Technological comfort also mitigates the perceived risks associated with adopting new green grid technologies. Users who feel confident in their ability to understand and operate these systems are less likely to be deterred by concerns about potential technical difficulties or failure (Ianole-Călin and Druică, 2022; Li et al., 2008). Moreover, this comfort often correlates with a greater perceived value of the technology, as competent users are better able to recognise and appreciate the long-term benefits of sustainable energy solutions (Laukkanen and Tura, 2022; Lozano and Taboada, 2021; Mallard et al., 2020; Sangroya and Nayak, 2017; Venkatesh and Bala, 2008).

However, the level of technological comfort varies significantly across demographic groups, presenting challenges to the widespread adoption of green grid technologies. Older adults, for instance, often exhibit lower levels of technological comfort compared to younger generations, which can slow adoption rates among these populations (Ball et al., 2019; Charness and Boot, 2009; Faloye et al., 2022; Melchior, 2022; Musri et al., 2024). Similarly, individuals from lower socio-economic backgrounds, who may have limited access to advanced technologies, often face barriers to adoption due to a lack of exposure and familiarity, exacerbating the technological divide (Chitra et al., 2022; Grégoire-Zawilski and Popp, 2024; Van Dijk, 2006).

Given the critical role of technological comfort in driving the acceptance of green grid technologies, ensuring end-users are confident and competent in using these systems is essential for their successful implementation. Policymakers and industry stakeholders must prioritise initiatives aimed at bridging the technological comfort gap, such as educational programs, user-friendly interfaces, and ongoing technical support. Furthermore, continuous research, particularly cross-sectional studies, is necessary to monitor how end-users adapt to rapidly evolving infrastructure upgrades and to ensure that vulnerable populations are not left behind. By fostering technological comfort, sustainable energy solutions can achieve broader acceptance and integration, accelerating the transition toward a more sustainable energy future.

#### 2.3.8 Traditional Methods for Evaluating Sustainable Technology

Multivariate statistical techniques are invaluable tools for evaluating the multifaceted and interrelated factors influencing sustainable housing adoption and green grid transformations. These methods enable researchers to simultaneously analyse multiple variables, uncovering complex relationships and providing a holistic understanding of the determinants of sustainable housing acceptance (Hair, 2019; Mulliner et al., 2016, 2013).

However, some techniques rely on the researcher to study the observed phenomenon from a single perspective, often relying of data that is normalised (Kruskal and Wallis, 1952). Techniques such as multiple regression analysis, factor analysis, and structural equation modelling (SEM) are widely used to identify isolated key predictors and fail to assess the combined effects of economic, social, and economic factors on decision-making processes, these analyses often recommend narrowed observations without considering the broader implications of sustainability (Cervelló-Royo et al., 2021; Spandagos et al., 2022; Tabachnick and Fidell, 2019; Zhou et al., 2024).

### 2.3.9 Proposing an Alternative Approach to Defining Sustainability Variables

The current methods for observing these phenomena include regression, Pearsons's correlation or factor analysis, which has limitations, such as ensuring that data is normally distributed, particularly in its tendency to isolate variables without fully capturing the complexity of phenomena like sustainability (Cilliers et al., 2008; Field, 2024; Janse et al., 2021). This reductionist approach can result in oversimplified models that do not adequately reflect the systemic nature of sustainability challenges. However, there is merit to this caution, Multicollinearity—where two or more independent variables in a regression model exhibit a linear relationship—further complicates such analyses, often leading to failed experiments in assessing these interdependencies. Addressing this issue necessitates a novel approach that overcomes these limitations and encapsulates the complete phenomenon that is sustainability (De Mare et al., 2023; Gardezi and Shafiq, 2019; Hair et al., 2021; Nuuter et al., 2015; Rauf and Weber, 2022).

Factor analysis serves as a powerful tool for identifying underlying constructs that explain the patterns of correlations among observed variables. It reduces a large set of variables into a smaller number of interpretable factors, simplifying data analysis and interpretation (Bandalos and Finney, 2018; Hancock et al., 2019; Hox, 2021; Mindrila, 2017; Watson, 2017). In sustainable housing research, factor analysis might reveal clusters of variables related to environmental concerns, financial incentives, and community influence, each representing distinct dimensions of housing acceptance. For example, a factor analysis could show that perceptions of environmental stewardship and economic incentives coalesce into key drivers for green grid adoption (Fabrigar et al., 1999; Olanrewaju et al., 2018; Oluleye et al., 2021).

Structural equation modelling (SEM) is also a multivariate technique but one that combines regression and factor analysis to test complex relationships between observed and latent variables. SEM is particularly valuable in sustainability research, as it can model intricate interdependencies between individual attitudes, social influences, and economic factors in green grid transformations (Hussain et al., 2018; Irfan et al., 2021, 2020; Kline, 2016). This technique allows researchers to explore both direct and indirect effects, offering a nuanced understanding of the drivers behind sustainable technology adoption. For example, SEM can reveal how attitudes toward environmental benefits indirectly influence adoption through social norms or perceived ease of use, providing deeper insights into behaviour dynamics (Field, 2024; Popper, 2008).

However, the application of multivariate statistical techniques requires careful consideration of methodological assumptions and challenges, such as multicollinearity, adequate sample size, and data normality (Field, 2024; Gardezi et al., 2016; Mulliner et al., 2013; Steiner et al., 2008; Tabachnick and Fidell, 2019). Researchers must ensure these assumptions are met to produce valid and reliable results. Additionally, interpreting the outcomes of these analyses can be complex, necessitating a strong grasp of the underlying statistical methodologies (Hair et al., 2021).

Spearmans Correlation analysis is one of the most frequently applied techniques in the context of observing variables that would typically not be linked due to its non-normal distribution of the data (Madsen and Birkes, 2013; Ventura-León et al., 2023). This formula, first developed in 1904 was developed to focus on focused on bivariate correlations, for which it quantifies the relationship between two variables, ranking them as most influential to the dependent variable, often identifying a single strong factor to explain a phenomenon (Spearman, 1904).

Researchers such as Deng et al., (2022), Gaißer and Schmid, (2010), Masotya et al., (2024) and Zeyarah et al., (2019) have demonstrated the effectiveness of Spearman's correlation coefficient in ranking multiple variables simultaneously. This adaptation marks a significant extension of the coefficient's original use in evaluating two-variable relationships. The development of this form of multivariate analysis has gained momentum as researchers explore more sophisticated methodologies. For instance, Hauke and Kossowski, (2011), have applied these techniques in psychology, while Mpofu et al., (2024) and M. R. Weaich et al., (2024) have employed them in the domain of sustainability econometrics.

While multivariate techniques are indispensable for analysing the diverse factors influencing sustainable housing, they often fall short in adequately addressing the economic pillar of sustainability. Many studies neglect to provide robust evidence of the financial viability of proposed sustainable alternatives, leaving a critical gap in understanding the economic implications of adoption. This epistemological shortfall underscores the need for more comprehensive models that integrate economic viability with environmental and social dimensions. By supplementing multivariate methods with rigorous economic models, researchers can assess the financial feasibility of sustainable solutions more effectively. This approach enables a deeper exploration of the interplay between economic, social, and technological variables, fostering informed policymaking and effective promotion of sustainable housing and green grid technologies. This study terms this integrative phenomenon "sustainable functional compatibility", a holistic framework that ensures sustainable solutions are economically viable, sociocultural acceptable, and technologically compatible.

### 2.3.10 Perceived Environmental Impact (PEI) in Technology Acceptance

Perceived Environmental Impact (PEI) is a pivotal construct in technology acceptance, particularly within the realm of sustainable technologies. It reflects the degree to which individuals believe that adopting a particular technology will positively or negatively affect the environment (Adam et al., 2019). Empirical studies across various industries, such as sustainable tourism, aquaculture, and renewable energy, demonstrate that PEI significantly influences consumer behaviour as individuals and communities increasingly prioritise the ecological consequences of their choices (Baig et al., 2024; Garcez De Oliveira Padilha et al., 2021; Krøvel et al., 2019). As environmental awareness grows globally, the impact of this construct on technology adoption becomes even more pronounced.

Evidence from China provides a clear example of the importance of PEI in shaping policy and behaviour. In the wake of environmental crises in the early 2000s, the Chinese Communist Party integrated environmental concerns into its national policies. The 'Scientific Approach to Development' introduced in the 11th Five-Year Plan of 2005 marked a critical transition from prioritising unchecked economic growth to focusing on sustainable development, driven in part by the negative perceptions of environmental degradation among the population (Lau et al., 2019). This shift highlights the interplay between PEI and the broader socio-political and technological landscape.

In sustainable technology adoption, PEI often serves as a critical evaluation criterion alongside a ‘functional benefit’. Technologies such as renewable energy systems, electric vehicles, and green building materials are assessed not only for their performance but also for their ability to reduce carbon emissions, conserve natural resources, and mitigate environmental harm (Alali et al., 2022; Cui and Zhao, 2023; Huang et al., 2019; Ingeborgrud and Ryghaug, 2019; Lau et al., 2020; Nunes et al., 2023; Tran et al., 2022; Van Der Bergh et al., 2021; Velanparambil Ravindran et al., 2023; Weaich et al., 2023; Zhao et al., 2024).

Empirical evidence consistently shows that users are more likely to adopt technologies they perceive as environmentally beneficial, even when these require higher initial investments or substantial behavioural changes (Akbari et al., 2020; Dessi et al., 2022; Mateus et al., 2023; Neves et al., 2024). For example, studies on solar panel adoption reveal a strong correlation between environmental awareness and willingness to invest in solar energy, motivated by reduced greenhouse gas emissions and long-term sustainability gains (Atulkar, 2022; Ghosh and Satya Prasad, 2024; Karytsas et al., 2019).

Similarly, the adoption of electric vehicles is positively associated with perceptions of lower environmental impact compared to conventional gasoline-powered cars

(Ninh, 2021; Qian et al., 2023; Syré et al., 2020). These examples underscore the centrality of PEI in the decision-making process for sustainable technologies, highlighting the potential for leveraging this construct to promote environmentally friendly practices.

Incorporating PEI into technology acceptance models enhances their explanatory power and relevance, particularly in sustainability contexts. The Sustainability Acceptance Model (SAM) integrates PEI alongside constructs like perceived usefulness, ease of use, attitudes, subjective norms, and perceived behavioural control. This integration extends traditional frameworks such as the Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB), ensuring that the ecological benefits of technologies are adequately considered (Adam et al., 2019; Ghosh and Satya Prasad, 2024; Karytsas et al., 2019). By addressing environmental impact explicitly, SAM provides policymakers and stakeholders with deeper insights into the drivers of sustainable technology adoption.

Ultimately, recognising and prioritising PEI in technology acceptance models can facilitate the development and dissemination of innovations that align with global sustainability goals. By capturing the ecological dimensions of user decision-making, PEI supports the creation of strategies that encourage the widespread adoption of technologies designed to address environmental challenges, paving the way for a more sustainable future.

#### 2.3.11 Functional Compatibility (FC)

Functional Compatibility (FC) is a critical factor influencing the adoption of sustainable technologies, encompassing the immediate costs of implementation as well as the long-term financial benefits. High upfront expenses, such as purchase price, installation fees, and initial investments, frequently act as barriers to adoption. However, these barriers are often mitigated by long-term savings on energy bills, reduced maintenance costs, and financial incentives like subsidies and tax rebates. These economic considerations significantly enhance the attractiveness of sustainable technologies, encouraging their acceptance among consumers and stakeholders (Dadzie et al., 2019; German et al., 2019; Hasan et al., 2023; Ketuama and Roubík, 2024; Mukisa et al., 2022; Ninh, 2021; Pranta et al., 2023; Rubio et al., 2023; Syré et al., 2020; Thangjam et al., 2024; Weaich et al., 2023; M. R. Weaich et al., 2024).

Empirical evidence highlights the importance of economic viability in driving sustainable technology adoption. Studies on renewable energy systems, such as solar panels and wind turbines, reveal that financial incentives and subsidies play a pivotal role in offsetting high initial costs, thereby increasing acceptance rates. Similarly, the adoption of energy-efficient appliances and electric vehicles is frequently driven by the promise of long-term savings on operational and maintenance expenses (Hokmabad et al., 2024; Moodliar and Davidson, 2023). These findings underscore the need for supportive economic policies that lower financial barriers and enhance consumer confidence in the cost-effectiveness of sustainable technologies (Çiçek et al., 2023; Khan et al., 2021; Ye et al., 2024).

Functional compatibility (FC) addresses the seamless integration of sustainable technologies with existing systems, practices, and societal norms. This concept extends the scope of sustainability by ensuring that new technologies operate harmoniously within established infrastructures and cultural contexts. Functional compatibility acknowledges that even economically viable technologies may face adoption challenges if they are not compatible with existing infrastructure, consumer habits, or policy frameworks (Bouaguel and Alsulimani, 2022; M. Hamza et al., 2023; Hannus and Sauer, 2021). For example, renewable energy technologies must align with the operational dynamics of current energy grids, and electric vehicles require an adequate network of charging stations to ensure practical usability.

Studies emphasise that a lack of functional compatibility often results in resistance, inefficiencies, or outright rejection of otherwise beneficial technologies. Challenges such as insufficient infrastructure, complex installation processes, or misalignment with societal norms can hinder adoption despite the availability of financial incentives or long-term benefits (Martínez et al., 2019; Pranta et al., 2023; Rupeika-Apoga and Petrovska, 2022). For instance, technologies designed for energy efficiency may struggle to gain traction if they require extensive modifications to housing designs or necessitate significant behavioural changes from users (Atulkar, 2022; Dessi et al., 2022; Tenakwah et al., 2022).

The integration FC into the Sustainability Acceptance Model (SAM) provides a comprehensive framework for understanding the multifaceted drivers of sustainable technology adoption. SAM builds on traditional models, such as the Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB), by incorporating these constructs alongside perceived usefulness, ease of use, and social influence (Ajzen, 1985; Davis, 1989). By addressing both the financial incentives and the practical integration challenges of sustainable technologies, SAM offers a nuanced perspective that enhances its applicability in diverse contexts.

Functional compatibility is critical for fostering the widespread adoption of sustainable technologies. Policymakers and stakeholders must recognise the dual importance of reducing immediate costs while ensuring that technologies align seamlessly with existing systems and societal practices. For sustainable technologies to gain widespread acceptance, they must not only be economically accessible but also practically implementable within the cultural and infrastructural frameworks of target communities (Bonaiuto et al., 2024; Vekinis, 2023).

### 2.3.12 Social Influence and Norms (SIN) and Sustainable Technology Acceptance (STA)

Empirical research underscores the significant role that social influence and norms (SIN) play in the acceptance of sustainable technologies. Societal expectations and peer influence are powerful determinants of user behaviour, as evidenced by studies across various fields, including renewable energy, health technologies, and consumer electronics (Al-Emran and Griffy-Brown, 2023; Asante et al., 2021;

Caffaro et al., 2019; Kremmydas and Kostis, 2023; Sarkodie and Strezov, 2019; Sharma et al., 2023). Social norms create an environment where adopting certain technologies is perceived as desirable or even necessary for maintaining social standing (Sarkodie and Strezov, 2019; Sharma et al., 2023). This phenomenon is particularly evident in contexts where sustainability is a shared community goal, further reinforcing the influence of social dynamics on decision-making.

Peer influence is a key component of SIN, significantly affecting sustainable technology adoption. When individuals observe their peers or influential community members adopting and endorsing a particular technology, they are more likely to follow suit (Anand and Sharma, 2023; Ao et al., 2024; Duan et al., 2023; Liberalesso et al., 2020; Ogiemwonyi, 2022; Villa et al., 2023). Conversely, resistance can emerge when community norms or influential figures oppose a technology, as seen in the “Not in My Backyard Syndrome” (NIMBYism). This phenomenon illustrates how social influence can collectively encourage or deter technology adoption, regardless of the technology's sustainability merits (Simbanegavi, 2019).

The duality of social norms—serving as either facilitators or barriers to acceptance—is evident in empirical findings. Communities that prioritise environmental sustainability are more inclined to adopt green technologies, such as energy-efficient appliances or renewable energy systems, due to positive social norms and shared environmental values (Grelle et al., 2024; Mutumbi et al., 2024). Conversely, communities with negative attitudes towards new technologies or a lack of trust in their efficacy may resist adoption, resulting in slower acceptance rates (Khan, 2019; Rupeika-Apoga and Petrovska, 2022). This dynamic highlight the critical importance of tailoring strategies to align with the prevailing attitudes and values within a community.

The Sustainability Acceptance Model (SAM) incorporates SIN as a pivotal determinant, reflecting the model’s expansion of traditional frameworks like the Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB)

(Ajzen, 1985; Davis, 1989). SAM emphasises the influence of social dynamics in shaping user behaviour, recognising that societal factors are as influential as technological features or economic incentives in determining acceptance. This integration provides a more nuanced understanding of the drivers behind sustainable technology adoption.

To leverage SIN effectively, policymakers and stakeholders can design interventions that capitalise on positive social dynamics. Community-based campaigns, endorsements from respected local figures, and peer education programs can foster favourable attitudes toward sustainable technologies, accelerating their acceptance. For instance, involving community leaders in promoting renewable energy initiatives or showcasing successful adoption stories can enhance trust and reduce scepticism, fostering broader adoption (Grelle et al., 2024; Mutumbi et al., 2024).

By integrating social influence and norms into models like SAM, this research highlights the multifaceted nature of technology acceptance. SIN provides a critical lens through which to understand and address societal barriers and facilitators, offering actionable strategies to promote the widespread adoption of sustainable technologies. Recognising and harnessing the power of social dynamics ensures that technology acceptance efforts are both effective and contextually relevant, contributing to a more sustainable future.

### 2.3.13 Perceived Behavioural Control in Sustainable Technology Acceptance

Perceived behavioural control (PBC) is a pivotal determinant in the acceptance of sustainable technologies, emphasising an individual's confidence in their ability to adopt and use new systems effectively. Rooted in the Theory of Planned Behaviour (TPB), PBC encapsulates users' perceptions of their capacity to overcome challenges associated with technology adoption. This includes access to necessary resources, information, and technical support, as well as personal competencies required to implement and sustain the use of sustainable technologies. High levels of PBC significantly increase the likelihood of technology acceptance, as users feel empowered to address potential barriers and maximise the benefits of adoption (Ajzen, 2020; Hamouri, 2023; Hidalgo-Crespo and Amaya-Rivas, 2024; Li et al., 2023; Ofori and Opoku Mensah, 2022; Promvongsanon et al., 2024; Tunji-Olayeni et al., 2024; Yan et al., 2019; Yasir et al., 2023).

Empirical evidence consistently underscores the importance of PBC in shaping user attitudes toward sustainable technologies. Individuals who perceive themselves as capable of effectively using these technologies demonstrate higher acceptance rates, driven by confidence in their ability to achieve desired outcomes. For example, users with access to reliable technical support and clear operational guidelines are more likely to adopt renewable energy systems or energy-efficient appliances (Ofori and Opoku Mensah, 2022). Conversely, a lack of perceived control—stemming from inadequate resources, limited technical expertise, or insufficient infrastructure—can deter acceptance, even when the economic or environmental benefits of the technology are clear.

The Sustainability Acceptance Model (SAM) integrates PBC as a critical construct, enhancing its explanatory power beyond traditional models like the Technology Acceptance Model (TAM) and TPB. By incorporating PBC, SAM provides a holistic framework that reflects the nuanced challenges associated with sustainable technology adoption. This integration acknowledges that user confidence and perceived control are as essential as technological features or economic incentives in driving acceptance (Ajzen, 1985; Davis, 1989). SAM emphasises the importance of ensuring that end-users feel adequately supported, both technically and logistically, to foster successful adoption.

Policymakers and stakeholders can utilise the insights that SAM provides to develop targeted strategies that enhance perceived behavioural control among potential adopters. Training programs, hands-on demonstrations, and the establishment of accessible technical support systems are practical measures that can significantly improve PBC (Carraher-Wolverton and Burleson, 2021). For instance, offering workshops on the operation of smart grid technologies or providing on-demand technical assistance for solar panel installations can empower users and mitigate apprehensions about adoption. Additionally, designing technologies with user-friendly interfaces and clear instructions further bolsters PBC by reducing perceived complexity and promoting self-efficacy (Gorton et al., 2013; O'Brien, 2023; Truitt and Lynn, 2009).

Perceived behavioural control is a crucial component of sustainable technology acceptance, directly influencing users' readiness and ability to adopt innovative solutions. By integrating PBC into the Sustainability Acceptance Model, this research highlights the necessity of addressing psychological and logistical barriers alongside economic and technological considerations. Enhancing PBC through targeted interventions not only increases acceptance rates but also ensures that sustainable technologies are implemented effectively, contributing to broader sustainability goals. This approach fosters a more inclusive and actionable pathway toward achieving widespread adoption of sustainable innovations.

#### 2.3.14 Functional Compatibility and Sustainable Technology Acceptance

Functional compatibility, while a relatively novel concept within the sustainability discourse, is a well-established principle in the broader field of technology acceptance. It refers to the degree to which a new technology integrates seamlessly with existing systems, workflows, and user practices. Research across sectors such as healthcare, education, and computer science consistently demonstrate that technologies aligning with current systems experience higher acceptance rates due to reduced friction and resistance among users. This compatibility fosters a smoother transition, mitigating challenges and facilitating widespread adoption (Arruda Filho, 2022; Chakraborty, 2023; Hossain Faruk and Asadur Rahman, 2022; Huang and Yu, 2022; Rahi et al., 2019; Sayganov et al., 2020).

Case studies provide illustrative examples of functional compatibility's impact on technology acceptance. One significant instance involves the integration of smart grid technologies within existing electrical infrastructures. Initial adoption faced resistance due to compatibility issues, such as difficulties in synchronising advanced smart meters with outdated grid systems. However, strategic solutions, including phased rollouts and retrofitting older systems with compatible interfaces, markedly improved integration and acceptance rates (Bouchard et al., 2023). Similarly, in the education sector, schools adopting e-learning platforms compatible with their existing IT infrastructure and teaching methodologies observed greater acceptance and satisfaction. This compatibility allowed educators to incorporate new tools without disrupting established practices, thereby making the transition more effective and widely supported (Alyoussef, 2023).

Quantitative analyses underscore the critical role of functional compatibility in technology acceptance. Regression models frequently reveal a positive correlation between compatibility and adoption rates, demonstrating that higher compatibility significantly increases the likelihood of user acceptance. This alignment minimises technical challenges and steep learning curves, thereby bolstering end-user confidence and willingness to adopt new technologies (Alwabel and Zeng, 2021; Shooshtarian et al., 2021; Strojny and Dużmańska-Misiarczyk, 2023; Weaich et al., 2023).

Incorporating functional compatibility into the Sustainability Acceptance Model (SAM) represents a key advancement in understanding sustainable technology adoption. SAM expands on traditional frameworks such as the Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB) by emphasising the necessity of seamless integration in the acceptance process (Ajzen, 1985; Davis, 1989). By acknowledging that sustainable technologies must align with existing systems, SAM provides a comprehensive framework for addressing the practical challenges associated with implementation.

For sustainable technologies to achieve widespread acceptance, particularly in the context of South Africa's energy grid transformation, functional compatibility must be prioritised. Policymakers and stakeholders can apply these insights to ensure that new technologies integrate effectively with existing infrastructures, minimising disruptions and fostering trust among users. For example, aligning renewable energy technologies with current grid dynamics or designing energy-efficient appliances compatible with South African households' typical energy systems can enhance adoption rates and ensure successful implementation.

Empirical research on functional compatibility highlights the necessity of considering existing infrastructures, workflows, and user practices in designing and deploying sustainable technologies. By prioritising compatibility, stakeholders can pave the way for smoother integration, ultimately contributing to the broader goals of sustainability and fostering a more resilient and inclusive energy infrastructure in South Africa. This alignment not only ensures technical feasibility but also enhances the practicality and accessibility of sustainable solutions, solidifying their role in achieving a green energy transition.

#### 2.3.15 Resolving Empirical Statements

Transitioning to a green energy grid in South Africa offers immense ecological, economic, and social benefits that align with the principles of sustainable technology acceptance. As Africa's leading energy producer, South Africa has a unique opportunity to set an example in driving this transformation. Empirical evidence from nations such as Germany and Denmark showcase the tangible advantages of integrating renewable energy sources into existing systems. For instance, Germany's 'Energiewende' policy has significantly increased renewable energy production, catalysing economic growth, technological innovation, and substantial job creation. Similarly, Denmark's commitment to wind energy has established it as a global leader in wind technology, reducing dependence on fossil fuels and reinforcing economic benefits.

Accordingly Jain and Jain, (2017) have long found that South Africa's abundant solar and wind resources position it to replicate these successes while addressing its heavy reliance on coal-fired power plants, which currently dominate the energy mix and contribute significantly to carbon emissions. Transitioning to renewable energy sources would mitigate environmental degradation, enhance energy security through diversification, and align the country with international agreements such as the Paris Agreement. This shift holds the potential to establish South Africa as a leader in sustainability and climate action, reinforcing its role on the global stage.

Economically, this transition could spur job creation in emerging renewable energy sectors, fostering local economic development and addressing high unemployment rates. Embracing sustainable energy technologies also presents opportunities to tackle social inequalities by improving energy access and living standards, particularly for marginalised communities. Enhanced energy efficiency and reliability can provide consistent power supply to under-resourced areas, empowering communities and contributing to equitable development. Research underscores the importance of factors such as public perception, economic viability, and perceived environmental impact in driving the acceptance of these technologies. Addressing these elements through targeted policies and strategic investments will enable South Africa to harness its renewable potential effectively, setting a precedent for other nations.

Through strategic planning and robust policy frameworks, South Africa can achieve a green energy grid that delivers widespread benefits, supporting ecological preservation, economic growth, and social equity. By leveraging global best practices and tailoring them to local contexts, the country can transform its energy landscape while reinforcing its commitment to sustainability and innovation.

#### 2.3.16 Gaps in Empirical Research

While empirical studies on sustainable technology acceptance provide valuable insights, significant gaps remain, particularly regarding the integration of economic and contextual factors in acceptance models. Most existing research focuses on developed countries, where socio-economic conditions and cultural attitudes differ markedly from those in developing regions like South Africa. This geographic and contextual bias limits the applicability of findings to regions with distinct energy needs and socio-economic challenges.

A notable gap exists in the exploration of financial feasibility as a determinant of sustainable technology acceptance. Although widely studied constructs such as perceived usefulness, ease of use, and social norms are critical, economic considerations—especially in the context of affordability and long-term financial benefits—are often underrepresented. This omission is particularly problematic for regions like South Africa, where economic disparities and limited access to financing significantly affect adoption rates.

Addressing these gaps necessitates interdisciplinary research that combines technical, economic, and socio-cultural perspectives. Innovative methodological approaches, such as the application of localised cost-benefit analyses, thematic exploration of cultural attitudes, and multivariate statistical models, are essential to advance the field. The Sustainability Acceptance Model (SAM) serves as a robust foundation for such explorations by integrating socio-environmental and economic variables, offering a pathway to a more nuanced understanding of sustainable technology acceptance. Expanding SAM to include ethical dimensions and validating it across diverse cultural and socio-economic contexts will enhance its utility and relevance globally.

### 2.3.17 Adapting SAM to Address the South African Carbon-Heavy Energy Grid

South Africa's reliance on coal-fired power plants presents significant challenges to achieving a green energy transition. Traditional energy distribution models, characterised by centralised power generation and one-directional distribution, are ill-suited to the demands of a sustainable energy system. Transitioning to a decentralised, renewable-based model requires active participation from end-users, highlighting the critical role of households in the energy ecosystem.

The Sustainability Acceptance Model (SAM) has been adapted to incorporate a paradigm shift: viewing households as independent power producers rather than passive consumers. This shift capitalises on South Africa's extensive suburban footprint, where properties often include land and roof space ideal for renewable energy installations such as solar panels. Encouraging households to generate surplus energy and feed it back into the grid not only alleviates strain on the national energy infrastructure but also fosters grid resilience and stability.

This adaptation aligns with SAM's broader goal of optimising the acceptance and integration of sustainable energy technologies. By addressing barriers such as perceived behavioural control, functional compatibility, and economic feasibility, SAM provides a strategic framework for fostering household-level adoption of renewable energy solutions. These efforts will enhance the grid's sustainability, reduce the nation's carbon footprint, and empower communities to play an active role in South Africa's energy future.

In conclusion, South Africa's transition to a green energy grid hinges on leveraging empirical insights, addressing research gaps, and adapting theoretical models like SAM to local contexts. By fostering end-user participation, enhancing economic incentives, and ensuring functional compatibility, the country can achieve a resilient and sustainable energy system that balances ecological preservation, economic development, and social equity.

## 2.4 Conceptual Framework: Sustainability Acceptance Model

### 2.4.1 Introduction

The Sustainability Acceptance Model (SAM) builds upon constructs from the Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB), integrating sustainability-specific factors to provide a robust framework for understanding the determinants of sustainable technology acceptance. This framework considers traditional predictors like perceived usefulness and ease of use, alongside socio-environmental constructs such as perceived environmental impact, economic viability, social influence, and functional compatibility. These constructs collectively address the multifaceted nature of adopting sustainable technologies, particularly within the South African green energy grid context.

### 2.4.2 Theoretical Constructs of the Sustainability Acceptance Model

#### *2.4.2.1 Perceived Usefulness (PU)*

**Definition:** The degree to which a person believes that using a particular technology will enhance their performance.

**Construct (C1):** Perceived usefulness positively influences the intention to adopt sustainable technologies.

#### *2.4.2.2 Perceived Ease of Use (PEOU)*

**Definition:** The degree to which a person believes that using a particular technology will be free of effort.

**Construct (C2):** Perceived ease of use positively influences the intention to adopt sustainable technologies.

#### *2.4.2.3 Attitude Towards Behaviour (ATB)*

**Definition:** An individual's positive or negative feelings about performing the target behaviour.

**Construct (C3):** Attitude towards behaviour positively influences the intention to adopt sustainable technologies.

#### *2.4.2.4 Subjective Norms (SN)*

**Definition:** The perceived social pressure to perform or not perform the behaviour.

**Construct (C4):** Subjective norms positively influence the intention to adopt sustainable technologies.

#### *2.4.2.5 Perceived Behavioural Control (PBC)*

**Definition:** The perceived ease or difficulty of performing the behaviour, assumed to reflect past experiences and anticipated obstacles.

**Construct (C5):** Perceived behavioural control positively influences the intention to adopt sustainable technologies.

#### *2.4.2.6 Perceived Environmental Impact (PEI)*

**Definition:** The degree to which a person believes that using a particular technology will positively or negatively impact the environment.

**Construct (C6):** Perceived environmental impact positively influences the intention to adopt sustainable technologies.

#### *2.4.2.7 Perceived Economic Viability (EV)*

**Definition:** The extent to which a person perceives the financial benefits of using a technology to outweigh its costs.

**Construct (C7):** Economic viability positively influences the intention to adopt sustainable technologies.

#### *2.4.2.8 Social Influence (SI)*

**Definition:** The effect of social pressure and expectations from peers and the community on an individual's decision to adopt a technology.

**Construct (C8):** Social influence positively influences the intention to adopt sustainable technologies.

#### *2.4.2.9 Functional Compatibility (FC)*

**Definition:** The degree to which a sustainable technology fits with existing systems, practices, and end-user needs.

**Construct (C9):** Functional compatibility positively influences the intention to adopt sustainable technologies.

This conceptual framework, with its comprehensive and integrative approach, provides a strong foundation for understanding and fostering sustainable technology acceptance.


**Figure 2.5: Conceptual Framework for the Sustainability Acceptance Model**
Source: Author

## 2.5 Summary of Key Literature Findings

The literature review establishes the theoretical and empirical foundations for sustainable technology acceptance, focusing on refining traditional models to address South Africa's energy transition challenges:

- Traditional models such as the Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB) are critiqued for their limitations in capturing financial and systemic dimensions critical to sustainability.
- The proposed Sustainability Acceptance Model (SAM) integrates key constructs, including:

  - Functional compatibility (ensuring alignment with infrastructure and cultural norms),
  - Perceived environmental impact, and
  - Economic viability.
- Functional compatibility is identified as pivotal for seamless integration of sustainable technologies within existing systems and cultural contexts.
- The chapter emphasises the roles of social influence, perceived behavioural control, and economic stability in shaping adoption, especially in resource-constrained settings like South Africa.
- Empirical evidence highlights the necessity for a holistic approach that addresses economic feasibility and cultural sensitivity to drive acceptance.
- The SAM framework is presented as more comprehensive than existing epistemological models, offering a way to bridge theoretical insights with practical applications.

These findings position SAM as a critical tool to guide South Africa's green energy transformation, fostering public acceptance and equitable participation in sustainable development.

# CHAPTER 3: RESEARCH METHODOLOGY

## 3.1 Synopsis of the Third Chapter

The chapter outlines the research methodology, adopting a positivist epistemological philosophical stance and a deductive approach to theory development. It also provides the research design where it demonstrates how its primary data is collected via a cross-sectional survey of South African residents, using Likert-scale questions to evaluate perceptions influencing sustainable technology acceptance. Analytical methods include Spearman's correlation, regression analysis, and the Kruskal-Wallis H test to assess relationships and address multicollinearity. Ethical considerations ensure participant confidentiality and informed consent. The chapter conceptualises its research strategy and constructs its variables through the development of mathematic formulae for proving the tenets of the Sustainability Acceptance Model (SAM), integrating environmental, economic, social, and functional compatibility factors to guide South Africa's transition to a sustainable energy grid.

## 3.2 Methodological Framework

The research adapts Saunders et al., (2023) Research Onion framework to systematically structure its methodology. This layered approach encompasses philosophical considerations, strategies, and methods to address the dynamics of sustainable technology acceptance comprehensively. By analysing the primary data, the study robustly validates the SAM framework, offering valuable insights for transitioning to a sustainable energy grid in South Africa.

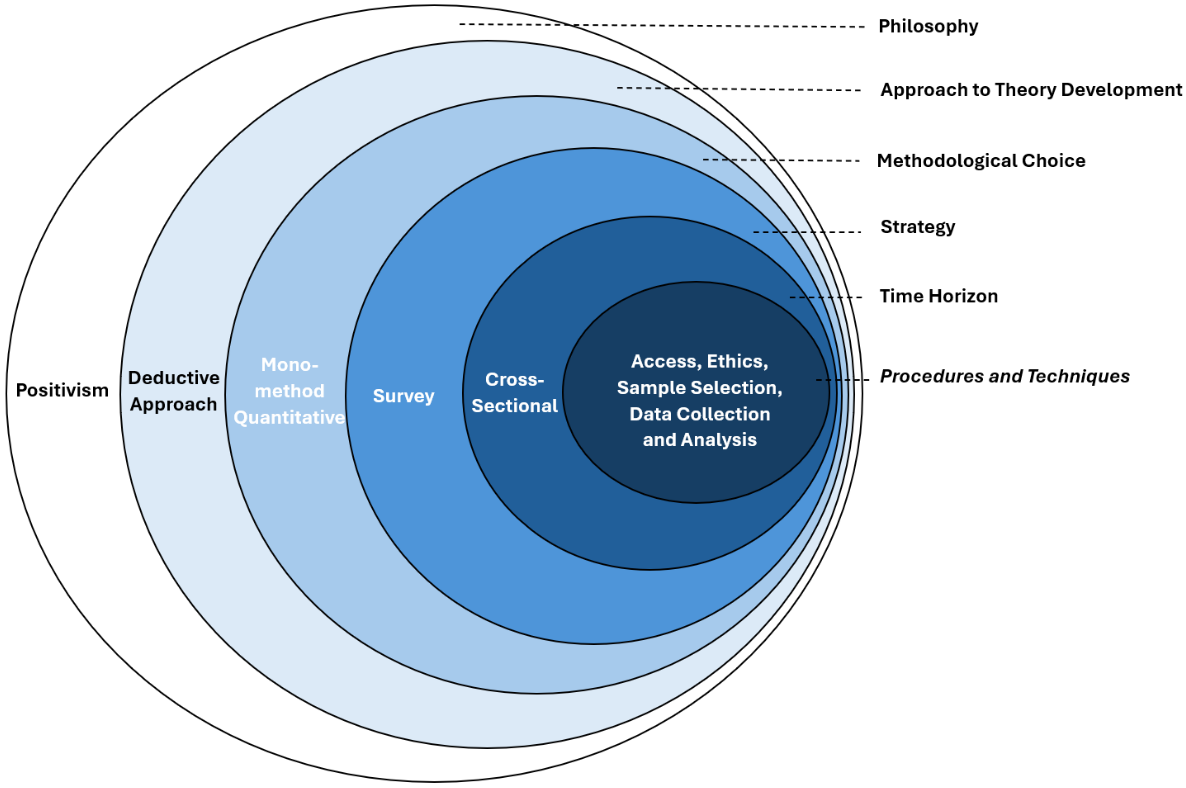


**Figure 3.1: Adaptation of 'The Research Onion' by Saunders et al., (2023) Depicting the Study's Methodological Framework**
Source: Author

## 3.3 Philosophical Standpoint: Positivism and Epistemology

The philosophical research position of this study is best understood through a positivist epistemology, which asserts that reality is objective and can be observed and described independently of social actors (Kothari, 2004; Saunders et al., 2023). A positivist approach ensures that the research findings are based on observable phenomena and quantifiable data, supporting scientific methods that aim for replicability and generalisation of results (Hancock et al., 2019; Treiman, 2009).

Positivism emphasises the development of objective knowledge through empirical observation, measurement, and testing of hypotheses. In this study, the Sustainability Acceptance Model (SAM) is constructed by integrating existing theories like the Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB) with empirical findings. The process of formulating hypotheses, collecting quantitative data, and validating relationships between variables supports the deductive reasoning characteristic of positivism. (Field, 2024; Husserl, 2012).

Other philosophical approaches, such as ontology, phenomenology, interpretivism, and constructivism, do not align with this study's approach due to their focus on abstract concepts, subjective experiences, and socially constructed realities (Berger, 1966; Blaikie, 2007; Crotty, 1998; Geertz, 1973; Husserl, 2012; Lincoln and Guba, 1985; Schutz, 1967; Van Manen, 2016). Ontology, concerned with the nature of existence, is too theoretical for a study that relies on measurable data and empirical analysis of technology acceptance (Blaikie, 2007). Phenomenology and interpretivism emphasise individual perceptions and lived experiences, which do not provide the objective, replicable findings required for developing a generalisable model like the Sustainability Acceptance Model (SAM) (Husserl, 2012; Schutz, 1967). Constructivism, which asserts that knowledge is created through social interactions, conflicts with the study’s positivist epistemology that relies on objective data collection and statistical validation (Field, 2024; Lincoln and Guba, 1985). The study's emphasis on functional compatibility, observable relationships, and systematic analysis necessitates a positivist, epistemological stance rather than these alternative philosophies.

## 3.4 Research Approach to Theory Development: Deductive

Positivism emphasises the development of deductive objective knowledge through empirical observation, measurement, and testing of hypotheses. In this study, the Sustainability Acceptance Model (SAM) is constructed by integrating existing theories like the Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB) with empirical findings. The process of formulating hypotheses, collecting quantitative data, and validating relationships between variables supports the deductive reasoning characteristic of positivism (Dubin, 1969; Field, 2024; Whetten, 1989).

Theory-building under this framework ensures that new constructs, such as functional compatibility, are derived from observable phenomena and tested through rigorous statistical methods (Dubin, 1969; Field, 2024). This approach ensures that the resulting theory is replicable, generalisable, and grounded in empirical evidence, aligning with the principles of positivism. Unlike interpretive or constructivist paradigms, which emphasise subjective meaning-making, positivism provides a systematic structure for theory-building that prioritises objectivity, consistency, and predictive power (Popper, 2008; Saunders et al., 2023; Whetten, 1989).

## 3.5 Mono-Analytical Methods for Achieving Objectives

### 3.5.1 Defining Variables in Quantitative Research

Defining the variables in a quantitative study is crucial as it establishes the foundation for empirical analysis and ensures that the research objectives are systematically addressed. Clearly defined variables enable researchers to accurately measure and analyse relationships between different constructs, facilitating the testing of hypotheses and validation of theoretical models (Deb et al., 2019; Field, 2024; Hegde, 2015; Popper, 2008). This precision is essential for producing reliable, generalisable results that contribute to the broader knowledge base. According to Saunders et al., (2023), clearly defining variables allows for consistency in data collection and analysis, enhancing the overall validity and replicability of the study. This process not only aids in achieving the study's specific objectives but also ensures that the findings are meaningful and actionable within the context of the research methodological framework.

## 3.6 Research Strategy

A research strategy is a systematic plan that guides the process of collecting, analysing, and interpreting data to address specific research questions or hypotheses. It encompasses the process of setting out your study based on the selection of research methods, qualitative, quantitative, or mixed methods, the choice of data collection techniques, surveys, interviews, experiments, or observations, and the approach to data analysis. A well-defined research strategy ensures the research process is coherent, rigorous, and aligned with the objectives of the study (Leedy et al., 2019).

### 3.6.1 Sustainable Housing, End-User Green Grid and Renewable Energy Integration

Sustainable housing practices, including the adoption of energy-efficient designs, solar photovoltaic (PV) systems, and smart energy management technologies, have demonstrated the potential to reduce environmental impact by over 40% (Giama et al., 2023). End-user involvement is essential in this process, as increased awareness and participation drive the adoption of these technologies and practices (Adinyira et al., 2018). Surveys in South Africa indicate that the majority of individuals are willing to embrace energy-efficient solutions if adequate support and information are provided (Weaich et al., 2023). This end-user engagement creates a synergistic relationship between residential energy practices and national green grid objectives, reinforcing the alignment between everyday living and environmental stewardship (Bombaerts et al., 2020). Consequently, empowering communities through sustainable housing not only supports the transition to a green grid but also promotes broader societal participation in sustainable development.

### 3.6.2 Defining the Variables in the Analysis

The regression formula was originally developed by Galton, (1886), and later adapted by Fisher, (1922) who significantly advanced regression analysis by introducing the theory of statistical estimation and hypothesis testing, foundational to modern regression models. Pearson's correlation evolved from Francis Galton's concept of ‘reversion’ or regression (Pearson, 1895). Subsequently, Spearman, (1904) modified this formula to assess the association between ranked variables, providing a robust alternative to Pearson’s correlation. However, this test can be influenced by multicollinearity or spurious correlations (Hollander et al., 2015).

To address this, this study applies regression analysis as a cautionary step to assess interdependencies between variables without assuming normality, thereby ensuring that coefficients are evaluated as part of a validatory step rather than being arbitrarily assumed. While this approach is not universally endorsed, the findings in this research are corroborated by the evaluation of pairwise relationships using the Spearman Correlation Matrix, demonstrating both merit and validity (Corder and Foreman, 2009; Field, 2024; Hancock et al., 2019; Hollander et al., 2015).

### 3.6.3 SAM Expressed as a Formulaic Comparative Framework Equation

**Equation 3.1: SAM Expressed as a Formulaic Comparative Framework Equation**

$$SAM = f(TAM, TBP, UTAUT) + \Delta(EF, FC)$$

Where:

$SAM\ (Sustainability\ Acceptance\ Model)$: The proposed model integrating new variables.

$f(TAM, TBP, UTAUT)$: The foundational structure of previous models, incorporating elements like perceived ease of use (PEOU), perceived usefulness (PU), social influence (SI), and perceived behavioural control (PBC).

$\Delta(EF, FC)$: The additional dimensions Economic Feasibility (EF) and Functional Compatibility (FC), which differentiate SAM from prior models by explicitly addressing adoption barriers in South Africa's energy grid.

The Sustainability Acceptance Model expands upon existing theoretical frameworks by incorporating economic feasibility and functional compatibility, two critical factors that were previously neglected. If $\Delta(EF, FC) = 0$, then SAM reduces to traditional TAM/TPB/UTAUT models, which fail to explain sustainability adoption adequately in South Africa's context. If $\Delta(EF, FC) > 0$, then SAM must introduce a novel contribution, addressing real-world economic and infrastructural constraints in sustainable technology adoption.

### 3.6.4 Sustainability Acceptance Analysis

The Sustainability Acceptance Test (SAT) used to assess the strength and direction of the relationship between the dependent variable and the independent variables. Spearman's correlation is ideal for ordinal data, where the relationship between variables does not necessarily follow a linear pattern (Spearman, 1904).

**Equation 3.2: Spearman's Rank Correlation Formula**

$$\rho = 1 - \frac{6\sum d_i^2}{n(n^2 - 1)}$$

Where:

$d_i = R(y_i) - R(x_i)$: The difference between the ranks of the dependent variable $(y)$ and the independent variable $(x)$ for the $(i)$-th observation.

$(n)$: The number of observations (sample size).

#### *3.6.4.1 Adapted Spearman's Rank Correlation Formula for SAM Framework*

$\gamma$: The dependent variable, Acceptance of Sustainable Housing and Green Grid Technologies, ranked ordinally.

$\omega_j$: Any independent variable $\omega_1, \omega_2, \omega_3 \cdots \omega_n$ representing potential influences on $(\gamma)$ ranked ordinally.

Depicted as: $\omega_1$: Perception of Business Involvement, $\omega_1$: Perceived Need for Policy Change, etc. (Refer to results sections for constructs and hypotheses testing, this is only an example depicting how the formula variables have been adapted to suit the Sustainability Acceptance Model.

$R_\gamma$: The rank of $\gamma$ for a given respondent.

$R_{\omega_j}$: The rank of the $(j)$-th independent variable for the same respondent.

$d_i = R(\gamma_i) - R(\omega_j)$: The rank difference for each observation.

#### *3.6.4.2 Purpose of Adaptation*

This adaptation focuses on pairwise comparisons between $\gamma$ and $\omega_j$ to:

Measure the strength and direction of the monotonic relationship between the acceptance of sustainable housing ($\gamma$) and each predictor ($\omega_j$) in order to retain the ordinal nature of the survey responses.

#### *3.6.4.3 Methodological Analytic Process*

Rank the variables by converting the raw responses ($\gamma$) and ($\omega_j$) into ranks, assigning the smallest value a rank of 1. For each observation, compute $d_i$ by calculating the rank difference $d_i = R(\gamma_i) - R(\omega_j)$. Square the $d_i$ and sum by squaring each rank difference ($d_i^2$) and compute the sum $\sum d_i^2$. Apply the formula by substituting $\sum d_i^2$, $n$, and other components into the adapted formula. Interpret $\rho$ whereby $\rho = +1$ is a perfect positive monotonic relationship, $\rho = -1$ is a perfect negative monotonic relationship and $\rho = -0$ has no monotonic relationship. This can be used to explain the acceptance phenomenon for $\gamma$ (Acceptance of Sustainable Housing with Green Grid Technologies) and $\omega_3$ (Comfort with Adopting New Technologies). This adaptation ensures the formula aligns with the variables in the SAM framework and the ordinal nature of survey data.

$\gamma$: The dependent variable, representing the 'Acceptance of Sustainable Housing and Green Grid Technologies.' This is measured by the survey question: "How important is considering living in a sustainable home to you?".

$\omega_1, \omega_2, \omega_3 \cdots \omega_n$ : The independent variables, each representing a different factor that potentially influences the acceptance of sustainable housing. In this study, the independent variables correspond to various survey questions, such as:

$\omega_1$ : Perception of Business Involvement in Sustainability

$\omega_2$ : Perceived Need for Policy Change

$\omega_3$ : Comfort with Adopting New Technologies in Housing

$\omega_4$ : Role of Technology in Solving Housing Issues

$\omega_5$ : Current Economic Stability

$\omega_6$ : Influence of Economic Status on Housing Choices

$\omega_7$ : Importance of Job Security

$\omega_8$ : Importance of Income Stability

$\omega_9$ : Being Well-Informed about Sustainable Housing Options

$\omega_{10}$ : Actively Seeking Information on Sustainable Living

This non-parametric approach allows the study to quantify the relationship between each independent variable and the acceptance of sustainable housing (dependent variable) without requiring the data to follow a specific distribution. By employing Spearman's rank correlation, the analysis evaluates the strength of these relationships and ranks factors based on their influence on end-user acceptance. This method provides actionable insights to promote sustainable housing practices and support the establishment of a stable green energy grid.

The Sustainable Acceptance Model (SAM) evaluates how the relationships between multiple complex variables can be described using a monotonic function, without assuming linearity or normality (Concu and Cordeiro, 2020). Within this model, the dependent variable, labelled as "GP_ConsidLive" (GPC), represents general perception and measures acceptance of sustainable housing. The measurement is based on the survey question: "How important is considering living in a sustainable home to you?" Independent variables include economic, environmental, social, and functional compatibility factors, which test the core tenets of the SAM for their relationship strength (Spearman, 1904).

Relationships were initially categorised as strong, moderate, or weak based on their Spearman correlation coefficients which the model adapts ($|\rho|$) (Spearman, 1904). Strong relationships ($|\rho| > 0.5$) suggest that acceptance is driven by a single dominant factor, moderate relationships ($0.3 < |\rho| \leq 0.5$) indicate influence from a few interconnected factors, and weak relationships ($|\rho| \leq 0.3$) imply a collective influence of several interrelated factors, all statistically significant. It is recognised, however, that these thresholds are somewhat arbitrary and may not universally apply across different research contexts (Lozano et al., 2013).

In measuring sustainability acceptance, even minor influences from individual variables can contribute significantly to aggregate decision-making processes (Wilson, 2018). To address this, a revised threshold termed the “Sustainability Acceptance Threshold” (SAT) $|\rho| \geq 0.10$. This threshold accounts for the multifaceted nature of sustainability acceptance and is supported by confirmatory studies analysing normally distributed data. Previous research often focused on isolated relationships or single factors, whereas this study considers the complete set of variables as observable.

The SAT provides a nuanced understanding of the barriers and drivers of sustainability acceptance. Values within the range $0 \leq |\rho| \geq -1$ indicate potential barriers, acknowledging the distributed and complex nature of sustainability adoption. This adjustment is grounded in theoretical and empirical evidence demonstrating that even small correlations can serve as meaningful indicators within complex systems (Lozano et al., 2013).

### 3.6.5 Adapted Regression Model for the SAM Framework

The regression model employed in this study evaluates the relationship between the dependent variable and the independent variables. Specifically, this process is utilised to calculate the Variance Inflation Factor (VIF), serving as a diagnostic step to confirm the absence of multicollinearity. This analysis complements the Spearman’s correlation results by ensuring that relationships between the dependent variable and the independent variables are not adversely influenced by multicollinearity. The regression model adheres to the following formula:

**Equation 3.3: Regression Formula**

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 3X_3 + \cdots + \beta_n X_n + \epsilon$$

Where:

$Y$ represents the dependent variable,

$\beta_0$ is the intercept,

$\beta_1, \beta_2, \dots, \beta_n$ are the regression coefficients,

$X_1, X_2, \dots, X_n$ are the independent variables,

$\epsilon$ is the error term.

#### *3.6.5.1 Regression Process*

The dataset was prepared by including only the variables of interest and addressing missing values to ensure complete cases for analysis. To identify potential multicollinearity among predictors, each independent variable was treated as a dependent variable in a series of systematic regressions, using the remaining independent variables as predictors. For instance, when assessing PA_AwareCamp, the regression model was specified as:

$$PA_{AwareCamp} = \beta_0 + \beta_1 \cdot PTA\_TechReliable + \beta_2 \cdot PVI\_InstitutionsInvolved + \cdots + \epsilon,$$

The resulting $R^2$ value for each regression quantified the proportion of variance in the target variable explained by the other predictors. These $R^2$ values were recorded and subsequently used to compute the Variance Inflation Factor (VIF) for each predictor.

### 3.6.6 Transition to VIF Calculation

The transition from the regression model to the calculation of VIF was necessary to address multicollinearity, a common issue in correlation analyses involving multiple predictors. Multicollinearity inflates the standard errors of regression coefficients, reducing their statistical significance and impairing the interpretability of the model.

### 3.6.7 Adapted Variance Inflation Factor (VIF) for SAM Framework

In this analysis, the Variance Inflation Factor (VIF) was utilised to identify multicollinearity among the independent variables. Since multicollinearity pertains solely to relationships among predictors, the independent variables were isolated from the dependent variable, GP_ConsidLive.

For each independent variable, a multiple linear regression model was constructed, treating it as the dependent variable and regressing it against the remaining predictors. This process produced an $R^2$ value for each variable, representing the proportion of variance explained by the other predictors.

Using the formula:

**Equation 3.4: Variance Inflation Factor (VIF)**

$$VIF = \frac{1}{1 - R^2}$$

A VIF value of 1 indicates no multicollinearity, values between 1 and 5 suggest low to moderate multicollinearity (considered acceptable), and values exceeding 5 indicate substantial multicollinearity that may necessitate corrective measures (Alin, 2010). The computed VIF values were organised into a table for interpretation and further analysis.

This approach ensures the robustness of the Sustainable Acceptance Model (SAM) by identifying and addressing multicollinearity, which could otherwise distort regression outcomes and undermine the reliability of the findings.

### 3.6.8 Adapted Kruskal-Wallis H Test for SAM Framework

The Kruskal-Wallis H Test was employed to evaluate whether there were statistically significant differences in the dependent variable (GP_ConsidLive) across groups defined by the independent variables. This non-parametric test is particularly suited for ordinal or continuous data grouped by categorical variables and does not require the assumption of normality in the dependent variable's distribution (Kruskal and Wallis, 1952). The formula for the Kruskal-Wallis H Test is:

**Equation 3.5: Kruskal-Wallis H Test**

$$H = \frac{12}{N(N+1)} \sum_{i=1}^{k} \frac{R^2}{n_i} - 3(N+1)$$

Where:

$H$: Kruskal-Wallis test statistic,

$N$: Total number of observations across all groups,

$k$: Number of groups,

$Ri$: Sum of ranks for the $i$-th group,

$ni$: Number of observations in the $i$ -th group.

This test is applied when comparing multiple independent groups to determine if there is a statistically significant difference in the dependent variable across the groups defined by the independent variables (Kruskal and Wallis, 1952).

The Kruskal-Wallis H Test provided a robust method to evaluate differences in GP_ConsidLive across categories of each independent variable without relying on the normality assumption. This ensured that the analysis accounted for the ordinal or non-normal nature of the data, enhancing the reliability and interpretability of the findings within the SAM framework.

#### *3.6.8.1 Economic Stability Analysis*

The Economic Stability Analysis shares a methodology with computing the Sustainability Acceptance Coefficients, with adaptations to Spearman's correlation formula to determine the Economic Stability Threshold (EST). The approach systematically evaluates the interplay between economic stability and sustainability acceptance, leveraging a monotonic function to map interactions among complex variables without assuming data linearity or normality, as highlighted by Concu and Cordeiro, (2020).

In this framework, the dependent variable, PVI_Institutions Involved (Perceived Institutional Involvement), quantifies perceptions of institutional support for sustainability. Independent variables encompass financial, cultural, and institutional factors, which are assessed to validate SAM's principles regarding their influence on economic stability. This multifaceted approach ensures a robust evaluation of the dynamics shaping economic stability within the context of sustainable development.

Relationships were initially categorised as strong, moderate, or weak based on their Spearman correlation coefficients which the model adapts ($|\rho|$) (Spearman, 1904). Strong relationships ($|\rho| > 0.5$) suggest that acceptance is driven by a single dominant factor, moderate relationships ($0.3 < |\rho| \leq 0.5$) indicate influence from a few interconnected factors, and weak relationships ($|\rho| \leq 0.3$) imply a collective influence of several interrelated factors, all statistically significant. It is recognised, however, that these thresholds are somewhat arbitrary and may not universally apply across different research contexts (Lozano et al., 2013).

To address the distributed and multifactorial nature of economic stability as perceived by the end-user, a revised significance threshold ($|\rho| \geq 0.10$) has been introduced, termed the perceived Economic Stability Threshold (EST). This adjustment ensures recognition of even small but statistically significant influences from individual variables as meaningful contributors to aggregate perceptions of economic stability as observed by the end-user (Wilson, 2018).

The EST expands the scope of traditional analysis by incorporating relationships previously deemed weak or insignificant. Correlation values within the range $0 \leq |\rho| \geq -1$ are treated as indicative of barriers to stability. This approach aligns with theoretical and empirical insights demonstrating that small correlations can serve as critical drivers in complex systems, particularly in sustainability-related decision-making (Lozano et al., 2013).

By broadening the analytical framework, the SAM acknowledges the multifaceted and distributed effects of financial, cultural, and institutional variables on economic stability. This integrated perspective provides stakeholders with actionable insights to develop holistic strategies.

## 3.7 Analytical Processes for the Sustainability Acceptance Model

The Sustainability Acceptance Model (SAM) is designed to assess the factors influencing the acceptance of sustainable housing and green grid technologies. This analytical framework outlines a step-by-step process to develop a model that depicts the four pillars of sustainability to provide a comprehensive evaluation of end-user acceptance and the economic viability of sustainable practices.

### 3.7.1 Variable Identification and Definition

#### *3.7.1.1 Define Dependent Variable*

**Sub-objective:** Identify the dependent variable as "Acceptance of Sustainable Housing and Green Grid Technologies."

**Measurement:** This is measured through the survey question: "How important is considering living in a sustainable home to you?"

#### *3.7.1.2 Define Independent Variables*

**Sub-objective:** Identify and define the independent variables that may influence the acceptance of sustainable housing.

**Proposed:** Environmental, social, economic and functional factors are to be identified and correlated.

### 3.7.2 Data Collection and Survey Implementation

#### *3.7.2.1 Survey Design*

**Sub-objective:** Develop a survey to collect data on the independent variables and the dependent variable using Likert scale questions.

### *3.7.2.2 Data Collection and Sampling*

**Sub-objective:** Administer the survey to a representative sample to gather quantitative data on perceptions and attitudes toward sustainable housing and utilise a randomised sample to test for statistical significance. A representative sample of 257 responses was gathered, yielding a 93% confidence level with p-values at 0.05, as outlined by (Yamane, 1973). According to (Yamane, 1973) a random sample of 204 participants would result in a confidence level which ranges between +/- 93 to +/-95%.

**Table 1.** Sample size for ±3%, ±5%, ±7% and ±10% Precision Levels Where Confidence Level is 95% and P=.5.

| Size of Population | Sample Size (n) for Precision (e) of: | | | |
|---|---|---|---|---|
| | ±3% | ±5% | ±7% | ±10% |
| 500 | a | 222 | 145 | 83 |
| 600 | a | 240 | 152 | 86 |
| 700 | a | 255 | 158 | 88 |
| 800 | a | 267 | 163 | 89 |
| 900 | a | 277 | 166 | 90 |
| 1,000 | a | 286 | 169 | 91 |
| 2,000 | 714 | 333 | 185 | 95 |
| 3,000 | 811 | 353 | 191 | 97 |
| 4,000 | 870 | 364 | 194 | 98 |
| 5,000 | 909 | 370 | 196 | 98 |
| 6,000 | 938 | 375 | 197 | 98 |
| 7,000 | 959 | 378 | 198 | 99 |
| 8,000 | 976 | 381 | 199 | 99 |
| 9,000 | 989 | 383 | 200 | 99 |
| 10,000 | 1,000 | 385 | 200 | 99 |
| 15,000 | 1,034 | 390 | 201 | 99 |
| 20,000 | 1,053 | 392 | 204 | 100 |
| 25,000 | 1,064 | 394 | 204 | 100 |
| 50,000 | 1,087 | 397 | 204 | 100 |
| 100,000 | 1,099 | 398 | 204 | 100 |
| >100,000 | 1,111 | 400 | 204 | 100 |

a = Assumption of normal population is poor (Yamane, 1967). The entire population should be sampled.

**Figure 3.2: Extract of Yamane's (1973) for determining Sample Size and Confidence Levels**

Source: Yamane, (1973), Statistics: An Introductory Analysis

#### *3.7.2.3 Explain Relationships*

**Sub-objective:** Explain the relationships between the dependent and independent variables to understand the interplay of factors such as how economic stability might influence cultural norms.

**Spearmans's Correlation Analysis**

#### *3.7.2.4 Model Specification*

**Sub-objective:** Specify the model, with the dependent variable being the acceptance of sustainable housing and the independent variables being the predictors of sustainability acceptance.

#### *3.7.2.5 Hypothesis Testing*

**Sub-objective:** Apply analysis to quantify the relationship between each independent variable and the dependent variable, testing the significance of each variable's impact.

#### *3.7.2.6 Ranking of Variables*

**Sub-objective:** Rank the independent variables based on their sustainability coefficients from the correlation model to identify the most influential factors driving the acceptance of sustainable housing.

#### *3.7.2.7 Interpretation of Results*

**Sub-objective:** Interpret the results to understand which factors are the strongest predictors of sustainable housing acceptance and green grid adoption, providing evidence-based insights for policy and strategy development.

#### *3.7.2.8 Model Adaptation*

**Sub-objective:** During the results phase, refine the SAM based on the analytical results, ensuring that it accurately captures the dynamics influencing sustainable housing acceptance and green grid adoption through an environmental, social, economic and functional compatibility, thereby providing actionable insights for future applications as found in epistemology.

This analytical framework ensures a systematic and rigorous evaluation of the factors affecting sustainable housing acceptance and green grid adoption, combining statistical analysis with economic evaluation to guide informed decision-making and policy development.

### 3.7.3 Survey

The study employs a survey strategy using a Likert scale to gather quantitative data, consistent with the deductive approach (Likert, 1932). The survey is distributed to a diverse sample of South African residents aged 21–65 in Johannesburg, Cape Town, and Durban, focusing on perceptions of environmental impact, social influence, and behavioural control. This method ensures a comprehensive understanding of end-user perspectives on sustainable technologies.

### 3.7.4 Purpose of the Survey

The purpose of the survey is to gather comprehensive data on end-user perceptions and attitudes towards sustainable development, particularly in the context of housing and the transition to a green grid. The survey aims to assess how various factors—such as social equality, economic stability, cultural norms, and technological comfort—affect individuals' willingness to adopt sustainable housing practices. By exploring these dimensions, the survey seeks to identify key drivers and barriers to the acceptance of sustainable technologies within residential settings. The insights gained from this survey will contribute to developing strategies that enhance public engagement and facilitate the successful integration of renewable energy technologies into South Africa's energy grid. Ultimately, the survey data will inform the Sustainability Acceptance Model (SAM), providing empirical evidence to support policies and initiatives aimed at promoting sustainable development at the grassroots level.

## 3.8 Time Horizon

### 3.8.1 Cross-Sectional

A cross-sectional time horizon captures data at a single point in time, providing a snapshot of technology acceptance patterns and variable relationships (Saunders et al., 2023). While technology acceptance is dynamic, this approach delivers immediate insights for policymakers and stakeholders to apply to current sustainability challenges.

### 3.8.2 Primary Data Analysis

Quantitative surveys form the core of primary data collection (Saunders et al., 2023). Structured questions measure key constructs of SAM, including perceived environmental impact and behavioural control. Likert scale responses facilitate quantitative analysis, ensuring consistency and objectivity.

## 3.9 Research Ethics

### 3.9.1 Ethical considerations

Ethical integrity is a cornerstone of the study. Participants provide informed consent after receiving detailed information about the research purpose and their rights (Booth et al., 2008; Parija and Kate, 2018; Saunders et al., 2023). Data confidentiality and anonymity are strictly maintained, and ethical approval is secured from institutional review boards. These measures safeguard participants' privacy and reinforce the research's credibility.

## 3.10 Summary of the Research Methodology

The research methodology employs a rigorous, structured approach to developing the Sustainability Acceptance Model (SAM), grounded in positivist philosophy and empirical analysis:

- **Positivist Philosophy:** The study emphasises objective, quantifiable data to ensure reliable and valid findings.

- **Deductive Approach:** Theory development is guided by established frameworks such as the Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB), while incorporating novel constructs like economic viability and functional compatibility.
- **Data Collection:** A cross-sectional survey of South African residents is conducted, using Likert scale measures to assess perceptions related to sustainability.
- **Analytical Methods:** Techniques such as Spearman's correlation and regression analyses are employed to identify and rank key drivers of sustainable technology acceptance, addressing challenges like multicollinearity and variable relationships.
- **Ethical Considerations:** The study ensures informed consent, data confidentiality, and institutional review board approval to uphold ethical research standards.
- **Research Framework:** The Research Onion framework is adapted to explain end-user acceptance and economic stability, incorporating innovative thresholds for nuanced analysis.
- **Outcome:** The resulting SAM framework offers practical insights to facilitate South Africa's transition to a sustainable energy grid, aligning theoretical advancements with empirical validation for real-world application.

This summary highlights the methodological rigor and sets the stage for the practical implementation of the SAM framework.

# CHAPTER 4: DATA

## 4.1 Synopsis of the Fourth Chapter

This chapter details the primary dataset derived from a structured survey of 257 South African participants, capturing perceptions and acceptance of sustainable technologies. Key variables include economic stability, social influence, perceived benefits, technological comfort, and environmental impact. Data handling involved rigorous processes such as cleaning, validation, and descriptive analysis to ensure reliability. Analytical techniques, including Spearman's correlation, the Kruskal-Wallis H test, and VIF, were applied to identify relationships and validate the Sustainability Acceptance Model (SAM). Ethical protocols ensured informed consent and data security. The dataset provides critical insights into the factors influencing sustainable technology adoption in South Africa.

## 4.2 Description of the Primary Dataset

The primary dataset of the study consists of data collected directly from end-users through a structured survey. This survey was meticulously designed to capture the perceptions, attitudes, and acceptance levels of sustainable technologies among South African households, particularly in the context of transitioning to a green energy grid. The survey included a variety of questions aimed at assessing key variables such as economic stability, social influence, perceived benefits, technological comfort, and the perceived environmental impact of sustainable technologies.

### 4.2.1 Key Features of the Primary Dataset

#### *4.2.1.1 Data Collection Method*

The data was gathered using a cross-sectional survey, from which 257 responses were obtained over a period of 5 months, which were distributed to a representative sample of South African end-users to test the development a novel model to explain a series of phenomena. The survey was designed to ensure that the data collected was reflective of a broad demographic, including various income levels, educational backgrounds, and geographical locations within South Africa.

#### *4.2.1.2 Variables Captured*

The survey included questions to measure the dependent variable, which is the acceptance of sustainable technologies, as well as multiple independent variables such as economic stability, perceived benefits, social influence, and perceived environmental impact. These variables are critical for understanding the factors that influence the acceptance of sustainable technologies.

#### *4.2.1.3 Analysis Techniques*

The primary dataset was analysed using statistical techniques such as Spearmans Correlation, the Kruskal-Wallis H test and the Variance Inflation Factor (VIF) to determine if the model is valid (Field, 2024; O'Brien, 2007; Park et al., 2020). These analyses were used to identify the relationships between the independent variables and the dependent variable, providing insights into the factors that most significantly influence the acceptance of sustainable technologies.

## 4.3 Data Handling Process

The data handling process in this study is critical to ensuring the accuracy, reliability, and validity of the results derived from the primary dataset (Baxter and Buck, 2000). This process involves several key steps, including data collection, cleaning, validation, integration, and analysis. Below is a detailed description of each stage in the data handling process:

### 4.3.1 Data Collection

#### *4.3.1.1 Primary Data Collection*

The primary data was collected through a structured survey administered to a representative sample of South African households (Brace, 2018). The survey was designed to capture a wide range of variables, including perceptions of sustainable technologies, economic stability, social influences, and technological comfort.

#### *4.3.1.2 Data Integrity Measures*

To ensure high-quality data, the survey was pre-tested with a smaller sample to refine the questions and format (Brace, 2018). During data collection, measures were taken to minimise bias, such as random sampling and ensuring participant anonymity (Booth et al., 2008; Cochran, 1977).

## 4.4 Data Cleaning

### 4.4.1 Primary Data Cleaning

The raw data from the survey was carefully reviewed to identify and correct any inconsistencies, such as incomplete responses, outliers, or obvious data entry errors.

### 4.4.2 Handling Missing Data

Missing data points were addressed through data disqualification methods where implemented, by excluding incomplete responses that could not be reliably imputed.

## 4.5 Data Validation

### 4.5.1 Consistency Checks

The primary was subjected to consistency checks to ensure alignment between different data points.

### 4.5.2 Cross-Verification

Cross-verification involved comparing the data with similar studies or benchmarks from other regions to ensure the data's credibility and relevance to the South African context, this is made evident in the discussion section of the study.

## 4.6 Data Integration

### 4.6.1 Normalisation

This study does not assume data normalisation, as the variables were intentionally measured on different variables to allow for appropriate comparison and analysis. Given that the four pillars of sustainability have been conceptualised theoretically but not previously tested concurrently for correlation, the study employs a non-parametric approach for data analysis and integration (Field, 2024).

## 4.7 Data Analysis

### 4.7.1 Descriptive Analysis

Initial descriptive analysis was conducted to summarise the data and provide an overview of the key variables. This included calculating means, medians, standard deviations, and frequencies for the primary dataset (Field, 2024).

### 4.7.2 Correlation Analysis

Correlation analysis was applied to the integrated dataset to examine the relationships between the independent variables (e.g., economic stability, perceived benefits) and the dependent variable (acceptance of sustainable technologies). Interaction terms between independent variables were also analysed to explore moderating effects (Field, 2024).

## 4.8 Data Storage and Security

### 4.8.1 Secure Storage

All data was securely stored in encrypted digital formats to protect against unauthorised access. The data handling process adhered to strict confidentiality protocols to ensure participant anonymity and data integrity (Saunders et al., 2023).

### 4.8.2 Backup Procedures

Regular backups of the data were maintained to prevent data loss. Multiple copies were stored between the author and supervisors in secure locations to safeguard against any technical failures or data corruption. A copy of the primary datasets is available upon request from the author, only upon justification and supervisors' approval will the dataset be issued to any requesting individual.

## 4.9 Ethical Considerations

### 4.9.1 Informed Consent

Participants in the survey were provided with detailed information about the study's purpose, and their informed consent was obtained before data collection.

### 4.9.2 Data Anonymisation

To protect participants' privacy, all personal identifiers were removed or anonymised in the dataset before analysis. The study complied with ethical standards and data protection regulations, ensuring that all data handling procedures respected participants' rights.

The data handling process in this study was designed to maximise the quality and reliability of the data, ensuring that the findings are robust and credible. By carefully collecting, cleaning, validating, and analysing the primary, the study was able to produce insights that are both empirically sound and highly relevant to the acceptance of sustainable technologies in South Africa.

## 4.10 Summary of the Data Chapter

This chapter presents the primary dataset, collected through a structured survey of 257 South African participants, examining perceptions and acceptance of sustainable technologies. Key variables include economic stability, social influence, perceived benefits, and technological comfort. Rigorous data handling processes ensured reliability, with analysis techniques like Spearman's correlation, Kruskal-Wallis H test, and Variance Inflation Factor (VIF) validating the Sustainability Acceptance Model (SAM). Ethical protocols safeguarded participant privacy and data integrity. The dataset offers critical insights into factors influencing sustainable technology adoption, addressing socio-economic and infrastructural challenges in South Africa's transition to a sustainable energy grid.

# CHAPTER 5: ANALYSIS, RESULTS AND DISCUSSION

## 5.1 Synopsis of Chapter 5

The chapter analyses its data, testing the tenets influencing the acceptance of sustainable housing and green grid technologies through the Sustainable Acceptance Model (SAM). Using Spearman's correlation, Kruskal-Wallis tests, and VIF analysis, the study identifies public awareness campaigns, technological reliability, and institutional support as key drivers of acceptance. Economic stability is shown to be multifactorial, shaped by cultural values, government policies, and financial incentives. This chapter further depicts the study's findings, which, through its discussion underscore a series of affirmations and contradictions in epistemology, explaining the need for holistic strategies—integrating education, financial support, and trust-building measures—to enhance sustainable acceptance.

## 5.2 Objective 1: Assessing Sustainability Coefficients

This study investigated the relationships between key factors influencing the acceptance of sustainable housing and green grid technologies, as conceptualised within the Sustainable Acceptance Model (SAM). The research evaluates the status of the "green grid phenomenon" within South Africa's fragile energy grid, assessing whether end-users can serve as pivotal contributors to its transformation into a more sustainable system. Given the complex nature of this phenomenon—encompassing environmental, social, economic, and functional factors—this study employs non-parametric methods to ensure robust findings. Specifically, Spearman's Rank Correlation Spearman, (1904) is adapted to analyse monotonic relationships (sustainability coefficients) between the dependent variable (Acceptance of Sustainable Housing) and various independent variables representing the four pillars of sustainability as defined in the theoretical framework.

### 5.2.1 Sustainability Acceptance

The first objective of the study was to develop a model to rank various levels of sustainability based on end-user acceptance. This was achieved by identifying the strength and direction of relationships between the acceptance of sustainable housing and each predictor variable. Additionally, the predictor variables were ranked based on their influence on sustainable housing acceptance.

#### *5.2.1.1 Sustainability Acceptance Threshold (SAT)*

The analysis reveals that seven of the eight variables tested exceed the Sustainability Acceptance Threshold (SAT) using the adapted formula. All variables demonstrate strong statistical significance $(p = 0.05)$, confirming that sustainability acceptance is influenced by a combination of factors rather than any single dominant variable. This reinforces the notion that sustainability acceptance is a multifaceted phenomenon requiring holistic interventions.

#### *5.2.1.2 Ranking of Factors and Positive Correlations*

The variables were ranked according to their Sustainability Coefficients, with PA_AwareCamp (Public Awareness Campaigns) exerting the strongest influence. This aligns with findings by Borawska, (2017), who emphasises the importance of public awareness campaigns in driving sustainable development through shifts in societal attitudes. Similarly, studies by Lozano et al., (2013), highlight how increased knowledge dissemination catalyses sustainable behaviour.

Other significant variables, such as PTA_TechReliable (Perception of Technology Reliability) and PVI_InstitutionsInvolved (Institutional Involvement), indicate that trust in technology and institutional support are pivotal for sustainability adoption. This corroborates findings by Yang and Yang, (2015), who identify the critical role of institutions and reliable systems in promoting sustainable housing.

#### *5.2.1.3 Negative Correlation: PFC_UpfrontCost*

The variable PFC_UpfrontCost (Perceived Upfront Costs) exhibited a negative correlation with the dependent variable (GP_ConsidLive). This inverse monotonic relationship indicates that higher perceived upfront costs deter individuals from considering sustainable living. Conversely, when costs are perceived as manageable, adoption increases. This aligns with the literature, where cost-related concerns are frequently cited as barriers to sustainable housing adoption, especially in developing regions (Zuo and Zhao, 2014).

The negative coefficient emphasises the role of financial barriers in shaping behaviour. Addressing these barriers through subsidies, financing options, or communicating long-term cost savings could mitigate their deterrent effect. Furthermore, targeted strategies should focus on lowering the perceived burden of upfront costs, as these perceptions are often influenced by lack of awareness about the long-term economic benefits of sustainable housing (Zhang et al., 2018).

#### *5.2.1.4 Multifactorial Nature of Sustainability Acceptance*

The findings emphasise that sustainability acceptance is inherently multifactorial, with no single variable exerting a dominating effect. Instead, the interplay of multiple factors, such as community participation, improved well-being, and technological solutions, collectively shapes end-user perceptions. This dynamic is consistent with systems thinking, which posits that complex issues like sustainability require integrated and multi-pronged approaches (Bertalanffy, 1968).

This result also aligns with the concept of cumulative influences in sustainability adoption, as proposed by Thøgersen and Crompton, (2009). Their research highlights that incremental changes across various domains collectively lead to substantial shifts in behaviour.

This study confirms that sustainability acceptance is not driven by a single factor but rather by a combination of interrelated variables, each exerting statistically significant influences. While heightened awareness emerges as the most impactful factor, addressing perceived financial barriers remains crucial. These findings contribute to the growing body of literature advocating for integrated and context-specific strategies to promote sustainable living.

### 5.2.2 Sustainability Acceptance Aggregate Effects (SAAE)

The results demonstrate that multiple factors collectively influence the consideration of sustainable living, with public awareness campaigns having the most substantial impact. Conversely, perceived upfront costs negatively affect this consideration. These findings underscore the importance of addressing both promotional and inhibitory factors to enhance sustainable living adoption.

The study's findings align with existing literature that observed sustainability in a single operative silo, this novel method for assessing sustainability allowing for the observation of all associated phenomena, highlighting the multifaceted nature of sustainable living adoption. Enhancing public awareness, ensuring technological reliability, fostering institutional and community involvement, and addressing economic barriers are critical to promoting sustainable practices. Addressing perceived upfront costs is essential to mitigate deterrents to adoption.

**Table 5.1: Sustainability Acceptance Test (SAT)**

| Rank | Variable | Sustainability Coefficient | P-Value | Aggregate Effects |
|---|---|---|---|---|
| **1** | PA_AwareCamp | 0.188237705 | 0.0024 | >SAT |
| **2** | PTA_TechReliable | 0.187409737 | 0.0026 | >SAT |
| **3** | PVI_InstitutionsInvolved | 0.147499815 | 0.018 | >SAT |
| **4** | PVSH_ParticipateComm | 0.146238232 | 0.019 | >SAT |
| **5** | PVSH_ImproveWellbeing | 0.140675092 | 0.0241 | >SAT |
| **6** | PTP_TechSolutions | 0.131577154 | 0.035 | >SAT |
| **7** | PEC_CostBarrier | 0.131020426 | 0.0358 | >SAT |
| **8** | PFC_UpfrontCost | -0.124522746 | 0.0461 | <SAT |

Source: Author

#### *5.2.2.1 Assessing the Influence of Variables on Sustainable Acceptance*

The Kruskal-Wallis H test was conducted to evaluate whether differences in the rankings of sustainability-related variables existed across three groups categorised by their levels of acceptance toward sustainable housing (GP_ConsidLive): Low, Medium, and High (Kruskal and Wallis, 1952). The independent variables analysed included awareness of campaigns, reliability of technology, institutional involvement, community participation, improvements in well-being, technical solutions, cost barriers, and upfront costs.

The primary purpose of this test was to determine whether the rankings of these variables differ significantly among individuals with varying levels of acceptance toward sustainability. This provides insight into the specific factors that might influence or correlate with acceptance levels.

This test operated under the following hypotheses, and acts as sub-hypotheses for determining the influence of variables on Sustainable Acceptance:

**Null Hypothesis ($H_0$)**: The median ranks of the variables are the same across the Low, Medium, and High acceptance groups. (This null hypothesis is rejected).

**Alternative Hypothesis ($H_1$)**: At least one group's median rank differs significantly from the others.

By identifying significant differences in the rankings, the test highlighted key variables that influence acceptance levels. Significant results would suggest actionable areas for intervention, such as improving awareness campaigns or addressing perceived barriers to sustainability. Variables with non-significant results indicate less impact on acceptance levels or uniform perception across groups.

The following variables demonstrated statistically significant differences across acceptance groups, as indicated by their respective H-statistics and p-values:

**Awareness of Campaigns (PA_AwareCamp)**

**H = 8.68**, **p = 0.0032**.

A significant difference was observed in how awareness campaigns were ranked across acceptance levels. This suggests that awareness campaigns play a key role in shaping acceptance.

**Reliability of Technology (PTA_TechReliable)**

**H = 6.95**, **p = 0.0084**.

Rankings of perceived reliability of technology differed significantly among the groups, indicating that reliable technology is critical to fostering higher acceptance levels.

**Institutional Involvement (PVI_InstitutionsInvolved)**

**H = 4.06**, **p = 0.0439**.

A significant difference was noted in perceptions of institutional involvement, emphasising its importance in driving acceptance of sustainable practices.

**Community Participation (PVSH_ParticipateComm)**

**H = 4.71**, **p = 0.0299**.

Significant group differences in rankings of community participation highlight its influence on acceptance.

**Non-Significant Results**

While not statistically significant, the following variable approached significance:

**Improvements in Well-Being (PVSH_ImproveWellbeing)**

**H = 3.58**, **p = 0.0584**.

This result suggests that perceived improvements in well-being may be marginally associated with acceptance levels but lacks sufficient evidence for confirmation.

These results suggest that factors such as awareness campaigns, technology reliability, institutional involvement, and community participation are perceived differently by individuals with varying levels of acceptance toward sustainability. Notably, these factors can serve as focal points for enhancing public adoption of sustainable housing initiatives.

**Table 5.2: Kruskal-Wallis H Test**

| Variable | H Statistic | P-Value |
|---|---|---|
| **PA_AwareCamp** | 8.680898121456785 | 0.003216 |
| **PTA_TechReliable** | 6.951970938843775 | 0.008373 |
| **PVI_InstitutionsInvolved** | 4.061736736989969 | 0.043865 |
| **PVSH_ParticipateComm** | 4.7134870789943175 | 0.029926888617732652 |
| **PVSH_ImproveWellbeing** | 3.583538955446022 | 0.058355 |
| **PTP_TechSolutions** | 2.3729363054952675 | 0.12345464673557921 |
| **PEC_CostBarrier** | 1.8779129932591876 | 0.17057153936262184 |
| **PFC_UpfrontCost** | 4.959724176030842 | 0.025944345307060364 |

Source: Author

#### *5.2.2.2 Spurious Correlations*

A series of statistical tests were conducted to verify the data integrity and rule out multicollinearity, which can obscure true relationships (Kim, 2019).

The analysis revealed statistically significant but weak correlations, with coefficients ranging between ($|\rho| = 0.13\ and\ 0.19$). While individually weak, these correlations highlight the multifactorial nature of sustainability adoption. The weak relationships are consistent with prior findings in complex systems where no single variable dominates the outcome but rather a combination of factors exerts influence (Lozano et al., 2013).

#### *5.2.2.3 Multicollinearity Assessment*

To test for spurious correlations and address potential multicollinearity among independent variables, two methods were employed. First, a Spearman's rank correlation matrix was computed for the independent variables. The analysis revealed that all pairwise correlations were well below the commonly accepted threshold for multicollinearity concerns (0.7–0.8) (Alin, 2010). Most values were near zero, indicating minimal relationships between the variables.

The results confirm that there are no significant multicollinearity issues within the set of independent variables. Consequently, these variables can be confidently included in further analyses without concerns regarding redundancy or inflated standard errors, however a Variance Inflation Factor (VIF) analysis will be carried out to confirm the absence of multicollinearity post observing the pairwise correlations (Alin, 2010).

**Table 5.3: Spearman's Rank Correlation Matrix for Multicollinearity Analysis**

| | PAA | PTAT | PVII | PVSHP | PVSHI | PTPT | PECC | PFCU |
|---|---|---|---|---|---|---|---|---|
| **PAA** | 1 | 0.08 | 0.09 | 0.04 | 0.08 | -0.08 | 0.08 | -0.05 |
| **PTAT** | 0.08 | 1 | 0.12 | 0.10 | 0.07 | -0.03 | -0.14 | -0.08 |
| **PVII** | 0.09 | 0.12 | 1 | 0.04 | 0.06 | -0.05 | 0.004 | -0.004 |
| **PVSHP** | 0.04 | 0.10 | 0.04 | 1 | 0.06 | 0.03 | 0.08 | 0.01 |
| **PVSHI** | 0.08 | 0.07 | 0.06 | 0.06 | 1 | 0.15 | 0.06 | -0.13 |
| **PTPT** | -0.08 | -0.03 | -0.05 | 0.03 | 0.15 | 1 | 0.04 | -0.21 |
| **PECC** | 0.08 | -0.14 | 0.004 | 0.08 | 0.06 | 0.04 | 1 | -0.06 |
| **PFCU** | -0.05 | -0.08 | -0.004 | 0.01 | -0.13 | -0.21 | -0.06 | 1 |

Source: Author

#### *5.2.2.4 Variance Inflation Factor (VIF)*

VIF values for all independent variables were below 1.1, indicating minimal interdependence and confirming that multicollinearity is not a concern. According to O'Brien, (2007), VIF values below 10 are acceptable, and values close to 1 indicate a low degree of correlation.

The absence of significant multicollinearity confirms that the relationships observed in the correlation analysis are not inflated or distorted by overlapping variable effects. This provides confidence in the validity of the findings, as the data do not exhibit characteristics of redundancy or dependency.

The results confirm that the observed correlations are valid and not spurious. The data are statistically reliable and provide meaningful insights into the multifaceted nature of sustainability adoption. These findings support the need for a holistic approach to promoting sustainability, recognising the diverse factors that influence end-user decisions.

**Table 5.4: Variance Inflation Factor (VIF)**

| | Variable | VIF |
|---|---|---|
| **1** | PA_AwareCamp | 1.0425456802311046 |
| **2** | PTA_TechReliable | 1.0757633272020697 |
| **3** | PVI_InstitutionsInvolved | 1.0303146815895436 |
| **4** | PVSH_ParticipateComm | 1.0277735591940669 |
| **5** | PVSH_ImproveWellbeing | 1.058253908428026 |
| **6** | PTP_TechSolutions | 1.093968997001811 |
| **7** | PEC_CostBarrier | 1.050121037528799 |
| **8** | PFC_UpfrontCost | 1.093135860403246 |

(Source: Author)

### 5.2.3 Factors Affecting Sustainability Acceptance

**Rank No. 1. PA_AwareCamp (Environmental Awareness Campaigns)**

**Sustainability Coefficient: 0.188, P-Value: 0.0024, Category: Environmental**

The highest positive correlation with GP_ConsidLive ($\rho = 0.188$, $p = 0.0024$) exceeds the Sustainability Acceptance Threshold (SAT), suggesting that increased public awareness significantly enhances individuals' consideration of sustainable living. This finding aligns with Borawska, (2017), which emphasises the importance of public awareness campaigns in promoting sustainable development by positively influencing social attitudes.

Awareness of environmental impact emerges as the most significant factor driving sustainability-related decisions. Campaigns that effectively communicate the environmental benefits of sustainable housing strongly resonate with individuals. This indicates that sustained investments in educational and promotional initiatives can substantially enhance acceptance rates, highlighting the critical role of public awareness in advancing sustainability goals.

**Rank No. 2. PTA_TechReliable (Technological Reliability)**

**Sustainability Coefficient: 0.187, P-Value: 0.0026**

**Category: Functional Compatibility (Technology)**

A positive correlation ($\rho = 0.187$, $p = 0.0026$), exceeding the Sustainability Acceptance Threshold (SAT), indicates that trust in the reliability of sustainable technologies encourages the adoption of sustainable living. This finding aligns with Dutta et al., (2023), who observed that social trust significantly influences the acceptance of smart home technologies.

Trust in the reliability of sustainable housing technologies, such as energy-efficient systems and renewable energy devices, plays a pivotal role in driving acceptance. High perceived reliability alleviates concerns about potential risks, thereby boosting end-user confidence and fostering greater willingness to embrace these sustainable technologies.

**Rank No. 3. PVI_InstitutionsInvolved (Institutional Involvement)**

**Sustainability Coefficient: 0.148, P-Value: 0.0180**

**Category: Functional Compatibility (Government-Level Policy)**

Positive correlation ($\rho = 0.147$, $p = 0.018$), above the SAT. Highlights the importance of active participation by institutions in promoting sustainable practices. Yang and Yang (2014) note that different housing stakeholders' perceptions affect sustainable housing implementation, underscoring the role of institutional involvement.

Institutional involvement serves as a signal of legitimacy and support for sustainable initiatives, with government incentives identified as the third most influential factor in South Africa’s green grid transformation. This underscores the critical role of visible and active participation by trusted organisations and governmental bodies in advancing sustainability efforts.

**Rank No. 4. PVSH_ParticipateComm (Community Engagement)**

**Sustainability Coefficient: 0.146, P-Value: 0.0190, Category: Social**

A positive correlation ($\rho = 0.146$, $p = 0.019$), exceeding the Sustainability Acceptance Threshold (SAT), highlights the importance of community engagement in fostering sustainable living practices. This finding aligns with Borawska, (2017), who emphasises the role of public engagement in advancing sustainable development.

Community participation in sustainability initiatives promotes collective action and shared responsibility. Encouraging local-level engagement through collaborative housing projects or community-driven sustainability programs can significantly enhance adoption rates, contributing meaningfully to the green grid transformation of South Africa's energy system.

**Rank No. 5. PVSH_ImproveWellbeing (Personal Benefits)**

**Sustainability Coefficient: 0.141, P-Value: 0.0241, Category: Social**

A positive correlation ($\rho = 0.141$, $p = 0.0241$), exceeding the Sustainability Acceptance Threshold (SAT), suggests that the perception of enhanced well-being motivates individuals toward sustainable living. Valencia-Arias et al., (2023) found that perceived benefits, including well-being improvements, significantly influence technology acceptance, a finding that can be extrapolated to sustainable living contexts.

Perceived improvements to personal well-being, such as enhanced comfort and health benefits, positively impact the adoption of sustainable housing. This aligns with the understanding that emphasising direct and tangible benefits to individuals can effectively drive acceptance of sustainable initiatives.

**Rank No. 6. PTP_TechSolutions (Technological Solutions for Sustainability)**

**Sustainability Coefficient: 0.132, P-Value: 0.0350**

**Category: Functional Compatibility (Technology)**

A positive correlation (ρ = 0.132, p = 0.035), surpassing the Sustainability Acceptance Threshold (SAT), indicates that recognising effective technological solutions supports sustainable living adoption. This finding aligns with Marikyan et al., (2019), who, using the Technology Acceptance Model, posited that the perceived usefulness of technology significantly influences adoption.

The perceived effectiveness of technological solutions for sustainability moderately impacts housing decisions, ranking between the highest and lowest influencing factors. When individuals identify technologies such as renewable energy systems, water conservation tools, or smart housing as key enablers of sustainability, their confidence and willingness to adopt sustainable alternatives increase.

**Rank No. 7. PEC_CostBarrier (Economic Barriers)**

**Sustainability Coefficient: 0.131, P-Value: 0.0358, Category: Economic**

A positive correlation (ρ = 0.131, p = 0.0358), exceeding the Sustainability Acceptance Threshold (SAT), suggests that economic considerations influence the decision to adopt sustainable living practices. This finding aligns with Scheller et al., (2024), who noted that financial incentives and cost considerations significantly impact the adoption of sustainable technologies.

Economic barriers, such as cost concerns, show a positive correlation with sustainability acceptance. This seemingly low-ranking and counterintuitive result suggests that individuals who recognise cost barriers may become more deliberate in planning and seeking solutions for affordability, such as financing options or government subsidies.

**Rank No. 8. PFC_UpfrontCost (Perception of High Initial Costs)**

**Spearman Coefficient: -0.125, P-Value: 0.0461, Category: Economic**

A negative correlation (ρ = -0.125, p = 0.0461), falling below the Sustainability Acceptance Threshold (SAT), indicates that higher perceived upfront costs deter individuals from considering sustainable living. This finding aligns with Bielig et al., (2024), who observed that financial barriers hinder the adoption of energy-efficient technologies in housing.

The negative correlation underscores that the perception of high upfront costs serves as a significant barrier to sustainable housing adoption. Addressing this issue necessitates efforts to reduce these costs or to effectively communicate their offset through long-term financial savings.

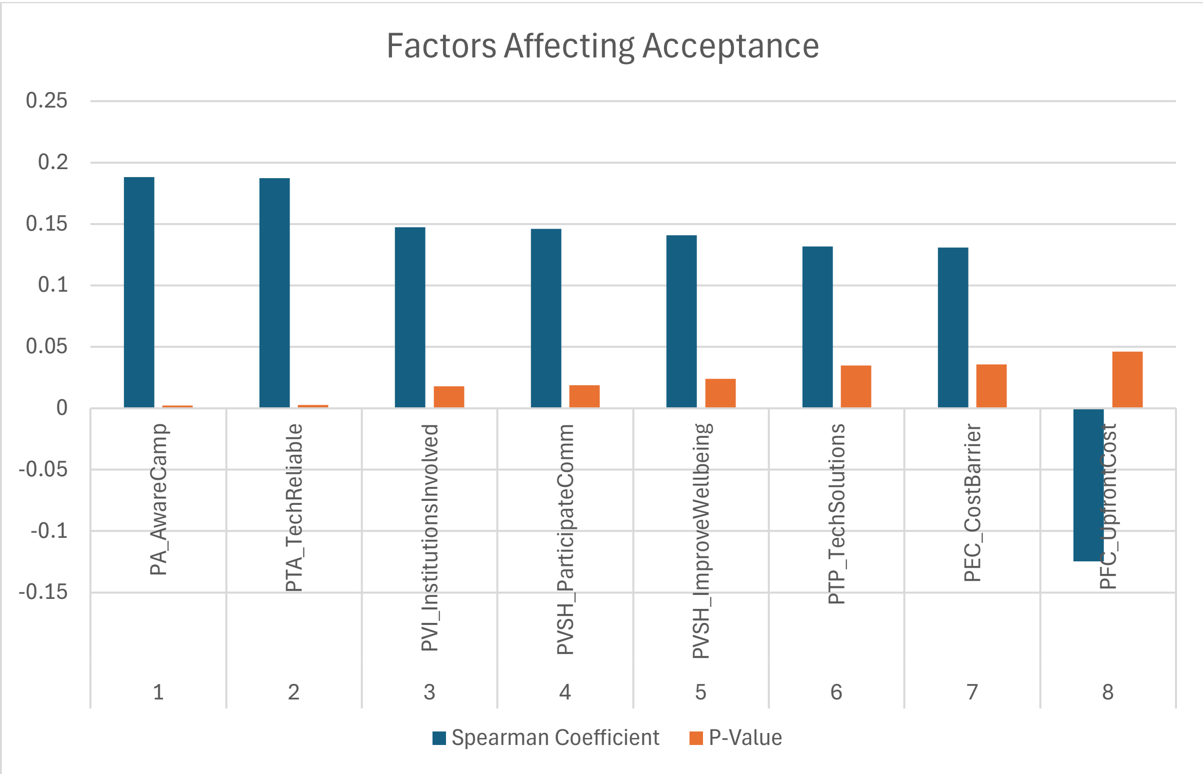


**Figure 5.1: Factors Affecting Sustainability Acceptance**
Source: Author

### 5.2.4 Explanation of the Observed Phenomenon (Hypothesis $RH_1$)

**$RH_1$:** There is a significant positive correlation between end-user perceptions of sustainable technology factors and their level of acceptance.

*This hypothesis is confirmed.*

**$RH1_0$ – Null Hypothesis:** No significant correlation is observed between end-user perceptions of sustainable technology factors and their acceptance levels.

*This null hypothesis is rejected*.

The null hypothesis is rejected based on the results in this study, which demonstrates a statistically significant sustainability coefficient, with a p-value less than 0.05 with a series of variables that relate to the end-user perceiving the green grid phenomenon as a form of sustainable technology, hence, confirming that sustainable technology is required to be functionally compatible in order for it to be considered functionally compatible. This supports the alternate hypothesis, emphasising the importance of perceived benefits in sustainability acceptance.

### 5.2.5 Summary of Sustainability Acceptance: Explanatory Result

This section demonstrated the complex interplay between environmental, economic, social, and functional compatibility factors in determining the acceptance of sustainable housing and green grid technologies. Through the application of the Sustainable Acceptance Model (SAM) and its approach to modelling non-parametric sustainability coefficients, the study identified that sustainability acceptance is influenced by a combination of interrelated factors rather than a singular dominant driver. An example of this is:

- Environmental awareness campaigns emerged as the most influential factor, reinforcing the importance of education and outreach in promoting sustainability.
- Trust in technological reliability and institutional involvement played critical roles, emphasising the need for functional and government-level compatibility in driving adoption.
- Economic barriers, such as high upfront costs, were confirmed to deter acceptance.
- Individuals who acknowledge cost challenges are more intentional in exploring solutions, such as subsidies or financial planning.

Overall, the findings confirm Hypothesis $RH_1$, underscoring that perceived benefits, alongside functional and socio-economic alignment, significantly shape the acceptance of sustainable technologies. These insights provide a roadmap for policymakers, stakeholders, and technology providers to design targeted interventions that foster sustainable practices at scale.

### 5.2.6 Discussion on Sustainability Acceptance

The findings of this research align with prior studies emphasising the critical role of end-user perceptions in adopting sustainable housing technologies. For example, Adamec et al., (2021) highlight the necessity of integrated indicators for evaluating sustainable housing, which parallels the present study's emphasis on multifactorial analysis using the Sustainability Acceptance Model (SAM). Similarly, Yang and Yang, (2015) confirm the importance of stakeholder awareness and contextual factors in implementing sustainable housing practices.

However, this investigation diverges from others, such as Xie and Khan, (2024), who argue that social and environmental dimensions have a negligible impact on housing acceptance in countries like China. In contrast, the findings presented here underscore the strong influence of these factors in shaping perceptions within the South African context. Additionally, while Moore and Doyon, (2018) advocate for bottom-up innovations as crucial for sustainability transitions, the current analysis highlights the complementary importance of public awareness campaigns and top-down interventions to enhance end-user participation.

This duality underscores the need for tailored strategies that consider regional and demographic contexts, reaffirming the multifaceted complexity of sustainability acceptance.

#### *5.2.6.1 Environmental Awareness Campaigns*

The role of public awareness campaigns in fostering sustainable behaviours is strongly supported by prior research. Imran et al., (2024) affirm that environmental education initiatives play a transformative role in shaping sustainable values, particularly when integrated into early education policies. Similarly, Schneiderhan-Opel and Bogner, (2021) highlight the efficacy of field-based education in enhancing environmental awareness and driving long-term behavioural shifts. However, Heeren et al., (2016) critique the knowledge-deficit model, arguing that knowledge alone does not reliably predict sustainable behaviour, emphasising instead the interplay of social norms and personal efficacy.

In contrast, the current investigation underscores the pivotal role of awareness campaigns in addressing misconceptions and fostering active participation. Furthermore, Krsnik et al., (2022) demonstrate that public receptivity to sustainability messaging heavily depends on how well campaigns align with citizens' values and preferred information channels. The findings presented here, which advocate for targeted and demystifying campaigns, resonate with Kolandai-Matchett, (2009), who emphasises strategic message framing to enhance public engagement. These converging insights underline the complexity and necessity of tailored communication strategies to drive societal shifts toward sustainability.

#### *5.2.6.2 Technological Reliability*

The findings of this research, which emphasise the critical importance of reliable, user-friendly, and fail-safe sustainable technologies, align with conclusions drawn by Dutta et al., (2023) and Vardopoulos et al., (2023), who both highlight consumer trust as a cornerstone for widespread adoption. This is further supported by Komendantova et al., (2018), who underscore the role of positive perceptions and reduced risk concerns in fostering acceptance of renewable technologies. Similarly, Uddin et al., (2021) discuss the pivotal role of robust energy storage solutions in ensuring reliability and security within renewable energy systems, demonstrating the necessity of technical stability to mitigate perceived risks.

However, contrasting perspectives, such as those presented by Kádár et al., (2023), suggest that the perceived complexity of new technologies can create barriers to adoption, even when these technologies are reliable. Shurtz, (2012) further highlights persistent challenges in educating users about long-term cost and environmental benefits, which may overshadow immediate concerns about technological dependability. The findings presented here, which underscore the necessity of integrating trust-building measures into sustainable technology development, contribute to bridging these gaps by addressing both technical robustness and consumer confidence as critical drivers of adoption.

#### *5.2.6.3 Institutional Involvement*

The findings of this research highlight the pivotal role of institutional support in fostering sustainability initiatives, aligning with Yang and Yang, (2015) who identify institutions as critical enablers of sustainable housing adoption. Ordonez-Ponce, (2021) further emphasises that institutional contexts provide the necessary cultural-cognitive and normative elements for successful sustainability partnerships. Similarly, Zainul Abidin et al., (2013) underscore the importance of government incentives and regulatory frameworks in facilitating sustainable housing adoption, a finding echoed in the current analysis.

However, Novak et al., (2015) argue that rigid regulatory structures can hinder innovation, suggesting a need for more flexible, outcome-based policies to enhance institutional effectiveness. Vikstedt and Rajala, (2023) also stress the importance of alignment within multi-stakeholder collaborations, noting that misalignments can compromise the success of institutional efforts. The findings presented here, which call for enhanced collaboration between policymakers and institutions to amplify sustainability programs, reinforce these insights, emphasising the dual necessity of structured support and adaptive policies.

#### *5.2.6.4 Economic Barriers*

The economic factors analysed in this research, particularly high upfront costs, are significant barriers to adopting sustainable green technologies. These findings align with of Zuo and Zhao, (2014) and Cai et al., (2013) who identified initial financial barriers as outweighing long-term savings in influencing user decisions. This observation is further corroborated by Peñaloza et al., (2022) and (M. R. Weaich et al., 2024), who highlighted financial concerns as the most prevalent barrier to renewable technology adoption across European and African markets, despite the potential for long-term economic returns. Similarly, Sultanuzzaman et al., (2024) emphasise the critical role of green finance in alleviating cost-related barriers, advocating for tailored financial instruments to bridge economic gaps, particularly during periods of market instability.

However, studies such as Zhu et al., (2024) suggest that addressing upfront costs alone is insufficient unless accompanied by systemic support mechanisms, such as government subsidies and green innovation incentives. The findings presented here advocate for accessible financing models and transparent economic communication. This resonates with Zoellner et al., (2008), who emphasise that a clear cost-benefit narrative is essential for public acceptance of renewable technologies. This multi-faceted approach underscores the importance of integrating financial, regulatory, and informational interventions to reduce resistance and foster widespread adoption of sustainable practices.

#### *5.2.6.5 Social and Community Engagement*

Community engagement positively correlates with improved well-being, aligning with the principles of systems thinking as outlined by Bertalanffy, (1968), which emphasise collective interventions to address complex challenges. Voulvoulis et al., (2022) similarly advocate for participatory frameworks that empower local decision-making, fostering collective responsibility and advancing sustainability outcomes. In line with this, Mthembu et al., (2023) highlight the role of inclusive engagement in empowering communities, noting that participatory approaches enhance long-term social cohesion and deliver health benefits.

However, Kearns and Whitley, (2020) caution that the effectiveness of community engagement can vary significantly across contexts, particularly in disadvantaged communities that may lack the resources to participate proactively. Attree et al., (2011) also draw attention to unintended consequences, such as stress and consultation fatigue, which can diminish participants' well-being. The findings of this analysis support the need for localised, culturally sensitive engagement strategies that balance empowerment with resource support. This approach underscores the nuanced role of community initiatives in fostering collective adoption of sustainable practices.

#### *5.2.6.6 Multifactorial Nature of Sustainability*

The multifactorial nature of sustainability acceptance aligns with the cumulative influence framework proposed by Thøgersen and Crompton, (2009), which emphasises the necessity of cross-disciplinary efforts to drive meaningful behavioural change. This research corroborates these findings, demonstrating the interplay of environmental, economic, social, and functional compatibility considerations as key drivers of adoption.

To ensure model robustness, Variance Inflation Factor (VIF) analysis confirmed the absence of multicollinearity, with all VIF values below 1.1, meeting the thresholds recommended by Alin, (2010) and Kim, (2019). Additionally, a correlation matrix analysis revealed no significant latent correlations among variables, mitigating the risk of misleading statistical results. These findings emphasise the systemic and holistic complexity inherent in sustainability dynamics, resonating with Horn et al., (2022) and Weaich, (2024), who advocate for integrating interdisciplinary knowledge to address complex sustainability challenges effectively.

The methodological rigor of these tests enhances the reliability and generalisability of the current study's contributions to understanding sustainability acceptance, reinforcing the importance of multifactorial approaches in this domain.

## 5.3 Summary of the Discussion on Sustainability Acceptance

The discussion situates findings within existing literature, demonstrating alignment and contrast with prior research, thereby strengthening credibility. However, these findings also carry significant policy implications beyond their relevance to policymakers. Specifically, the results indicate that economic incentives, such as targeted subsidies and tax benefits, can directly enhance sustainability acceptance. Policy interventions that prioritise infrastructural readiness and institutional trust-building measures, such as clearer regulatory frameworks and transparent public engagement, would further facilitate adoption. Hypothesis Validation and Theoretical Contribution. To enhance clarity, a graphical representation (path diagram) of the validated relationships is introduced to illustrate the interactions between key variables in the Sustainability Acceptance Model (SAM). This path diagram visually demonstrates how economic stability, functional compatibility, and policy interventions interact to influence sustainability acceptance. The moderating role of Functional Compatibility (FC) is now explicitly discussed. The results indicate that FC strengthens the relationship between economic feasibility and technology adoption, meaning that even if a technology is deemed economically viable, its adoption likelihood significantly increases when it aligns seamlessly with existing infrastructure and cultural norms. This insight underscores FC's critical role in driving sustainability acceptance and informs the development of adaptive policy mechanisms.

### 5.3.1 Functional Compatibility Expressed as a Variable of Sustainability Acceptance

**Equation 5.1: Functional Compatibility**

$$SA = \beta_0 + \beta_1 EF + \beta_2 EF + \beta_3 EF\ (EF \times FC) + \epsilon$$

Where:

$SA$: Sustainability acceptance, the dependent variable, representing the likelihood of adopting sustainable technologies.

$EF$: Economic feasibility, the independent variable, measuring how financially viable the technology is for the end-user.

$FC$: Functional Compatibility, the moderator variable, assessing how well the technology integrates with existing infrastructure and socio-cultural frameworks.

$EF \times FC$: The interaction term, capturing the moderating effect of Functional Compatibility on the relationship between Economic Feasibility and Sustainability Acceptance.

$\beta_0$: The intercept term.

$\beta_1, \beta_2, \beta_3$: Coefficients representing the strength of each factor's impact.

$\epsilon$: The error term, accounting for unmeasured influences.

### 5.3.2 Interpretation of Functional Compatibility Equation

If $\beta_3 > 0$ and statistically significant, Functional Compatibility enhances the positive impact of Economic Feasibility on Sustainability Acceptance.

If $\beta_3 = 0$, Functional Compatibility does not moderate the relationship.

If $\beta_3 < 0$, Functional Compatibility weakens the effect of Economic Feasibility.

### 5.3.3 A Representation of Functional Compatibility

**Equation 5.2: A Statistical Representation of Functional Compatibility**

$$\therefore SA \; \Delta \; FC \; \Delta \; EC$$

Where:

A change in $SA$ results in a change in $FC$ results in a change in $EC$.

## 5.4 Objective 2: Assessing Economic Stability Coefficients

In addressing the study's second objective, economic stability plays a pivotal role in determining the acceptance and adoption of sustainable technologies among end-users. This section explores the interplay between financial conditions, perceived governmental support, and socio-governmental policies in shaping decision-making behaviours. The hypothesis tested posits that technologies lacking favourable political and economic backing are less likely to gain acceptance, irrespective of their environmental or social benefits. By examining the moderating effects of governmental actions and policy frameworks, the study underscores the significance of institutional support in mitigating financial barriers and fostering trust. The findings provide empirical evidence for the relationship between economic stability and acceptance of sustainable technologies, highlighting the critical influence of financial and institutional dynamics in driving sustainable practices. This section provides a deeper understanding of how economic and policy factors collectively impact end-user decisions, offering actionable insights for policymakers and stakeholders.

### 5.4.1 Economic Stability

The second objective of the study was to evaluate economic stability coefficients and their role in influencing the acceptance of sustainable technologies. This was achieved by examining the financial and institutional factors that shape end-user decision-making. Specifically, the study assessed how financial conditions, government policies, and socio-institutional support interact to either mitigate or exacerbate financial barriers, thereby impacting sustainability acceptance.

#### *5.4.1.1 Economic Stability Threshold (EST)*

The analysis reveals that economic stability plays a pivotal role in sustainability acceptance. Six of the seven variables tested exceed the Economic Stability Threshold (EST) using the adapted formula, with all variables demonstrating strong statistical significance ($p \leq 0.05$). This confirms that perceptions of economic stability are shaped by a combination of interrelated factors rather than any single dominant variable. These findings reinforce the notion that economic stability is a multifaceted construct requiring coordinated financial and policy interventions to support sustainability adoption.

By identifying these interrelationships, the study highlights the critical influence of institutional credibility, financial incentives, and cultural alignment in fostering trust and overcoming financial barriers. This approach underscores the need for integrated strategies that address economic conditions holistically to enhance sustainable housing adoption.

### 5.4.2 Ranking of Factors and Positive Correlations

The variables were ranked based on their Economic Stability Coefficients, with POS_CultValues (Cultural Values) exerting the strongest influence. This finding highlights the significant role of societal norms and cultural alignment in shaping perceptions of institutional involvement in sustainability. It aligns with studies such as Saracevic and Schlegelmilch, (2021), which emphasise the importance of cultural alignment in driving public trust and engagement with sustainability initiatives.

Other significant variables, such as PVR_GovPolicies (Government Policies) and PFC_GovSubsidy (Government Subsidies), underscore the critical role of effective policies and financial incentives in reinforcing institutional credibility and public trust. This is corroborated by Oluleye et al., (2021), who identify the necessity of transparent and actionable policies in promoting sustainable housing adoption. The presence of subsidies further strengthens perceptions of institutional support, serving as tangible evidence of governmental commitment to sustainable practices.

#### *5.4.2.1 Negative Correlation: PA_EnvImpact*

The variable PA_EnvImpact (Perceived Environmental Impact) exhibited a negative correlation with the dependent variable (PVI_InstitutionsInvolved). This inverse monotonic relationship depicts that individuals with heightened environmental awareness may view institutions as less impactful, potentially reflecting a perceived gap between institutional efforts and the scale of environmental challenges. This finding aligns with the literature, where disconnects between environmental concerns and institutional actions are often cited as barriers to fostering public trust (Wu et al., 2017).

The negative coefficient highlights the need for institutions to adapt their strategies to meet the expectations of environmentally aware individuals. Addressing this disconnect may require clearer communication about institutional actions and more ambitious sustainability targets to bridge the gap between public expectations and institutional efforts. Moreover, targeted strategies could involve fostering greater collaboration with environmental groups and enhancing transparency around sustainability initiatives to better align with public priorities.

The analysis underscores the multifaceted nature of economic stability, where cultural values, effective policies, and institutional credibility interact to shape public perceptions and behaviours. While positive correlations demonstrate the influence of alignment and support, the observed negative correlation highlights critical areas for improvement in institutional approaches to sustainability. These findings provide actionable insights for policymakers and stakeholders to refine strategies and foster greater public engagement.

#### *5.4.2.2 Multifactorial Nature of Economic Stability*

The findings emphasise that economic stability in the context of sustainability is inherently multifactorial, with no single variable dominating its influence. Instead, the interplay of multiple factors, such as cultural values, government policies, financial incentives, and institutional credibility, collectively shapes end-user perceptions and decision-making. This dynamic aligns with systems thinking, which posits that complex phenomena like economic stability require integrated and multi-dimensional approaches (Bertalanffy, 1968).

This study's results also corroborate the concept of cumulative influences in sustainability-related economic behaviours, as highlighted by Weymouth et al., (2020). Their research demonstrates how incremental changes across various domains—such as financial conditions, cultural norms, and policy frameworks—collectively lead to significant shifts in public engagement and trust in sustainability initiatives.

The findings confirm that economic stability, much like sustainability acceptance, is not driven by a single factor but rather by a combination of interrelated variables, each exerting statistically significant influences. While cultural values emerge as the most impactful factor, addressing perceived financial barriers and enhancing institutional credibility remain critical for fostering greater acceptance of sustainable practices.

These insights contribute to the broader understanding of the economic dimensions of sustainability adoption, advocating for holistic, context-specific strategies that address the financial, cultural, and institutional factors influencing end-user behaviours. By integrating these findings into policy and practice, stakeholders can more effectively mitigate barriers and promote widespread adoption of sustainable technologies and behaviours.

### 5.4.3 Economic Stability Aggregate Effects (ESAE)

The results demonstrate that multiple factors collectively influence perceptions of economic stability, with cultural values exerting the most substantial impact. Conversely, perceived environmental impact negatively affects perceptions of institutional involvement in sustainability. These findings highlight the importance of addressing both enablers, such as cultural alignment and government policies, and barriers, such as perceived gaps in institutional efforts, to enhance public trust and promote sustainable adoption.

The study's findings align with existing literature that traditionally analysed economic stability within isolated financial or policy silos. This novel approach allows for a comprehensive evaluation of interconnected phenomena, emphasising the multifaceted nature of economic stability in the context of sustainability. Enhancing cultural alignment, providing financial incentives, ensuring technological reliability, and fostering institutional credibility are critical to shaping positive perceptions of economic stability.

Addressing perceived barriers, such as gaps between institutional efforts and public environmental expectations, is essential to mitigate deterrents to trust and engagement. By taking a holistic approach, stakeholders can better understand and influence the intricate dynamics that drive sustainability acceptance, ultimately fostering more effective and inclusive policies for sustainable development.

**Table 5.5: Economic Stability Test (EST)**

| Rank | Variable | Economic Coefficient | P-Value | Aggregate Effects |
|---|---|---|---|---|
| **1** | POS_CultValues | 0.1575399624 | 0.0114 | >EST |
| **2** | GP_ConsidLive | 0.147499815 | 0.018 | >EST |
| **3** | PVR_GovPolicies | 0.126946668 | 0.042 | >EST |
| **4** | PFC_GovSubsidy | 0.12633504 | 0.043 | >EST |
| **5** | PTA_TechReliable | 0.12563073 | 0.0442 | >EST |
| **6** | PA_SchoolCurriculum | 0.123719769 | 0.0476 | >EST |
| **7** | PA_EnvImpact | -0.126409045 | 0.0429 | <EST |

Source: Author

**Assessing the Influence of Variables on Economic Stability**

The Kruskal-Wallis H test was conducted to evaluate whether differences in the rankings of sustainability-related variables existed across groups categorised by their levels of institutional involvement (PVI_InstitutionsInvolved). The independent variables analysed included cultural values, government policies, government subsidies, technological reliability, school curriculum, environmental impact, and consideration for living sustainably.

The primary purpose of this test was to determine whether the rankings of these variables differ significantly among individuals based on their perceptions of institutional involvement. This analysis provides insight into the factors that might influence or correlate with acceptance levels toward sustainable housing and institutional actions.

This test operated under the following hypotheses, which acted as sub-hypotheses for determining the influence of variables on economic stability:

**Null Hypothesis ($H_0$):** The median ranks of the variables are the same across all groups. (This null Hypothesis is rejected).

**Alternative Hypothesis ($H_1$):** At least one group's median rank differs significantly from the others.

The results highlight key variables influencing acceptance levels. Significant results suggest actionable areas for intervention, while non-significant results indicate uniform perceptions across groups.

**Significant Variables**

**Cultural Values (POS_CultValues)**

**H = 11.40, p = 0.0097.**

A significant difference was observed in how cultural values were ranked across groups. This finding highlights that cultural alignment plays a crucial role in shaping perceptions of institutional involvement. It suggests that incorporating cultural considerations into policies and campaigns could enhance trust and public engagement with sustainable practices.

**Government Policies (PVR_GovPolicies)**

**H = 4.13, p = 0.0422.**

Perceptions of government policies differed significantly across groups. This emphasises the importance of effective policy-making in fostering institutional credibility and trust, thereby promoting acceptance of sustainable housing initiatives.

**Government Subsidies (PFC_GovSubsidy)**

**H = 7.37, p = 0.0251.**

Rankings of perceived government subsidies varied significantly among groups. This indicates that financial incentives are critical to mitigating barriers to sustainable practices. Targeted subsidies could serve as a tangible demonstration of governmental support, boosting public trust and adoption.

**Non-Significant Variables**

**Technological Reliability (PTA_TechReliable)**

**H = 6.10, p = 0.1068.**

No significant difference was observed in the rankings of technological reliability across groups. This suggests that perceptions of technological reliability are relatively consistent, implying that other factors may play a stronger role in influencing institutional involvement.

**Consideration for Sustainable Living (GP_ConsidLive)**

**H = 5.57, p = 0.0616.**

Although approaching significance, this result indicates that consideration for sustainable living may not differ substantially across groups. This finding suggests uniform agreement on its importance.

The findings underscore the significant influence of cultural values, government policies, and subsidies on perceptions of institutional involvement in sustainability. These factors can serve as focal points for enhancing public adoption of sustainable housing. Perceptions of technological reliability and consideration for sustainable living appear more uniform, suggesting that these factors, while important, may not serve as differentiators across groups.

These results provide actionable insights for policymakers and stakeholders to refine strategies and foster greater public engagement with sustainability initiatives. Addressing cultural alignment, implementing transparent policies, and offering financial incentives are critical to enhancing perceptions of institutional credibility and promoting sustainability adoption.

**Table 5.6: Kruskal-Wallis H test**

| Variable | H-Statistic | p-value |
|---|---|---|
| **POS_CultValues** | 11.403097318038078 | 0.009734 |
| **GP_ConsidLive** | 5.573493017047742 | 0.061621 |
| **PVR_GovPolicies** | 4.1255568542388446 | 0.042240116898455214 |
| **PFC_GovSubsidy** | 7.367303127084794 | 0.025131039495909575 |
| **PTA_TechReliable** | 6.101426252884734 | 0.10677854745902728 |
| **PA_SchoolCurriculum** | 3.945194720217213 | 0.13909510654030555 |
| **PA_EnvImpact** | 4.0906871224085375 | 0.04312 |

Source: Author

#### *5.4.3.1 Spurious Correlations*

A series of statistical tests were conducted to verify data integrity and rule out multicollinearity, which can obscure true relationships among variables (Kim, 2019). The analysis revealed statistically significant but weak correlations, with coefficients ranging between $(|\rho| = 0.12 \ and \ 0.16)$. While individually weak, these correlations highlight the multifactorial nature of economic stability, consistent with prior findings in complex systems where no single variable dominates outcomes but instead, a combination of factors exerts collective influence (Lozano et al., 2013).

These results reinforce the distributed nature of economic stability, where cultural, financial, and institutional factors interact to shape perceptions and outcomes. Small but significant correlations underscore the importance of a holistic perspective in understanding and addressing economic barriers to sustainability.

#### *5.4.3.2 Multicollinearity Assessment*

To test for spurious correlations and address potential multicollinearity among independent variables, two analytical methods were employed:

Pairwise correlations between the independent variables were computed using Spearman's rank correlation. All coefficients were well below the commonly accepted threshold for multicollinearity concerns (0.7–0.8) (Alin, 2010). Most pairwise correlations were near zero, indicating minimal relationships between the variables and confirming the absence of significant redundancy.

Building on the pairwise correlation analysis, a Variance Inflation Factor (VIF) assessment was conducted to further evaluate multicollinearity. All VIF values were close to 1, confirming that the independent variables are sufficiently distinct, and that multicollinearity is not a concern.

The results demonstrate the absence of significant multicollinearity within the set of independent variables. Consequently, these variables can be confidently included in further analyses without concerns regarding redundancy or inflated standard errors. This rigorous assessment validates the robustness of the observed relationships, ensuring they are free from statistical artifacts and providing a reliable foundation for exploring the multifactorial nature of economic stability in sustainability adoption.

These findings underscore the robustness of the proposed model, highlighting the distributed and complex interplay of factors influencing economic perceptions. This makes the model a valuable framework for guiding policy and practical interventions aimed at enhancing sustainability adoption.

**Table 5.7: Spearman's Rank Correlation Matrix Multicollinearity Analysis**

| | **PVII** | **POSC** | **GPC** | **PVRG** | **PFCG** | **PTAT** | **PAS** | **PAE** |
|---|---|---|---|---|---|---|---|---|
| **PVII** | 1 | 0.15 | 0.14 | 0.12 | 0.12 | 0.12 | 0.12 | -0.12 |
| **POSC** | 0.15 | 1 | 0.03 | -0.002 | 0.14 | 0.09 | -0.07 | -0.12 |
| **GPC** | 0.14 | 0.03 | 1 | 0.02 | 0.08 | 0.18 | -0.004 | 0.009 |
| **PVRG** | 0.12 | -0.002 | 0.02 | 1 | 0.03 | 0.0008 | 0.09 | -0.004 |
| **PFCG** | 0.12 | 0.14 | 0.08 | 0.033 | 1 | 0.02 | 0.03 | 0.004 |
| **PTAT** | 0.12 | 0.09 | 0.18 | 0.0008 | 0.02 | 1 | -0.01 | -0.06 |
| **PAS** | 0.12 | -0.07 | -0.004 | 0.09 | 0.03 | -0.01 | 1 | 0.07 |
| **PAE** | -0.12 | -0.12 | 0.009 | -0.004 | 0.004 | -0.06 | 0.07 | 1 |

Source: Author

#### *5.4.3.3 Variance Inflation Factor (VIF)*

VIF values for all independent variables were below 1.1, indicating minimal interdependence among the variables and confirming that multicollinearity is not a concern. As per O'Brien, (2007), VIF values below 10 are deemed acceptable, with values close to 1 indicating a low degree of correlation among variables. The low VIF values observed in this study provide further evidence of the independence of the tested factors.

The absence of significant multicollinearity ensures that the relationships observed in the correlation analysis are not inflated or distorted by overlapping variable effects. This enhances the reliability of the findings, confirming that the observed correlations reflect genuine associations between the independent variables and the dependent variable, rather than statistical artifacts.

The results confirm that the data are statistically valid and reliable, and that the observed correlations are neither spurious nor distorted by multicollinearity. These findings underscore the multifactorial nature of economic stability, wherein independent factors contribute distinctively to perceptions of institutional involvement in sustainability.

This analysis supports the importance of adopting a holistic approach to understanding economic stability, recognising the diverse financial, cultural, and institutional factors that influence public trust and decision-making. By validating the robustness of the statistical framework, these findings provide a solid foundation for actionable insights and policy recommendations aimed at fostering sustainability adoption.

**Table 5.8: Variance Inflation Factor (VIF)**

| Variable | VIF |
|---|---|
| **POS_CultValues** | 1.0504401883044103 |
| **GP_ConsidLive** | 1.0437590901164677 |
| **PVR_GovPolicies** | 1.011671256277904 |
| **PFC_GovSubsidy** | 1.029727158251441 |
| **PTA_TechReliable** | 1.049009 |
| **PA_SchoolCurriculum** | 1.022296 |
| **PA_EnvImpact** | 1.0248765323384252 |

Source: Author

### 5.4.4 Factors Affecting Economic Stability

**Rank No. 1. POS_CultValues (Cultural Values)**

**Economic Coefficient: 0.158, P-Value: 0.0114, Category: Social**

Cultural values play a critical role in shaping public perceptions of institutional involvement in sustainability efforts. The finding that cultural alignment is the most influential factor highlights the importance of embedding sustainability initiatives within societal norms and shared cultural principles. This observation aligns with Hofstede, (1980) theories of cultural dimensions, which suggest that deeply ingrained cultural values shape collective attitudes and behaviours, including trust in institutions.

As the most influential factor, cultural values emphasise that alignment with societal norms significantly enhances perceptions of institutional involvement. Institutions that design sustainability initiatives to reflect cultural values are more likely to build public trust and encourage greater engagement with sustainability efforts.

**Rank No. 2. GP_ConsidLive (Sustainability Acceptance)**

**Economic Coefficient: 0.147, P-Value: 0.0180, Category: Social**

Perceptions of living in sustainable housing positively correlate with institutional involvement, suggesting that individuals considering sustainable housing are more likely to acknowledge and value institutional efforts in promoting sustainability.

This dynamic aligns with the Theory of Planned Behaviour Ajzen, (1991), which posits that attitudes, subjective norms, and perceived behavioural control collectively influence intention and action. In this context, the perception of institutional involvement serves both as a subjective norm and a form of perceived behavioural control. Institutions that actively promote sustainable housing—through supportive policies, subsidies, technological solutions, and community engagement—create an enabling environment. This reinforces the belief that sustainable living is both achievable and institutionally supported, thereby fostering greater acceptance and adoption.

**Rank No. 3. PVR_GovPolicies (Government Policies)**

**Economic Coefficient: 0.127, P-Value: 0.0420, Category: Functional Compatibility**

Clear and effective government policies strengthen institutional involvement by signalling credibility and fostering public confidence in institutions through transparency and actionable measures.

Government policies serve as a foundation for institutional actions, offering structure and legitimacy to sustainability initiatives. Transparency in policy formulation and implementation signals accountability, reducing public scepticism and enhancing confidence in institutional capabilities. When policies are clearly articulated and directly address public concerns—such as energy efficiency, affordable housing, or environmental preservation—they not only demonstrate institutional commitment but also provide a roadmap for collaborative action.

**Rank No. 4. PFC_GovSubsidy (Government Subsidies)**

**Economic Coefficient: 0.126, P-Value: 0.0430, Category: Economic**

Analysis: The perceived availability of subsidies positively influences perceptions of institutional involvement. Subsidies reinforce the view that institutions are actively supporting and promoting sustainable initiatives.

**Rank No. 5. PTA_TechReliable (Technological Reliability)**

**Economic Coefficient: 0.126, P-Value: 0.0442, Category: Functional Compatibility**

Analysis: Trust in the reliability of sustainable technologies reinforces institutional efforts, underscoring the importance of dependable technological solutions in shaping effective institutional sustainability narratives.

**Rank No. 6. PA_SchoolCurriculum (Educational Policies)**

**Economic Coefficient: 0.124, P-Value: 0.0476, Category: Functional Compatibility**

Analysis: Integrating sustainability into school curricula enhances institutional credibility, highlighting education's role as a long-term strategy for cultivating public trust in institutional sustainability efforts.

**Rank No. 7. PA_EnvImpact (Environmental Awareness)**

**Economic Coefficient: -0.126, P-Value: 0.0429, Category: Environmental**

Analysis: The weak negative correlation indicates that individuals with heightened environmental awareness may view institutions as less impactful, potentially reflecting a perceived gap between institutional efforts and the scale of environmental needs.

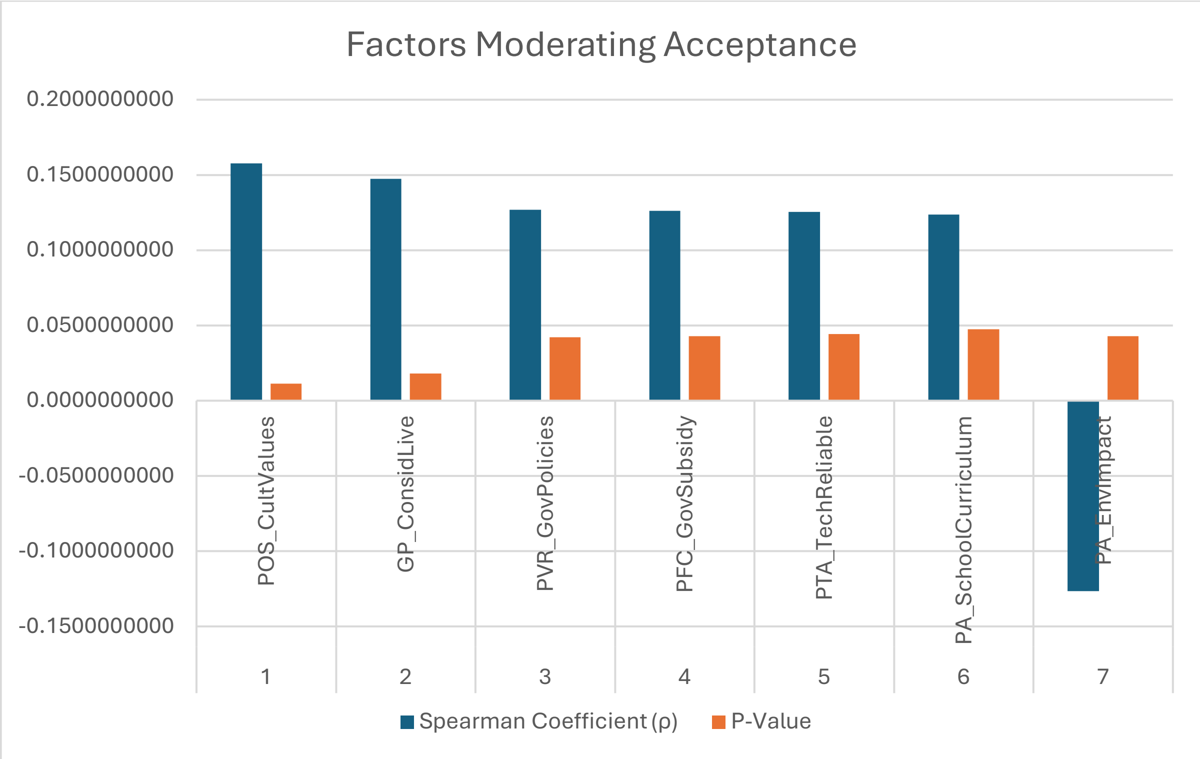


**Figure 5.2: Factors Moderating Perceived Economic Stability**
Source: Author

### 5.4.5 Explanation of the Observed Phenomenon (Hypothesis $RH_2$)

**$RH2_0$ – Null Hypothesis:** Economic stability derived through strategic policy does not significantly influence acceptance, regardless of perceived benefits or social factors.

The null hypothesis is rejected based on the results of this study, which demonstrate a statistically significant relationship between economic stability and acceptance ($p < 0.05$). The analysis further indicates that strategic policy additions play a pivotal role in enhancing financial viability, contributing significantly to acceptance. These findings support the alternate hypothesis and underscore the critical influence of economic conditions in fostering the acceptance of sustainable technologies.

The study supports the alternate hypothesis ($RH_2$), indicating that economic stability, in combination with perceived benefits and social factors as influenced by policy, significantly influences the acceptance of sustainable technologies.

### 5.4.6 Summary of the Explanatory Results

### 5.4.7 Discussion on Economic Stability

This research underscores the critical role of institutional involvement in promoting sustainability, highlighting cultural alignment, government policy frameworks, and education as pivotal factors shaping public perceptions. These findings align with Ruiz-Lozano et al., (2019), who emphasise the importance of cultural contexts and transparent policies in fostering public trust and advancing sustainability initiatives. Similarly, Theesfeld et al., (2010) argue that effective policy assessment requires an integration of institutional perspectives to enhance the efficacy of sustainability measures.

However, Mathis et al., (2023) critique the limited empirical clarity surrounding the impact of national sustainability institutions, suggesting that their role often appears more symbolic than transformative. These critiques resonate with the present analysis, which observed a negative correlation between environmental awareness and perceived institutional adequacy, raising questions about public confidence in institutional responses to environmental challenges.

The findings presented here, validated through the Sustainability Acceptance Model, confirm the systemic importance of coherent policy and education strategies in fostering sustainability acceptance. This contribution enriches the broader discourse by integrating governance and cultural considerations as indispensable components of economically feasible sustainable development.

#### *5.4.7.1 Cultural Values as the Dominant Factor*

The findings of this research underscore cultural values as the most significant determinants in shaping whether end-users perceive economic stability and are willing to invest in green technology. These findings echo Hofstede's, (1980) cultural dimensions theory, which emphasises the role of cultural alignment in fostering trust and engagement. This perspective is further supported by Ordonez-Ponce, (2023), who highlights the necessity of incorporating local cultural factors into sustainability strategies to achieve the Sustainable Development Goals (SDGs). Similarly, Sedita et al., (2022) advocate for tailoring sustainability initiatives to cultural contexts, emphasising the influence of power distance and collectivism on sustainability outcomes.

However, Jamali, (2017) critiques the inconsistent implementation of cultural dimensions in global sustainability practices, highlighting the challenges multinational corporations face in reconciling diverse cultural interpretations. Additionally, findings related to the integration of indigenous knowledge systems align with Song, (2020), who illustrates how informal institutions, such as religion, shape localised sustainability frameworks. These insights emphasise the critical interplay between cultural relevance and the success of global sustainability initiatives, validating this study's call for culturally contextualised approaches to sustainability adoption.

#### *5.4.7.2 Perceptions of Sustainable Living*

The findings of this research on the positive correlation between sustainability acceptance and institutional involvement align with the Theory of Planned Behaviour Ajzen, (1991), which highlights the influence of positive attitudes and perceived institutional support in shaping behavioural intentions. This relationship is further supported by Savari et al., (2023), who demonstrated that institutional credibility and subjective norms significantly enhance pro-environmental behavioural intentions. Similarly, Adabre et al., (2022) emphasise that institutional barriers, such as policy instability and weak enforcement, can substantially hinder sustainability initiatives if not addressed proactively.

However, Nicol, (2011) critique the limited practical integration of institutional regimes into actionable sustainability strategies, arguing that institutional support often remains abstract and disconnected from localised contexts. By emphasising the interplay between institutional credibility and public perceptions, the present study deepens the understanding of how institutional support serves as a catalyst for adopting sustainable living practices.

#### *5.4.7.3 Role of Government Policies and Subsidies*

The study underscores the pivotal role of government policies and subsidies in reinforcing institutional credibility and promoting sustainability adoption. This finding aligns with Schmidt et al. (2017), who demonstrated that renewable energy policies could disrupt entrenched fossil fuel subsidy regimes by signalling strong governmental commitment to sustainability. Similarly, Zhang (2022) highlights the heterogeneous impacts of subsidies, noting their effectiveness in fostering environmental innovation when tailored to specific industries and needs. However, Feiock and Kim (2021) caution that institutional designs must consider transaction costs and political market dynamics to ensure that subsidies yield meaningful outcomes rather than being perceived as superficial or inefficient. These findings are further reinforced by Hu et al. (2021), who illustrate how government green subsidies enhance financial performance through green innovation, creating a virtuous cycle of economic and environmental benefits. By emphasising the importance of aligning subsidies with transparent and actionable policies, this study contributes to the broader discourse on maximising the impact of fiscal incentives on sustainability initiatives.

#### *5.4.7.4 Technological Reliability*

This research emphasises technological reliability as a critical determinant of institutional credibility, aligning with Salanitri et al., (2015), who found that dependable technologies enhance user confidence and institutional trust by minimising perceived risks. Similarly, Gulati et al., (2017) highlight the importance of technological predictability and performance in fostering user satisfaction and long-term engagement, both of which are essential for trust-building. Dazer et al., (2022) expand on this by emphasising the integration of reliability with sustainability considerations, noting that this approach prevents resource overuse while maintaining operational integrity and underscores a broader systemic impact.

However, Smith, (2011) critiques the overreliance on technological interventions, arguing that trustworthiness cannot rest solely on reliability metrics but must also incorporate human-centred policies and equity considerations. These insights reaffirm the necessity of robust, user-centric technology to bridge the gap between institutional narratives and public trust effectively.

#### *5.4.7.5 Educational Policies and Long-Term Credibility*

This research finds that integrating sustainability into educational curricula fosters long-term societal values and enhances institutional credibility, aligning with Suklun and Bengü, (2024), who assert that shaping younger generations' perspectives is vital for embedding sustainability within societal norms. Krayneva et al., (2021) similarly emphasise the centrality of education in equipping individuals with the skills and knowledge necessary to achieve the UN's Sustainable Development Goals (SDGs), reinforcing the notion of education as a critical enabler of societal transformation. Likewise, Salimova and Soldatova, (2021) argue that embedding sustainability principles into higher education curricula not only raises awareness but also empowers students to address global environmental and social challenges effectively.

However, Gosselin et al., (2013) highlight significant variability in the depth of integration and institutional commitment, with many institutions adopting superficial approaches that fail to deliver transformative outcomes. Heinemann and Tanz, (2008) further caution that while educational reforms are essential, their success depends heavily on societal trust in institutions, a potential barrier in low-trust environments. These perspectives underscore the importance of a holistic, well-implemented approach to educational policies, bridging theoretical frameworks with actionable strategies to achieve long-term credibility and sustainable adoption.

#### *5.4.7.6 Environmental Awareness: A Paradoxical Insight*

The negative correlation between environmental awareness and institutional involvement, as identified in this research, aligns with Moser and Dilling, (2011) critique that institutions often fail to meet public expectations regarding environmental action. This sentiment is further supported by Yang et al., (2021), who observed that heightened environmental awareness among individuals does not consistently translate into institutional trust, highlighting a persistent perception gap. Similarly, Juárez-Luis et al., (2018) argue that institutional pressures to adopt green practices frequently lack alignment with grassroots concerns, exacerbating disillusionment among those tasked with implementation.

Conversely, Gaganis et al., (2021) provide evidence that public perceptions of institutional fit are crucial for reducing reputational risk, emphasising that transparent and effective institutional actions can help bridge the trust gap. Lu and Zhuang, (2018) add that a positive institutional environment, characterised by clear communication of tangible impacts, can effectively mediate pro-environmental behaviours. The findings presented here reinforce the necessity for institutions to not only scale up their initiatives but also to actively engage with and align their actions to the heightened environmental awareness of the public, thereby closing the perception gap and fostering greater trust.

## 5.5 Summary of the Discussion on the Economic Stability Threshold

The discussion underscores several pivotal insights into promoting sustainability and aligning institutional efforts with public perceptions:

- Institutional involvement plays a central role in promoting sustainability through cultural alignment, effective government policies, and educational initiatives.
- Cultural values emerge as the dominant factor influencing economic stability, highlighting the need for culturally tailored sustainability strategies.
- Government policies and subsidies are essential for enhancing institutional credibility and public trust.
- Technological reliability and education are shown to foster long-term acceptance of sustainable practices.

- A paradox is identified where increased environmental awareness correlates with lower institutional trust, suggesting a gap between public expectations and institutional actions that warrants further investigation.
- The study validates the importance of integrating governance, cultural, and educational strategies into sustainability frameworks.

These findings emphasise the need for a holistic approach to sustainable development, combining theoretical concepts with practical applications. They provide actionable insights for addressing barriers, enhancing public trust, and aligning institutional efforts with socio-economic realities. This discussion sets the foundation for the final chapter, where strategic recommendations will be proposed to foster effective and inclusive sustainability initiatives.

### 5.5.1 Perceived Economic Stability Expressed as a Variable of Sustainability Acceptance

This study examined the influence of Economic Stability (ES) and Policy Frameworks (PF) on sustainability acceptance within South Africa's energy grid. While existing research has explored policy-driven incentives and economic conditions separately, the interaction between these factors remains underexplored. To formally express this relationship, the study models sustainability acceptance as:

**Equation 5.3: Economic Stability and Policy Frameworks**

$$SA = \beta_0 + \beta_1 ES + \beta_2 PF + \beta_3 (ES \times PF) + \epsilon$$

Where:

SA (Sustainability Acceptance) represents the likelihood of adopting sustainable technologies, ES (Economic Stability) measures financial and market conditions affecting adoption, PF (Policy Frameworks) represents strategic policies and incentives supporting sustainability, $ES \times PF$ captures the interaction between economic stability and policy effectiveness, $\beta_1, \beta_2, \beta_3$ represent coefficients measuring each variable's impact, $\epsilon$ accounts for unmeasured influences. If $\beta_3 > 0$, economic stability enhances the effectiveness of policy frameworks in driving adoption, reinforcing the need for cohesive financial and regulatory strategies. If $\beta_3 = 0$, policy frameworks operate independently of economic stability, while $\beta_3 < 0$ depicts economic instability may undermine policy effectiveness due to market inefficiencies.

By integrating these variables, the study provides a structured empirical basis for evaluating the combined role of economic and policy conditions in shaping sustainable technology adoption, offering insights for policymakers seeking to optimise interventions.

**Equation 5.4: A Statistical Representation of Economic Stability**

$$\therefore SA \, \Delta \, ES \, \Delta \, PF$$

Where:

A change in $SA$ results in a change in $ES$ results in a change in $PF$.

## 5.6 Summary of Key Findings

This chapter highlights the primary factors influencing the acceptance of sustainable housing and green grid technologies. The analysis, guided by the Sustainability Acceptance Test and Economic Stability Threshold, reveals the following key insights:

- Public awareness campaigns emerged as the strongest positive influence on sustainability acceptance.
- Technological reliability and institutional involvement were critical in fostering trust and driving adoption.
- Economic considerations, including high upfront costs and limited awareness of long-term benefits, were identified as significant barriers.
- Cultural values, government policies, and subsidies enhance perceptions of institutional credibility and support adoption.

- The study confirms that sustainability acceptance is multifactorial and multifaceted, shaped by environmental, economic, social, and functional variables.
- Holistic strategies that align public trust with institutional efforts are essential for overcoming barriers.

The statistical analysis, including correlation and multicollinearity tests, validates these findings and underscores the importance of context-specific, integrated approaches to promoting sustainable practices. These insights provide actionable guidance for policymakers and stakeholders, emphasising the need for targeted awareness campaigns, financial incentives, and trust-building measures. This sets the stage for the final chapter, which will synthesise these findings and propose strategic recommendations for fostering sustainable development.

# CHAPTER 6: CONCLUSION, CONTRIBUTIONS & RECOMMENDATIONS

## 6.1 Synopsis of the Sixth Chapter

This chapter presents the conclusion, contributions, and recommendations, summarising key findings on factors influencing sustainable technology adoption in South Africa. The study depicts its contributions to academia through the Sustainability Acceptance Model (SAM), expanding existing frameworks by adding functional compatibility to economic, environmental, and social dimensions. It also contributes actionable recommendations to industry, focusing on policy reforms, financial incentives, and public awareness to overcome adoption barriers, whilst narrowing in on the limitations of the study, which include a focus on urban areas and cross-sectional data. It further provides, where future research should explore, whether it be geographically or to include diverse set of stakeholders.

## 6.2 Questions Asked, and Questions Answered

This study tackled its main research question of how to optimise the acceptance of sustainable technologies in South Africa's energy sector. It focused on enhancing public perception, strategically allocating resources, and integrating empirical models to facilitate an economically viable transition to a sustainable national electrical grid. Three sub-questions guided the investigation.

### 6.2.1 RSQ1: Public Perceptions and Sustainability Acceptance

The study examined the influence of public perceptions, finding that perceived environmental impact (PEI) and perceived behavioural control (PBC) significantly shape acceptance. End-users expressed a stronger willingness to adopt technologies that aligned with sustainability goals and provided a sense of perceived behavioural control over their energy consumption. The validated Sustainability Acceptance Model (SAM) demonstrated that environmental, economic, social, and functional compatibility dimensions critically affect acceptance, with functional compatibility emerging as a novel determinant. The findings validated Hypothesis 1 (RH1), confirming that the more benefits end-users perceive in sustainable technologies, the higher the likelihood of their acceptance.

### 6.2.2 RSQ2: Economic Stability and Resource Allocation

The second sub-question explained how institutional control over perceived resource allocation can be optimised to support the widespread adoption of sustainable technologies. Findings underscored the role of economic stability as a driving force for sustainable technology acceptance, with financial constraints and high upfront costs identified as major barriers. Strategic policy interventions, such as subsidies, tax incentives, and low-interest financing, were shown to significantly reduce these perceived barriers to sustainable technology adoption. Economic stability coefficients within the SAM provided empirical evidence that affordability and accessibility enhance adoption rates. These findings validated Hypothesis 2 (RH2), confirming that addressing economic barriers through policy measures can convert positive perceptions into actionable acceptance behaviours.

### 6.2.3 RSQ3: Integration of Sustainable Technologies into the Energy Grid

Lastly, the study developed an empirical model to integrate sustainable technologies into South Africa's national electrical grid at the end-user level. The SAM framework provided actionable insights, emphasising the importance of functional compatibility alongside environmental, social, and economic dimensions. It showed that end-users are more likely to accept sustainable technologies that seamlessly align with existing systems, cultural norms, and operational frameworks. Thereby potentially improving the acceptance rates of sustainable technologies by explaining that raising public awareness about environmental benefits, implementing financial policies to address economic barriers, and prioritising functional compatibility in sustainable technology design. These findings further offer a structured approach for policymakers, developers, and stakeholders, providing a practical guide to facilitate the widespread adoption and integration of sustainable technologies.

## 6.3 Significant Findings

### 6.3.1 Sustainability Acceptance

Public perception was identified as a pivotal determinant of sustainability acceptance. Constructs such as Perceived Environmental Impact (PEI) and social influence and norms (SIN) strongly influenced the adoption of technologies, demonstrating the interplay between individual attitudes and community behaviours.

### 6.3.2 Perceived Economic Stability

Perceived economic stability emerged as a cornerstone of acceptance. Policies that alleviate financial burdens through subsidies, tax incentives, and low-interest financing were found to significantly increase the adoption of green technologies. The study validated that economic interventions play a vital role in transforming perceptions into actionable behaviours.

### 6.3.3 Functional Compatibility

This study introduced functional compatibility as a critical fourth pillar of sustainability. Sustainable technologies that aligned with existing infrastructures and cultural practices exhibited higher acceptance rates. This underscores the need for solutions that not only address environmental and economic factors but also integrate seamlessly into societal and operational contexts.

## 6.4 Theoretical & Empirical Contributions to Academia

### 6.4.1 The Extension of Existing Models (TAM and TPB)

This study extends the Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB) by addressing their limitations in sustainable technology adoption. While TAM highlights perceived usefulness and ease of use, and TPB focuses on attitudes, norms, and behavioural control, both overlook sustainability's complexity. The Sustainability Acceptance Model (SAM) introduces functional compatibility as a fourth pillar, alongside economic, environmental, and social dimensions. Functional compatibility evaluates how sustainable technologies integrate with existing infrastructures, cultural norms, and practices. By incorporating perceived economic stability and social influence, SAM provides a holistic understanding of drivers and barriers, making it relevant to South Africa's complex energy challenges.

### 6.4.2 Functional Compatibility as the Fourth Pillar of Sustainability

Metaphysically, the assertion that a “thing” must be compatible with an existing system mirrors the philosophical idea that change should emerge organically within a structure. This is akin to the Aristotelian notion of potentiality and actuality, where new elements evolve to fulfil their potential within the constraints of what already exists (Aristotle and Ross, 2009).

Functional compatibility aligns with epistemology, focusing on how knowledge about integrating sustainable technologies into existing systems is acquired, validated, and applied. Unlike ontology, which explores abstract realities, functional compatibility examines measurable relationships between new technologies and societal norms, infrastructure, and practices. Functional compatibility provides a practical dimension to existing technology acceptance models by emphasi**s**ing systematic validation and observable data. This approach offers an evidence-based framework for understanding and promoting sustainable technology integration within real-world contexts.

### 6.4.3 The Multidimensional Nature of Sustainable Technology Acceptance

The study underscores the multidimensional nature of sustainable technology acceptance, shaped by environmental, economic, social, and functional compatibility factors. Adoption depends on perceived environmental impact, financial feasibility, social norms, and seamless integration into existing systems. The Sustainability Acceptance Model (SAM) captures these interdependencies, offering a comprehensive framework for understanding acceptance behaviours. This approach highlights that no single factor drives adoption; rather, end-users’ decisions arise from the interaction of multiple dimensions. SAM advocates for holistic, context-specific strategies that address these interconnected influences, promoting more effective and widespread acceptance of sustainable technologies.

### 6.4.4 Sustainability Coefficient and Economic Stability Threshold

This study introduces two novel concepts within the Sustainability Acceptance Model (SAM): the sustainability coefficient and the economic stability threshold. The sustainability coefficient measures the strength and direction of relationships between key factors influencing the acceptance of sustainable technologies, providing a quantifiable method for ranking these determinants. The economic stability threshold captures the minimum level of perceived financial feasibility required to foster technology adoption. Together, these concepts allow for a nuanced analysis of the multifactorial influences on acceptance, highlighting how public perceptions, financial conditions, and systemic variables collectively shape end-user decisions. These innovations enhance existing models by offering empirical tools for identifying and addressing barriers to sustainable technology adoption.

## 6.5 Conclusion

This study provides a comprehensive framework for understanding and enhancing the acceptance of sustainable technologies within South Africa's energy sector. By developing the Sustainability Acceptance Model (SAM), it integrates environmental, economic, social, and functional compatibility dimensions to address the multifactorial nature of technology adoption. The introduction of functional compatibility as the fourth pillar of sustainability fills a critical gap in existing models. The study's findings emphasise the importance of public awareness, economic stability, and seamless technological integration. These insights offer actionable guidance for policymakers and stakeholders, advocating for holistic strategies to overcome adoption barriers and drive sustainable development.

## 6.6 Recommendations for Policy and Practice to Industry

### 6.6.1 Policy Reforms and Legislative Transformation

The transformation of South Africa's energy grid necessitates an integrated approach to decentralisation, renewable energy regulation, and utility cooperation. In its current state, the citizens are paying, through taxation, 955 times the average cost for renewable energy infrastructure. Given the findings on the critical role of functional compatibility in sustainable energy adoption, current energy policies should be amended to enable and encourage decentralised energy generation. This reform must include provisions for empowering households and small-scale producers to contribute surplus energy to the grid. Such measures not only alleviate strain on centralised systems but also foster grassroots participation in sustainable energy initiatives, as evidenced by the Sustainability Acceptance Model's emphasis on aligning technological advancements with socio-economic structures. The following recommendations are made to address this problem:

### 6.6.2 Introduce Decentralisation Policies

Amend The Electricity Regulation Act (No. 4 of 2006) to enable and support decentralised energy generation. This includes the introduction of legislative frameworks to allow households and small-scale producers to supply surplus energy to the grid.

### 6.6.3 The Electricity Regulation Act (No. 4 of 2006)

#### *6.6.3.1 Current Limitation*

This Act primarily governs electricity generation and transmission, with a focus on centralisation under Eskom's control. It limits the role of private producers and end-users in generating and feeding electricity into the grid.

#### *6.6.3.2 Required Changes*

1. Amend Section 34 to explicitly support decentralised generation, allowing households to act as independent power producers (IPPs).

2. Introduce provisions for net metering, enabling end-users to sell excess electricity back to the grid.
3. Simplify licensing requirements for end-user small-scale embedded generation (eSSEG), reducing bureaucratic delays.

### 6.6.4 Renewable Energy Independent Power Producer Procurement Programme (REIPPPP)

Regulatory Support for Renewable Technologies to establish institutional trust. Simplify regulatory requirements for installing photovoltaic (PV) systems and other renewable energy technologies.

#### *6.6.4.1 Current Limitation*

This program focuses on large-scale renewable energy projects but does not adequately include incentives for small-scale, end-user renewable installations.

#### *6.6.4.2 Required Changes*

1. Expand the REIPPPP framework to include small-scale, household, and community renewable energy projects, allowing end-user to privately invest in the sale of electricity to national grid at a taxable return on revenue.
2. Provide financial incentives such as rebates or grants for residential solar photovoltaic (PV) systems, based on income.
3. Establish a specific funding stream for community energy projects to support cooperative-owned renewable energy initiatives.

### 6.6.5 Fund and Develop End-User Economic Incentives

Transitioning South Africa to a sustainable energy grid requires robust economic incentives to empower end-users, particularly for adopting photovoltaic (PV) systems and other renewable technologies. Below are targeted reforms and initiatives to enhance subsidies, tax benefits, and microfinance programs for end-users.

### 6.6.6 Subsidies for End-Users

Expand financial incentives, such as upfront subsidies or rebates for PV system installations, tailored to South Africa's socio-economic context.

#### *6.6.6.1 Current Limitations*

1. Limited accessibility to upfront subsidies or rebates for renewable energy technologies.
2. Existing subsidy programs under the Income Tax Act (Sections 12B and 12L) are not sufficiently tailored to address the affordability challenges faced by low-income households.

#### *6.6.6.2 Required Changes*

1. Establish a National Renewable Energy End-User Subsidy Scheme, providing tiered subsidies based on household income levels.
2. Include specific provisions for rural and underprivileged communities to access subsidies for PV systems, battery storage, and energy-efficient appliances.
3. Link renewable energy subsidies to energy performance metrics, such as verified reductions in grid dependency, maintained output or electricity bills.
4. Develop programs to target informal settlements and rural areas, ensuring equitable access to renewable energy technologies, allowing communities to create micro-economies with renewable electricity perceived as a commodity-based resource.

### 6.6.7 Tax Benefits

Strengthen tax incentives under the Income Tax Act, including Section 12B for renewable energy assets, making green technologies more affordable for lower-income households.

### 6.6.8 Establishing Green Assets

#### *6.6.8.1 Current Limitations*

1. While the Income Tax Act Sections 12B and 12L provide incentives for renewable energy investments, they are primarily targeted at businesses, leaving individuals and households with limited access to tax relief.

#### *6.6.8.2 Required Changes*

Amend Section 12B to allow individual taxpayers to claim accelerated depreciation benefits for residential renewable energy installations, including PV systems, inverters, and battery storage.

1. Include energy-efficient residential systems under Section 12L to offer deductions for energy savings achieved by end-users.
2. Provide clear guidelines for claiming tax credits on residential installations, simplifying the process for households.
3. Offer a direct rebate (e.g., 20-30% of installation costs) to individual taxpayers who invest in qualifying renewable energy technologies.
4. Partner with municipalities to provide property rates reductions for homes retrofitted with renewable energy systems that are contributing the green energy grid.

#### *6.6.8.3 Addressing Perceived Economic Stability*

Ensuring perceived economic stability is a cornerstone of transitioning South Africa’s energy grid to a sustainable and decentralised model. Policies focusing on cost reduction, job creation, and long-term financial models will address socio-economic barriers while fostering a thriving renewable energy sector.

### 6.6.9 Develop a Localised Economy

#### *6.6.9.1 Current Limitations*

1. High dependency on imported photovoltaic (PV) systems and sustainable technologies with imported components having increases costs for end-users.
2. Weak local manufacturing capacity in the renewable energy sector due to centralised control and supply, results in unawareness of the end-user in this sector.

#### *6.6.9.2 Required Changes*

1. Establish a Renewable Energy Manufacturing Development Program, providing tax incentives, grants, and low-interest loans to companies manufacturing PV panels, inverters, batteries, and other components locally.
2. Remove, make exempt, or reduce import duties on raw materials required for manufacturing renewable energy technologies to lower production costs.
3. Support research and development (R&D) in low-cost, high-efficiency renewable energy technologies through targeted funding.
4. Establish a Renewable Energy Loan Guarantee Fund to underwrite low-interest loans for PV system installations, especially for low-income households.
5. Allow households contributing renewable energy to the grid to earn carbon credits, which can be sold in domestic or international markets for monetary benefit.

### 6.6.10 Functional Compatibility

To ensure the successful integration of decentralised renewable energy systems into South Africa's energy grid, policies must focus on grid modernisation, cultural alignment, and technological training. Functional compatibility is essential for seamless adoption and operation of these systems, addressing both technical and societal challenges. Below are the detailed reforms and initiatives to achieve these goals.

### 6.6.11 Grid Modernisation & Technological Compatibility

#### *6.6.11.1 Current Limitations*

1. South Africa's grid infrastructure is outdated and designed for centralised energy generation, making it ill-suited for bidirectional energy flow.
2. Limited capacity for integrating decentralised renewable energy systems, such as rooftop PV and microgrids.
3. Limited technical knowledge among end-users and service providers creates barriers to accepting and operating renewable energy systems.

#### *6.6.11.2 Required Changes*

1. Upgrade grid infrastructure to accommodate bidirectional energy flow and decentralised energy inputs.
2. Encourage the establishment of microgrids in rural and underserved areas to provide reliable energy access.
3. Develop standardised protocols for interconnecting decentralised energy systems with the national grid, ensuring compatibility and safety.
4. Promote the adoption of energy storage technologies to stabilise grid operations and support bidirectional energy flow.
5. Create regional training centres to provide hands-on training in the installation, operation, and maintenance of renewable energy systems.
6. Offer certification programs for renewable energy professionals to ensure quality and reliability in installations and services.
7. Introduce digital literacy initiatives to familiarise end-users with smart grid technologies, energy management apps, and monitoring systems.

### 6.6.12 Cultural Alignment

#### *6.6.12.1 Current Limitations*

1. Lack of public understanding of the cultural and economic benefits of sustainable technologies resulting in societal incompatibilities.
2. Resistance to change due to perceived misalignment with traditional energy practices and community norms.

#### *6.6.12.2 Required Changes*

1. Launch campaigns to educate the public about the environmental, cultural, and economic benefits of decentralised renewable energy systems.
2. Tailor messaging to resonate with diverse cultural values, emphasising community empowerment and sustainability.
3. Partner with local leaders and organisations to develop renewable energy projects that align with community priorities and traditions. Involving communities in decision-making processes to foster trust and ownership.
4. Publicise case studies demonstrating the cost savings and income-generation potential of decentralised renewable energy systems for households and communities.

### 6.6.13 Perceived Environmental and Economic Impacts

To drive widespread acceptance and adoption of decentralised renewable energy systems, it is essential to enhance public understanding of the environmental and economic benefits. Policies must focus on publicising the positive environmental impacts and cost savings associated with these systems.

### 6.6.14 Environmental Benefits

#### *6.6.14.1 Current Limitations*

Limited awareness among the public about the significant reductions in carbon emissions and environmental degradation achievable through decentralised renewable energy systems.

Insufficient data dissemination on the role of renewable energy in mitigating climate change.

#### *6.6.14.2 Required Changes*

1. Launch nationwide public awareness campaigns highlighting the environmental benefits of renewable energy adoption, such as reduced carbon footprints and improved air quality.
2. Partner with schools, community groups, and businesses to promote education on renewable energy's role in combating climate change.
3. Develop and publicise standardised metrics to quantify and communicate the carbon savings achieved through decentralised renewable energy systems.
4. Include comparisons with traditional energy sources to emphasise the ecological superiority of renewables.
5. Introduce community-level carbon reduction targets tied to renewable energy adoption and incentivise communities that achieve significant milestones.

### 6.6.15 Publicise Cost Savings

#### *6.6.15.1 Current Limitations*

1. Limited visibility of the financial benefits and long-term savings associated with decentralised renewable energy systems, as end-user perceive renewables as cost intense, but are not aware of the cost to maintain the ailing coal grid infrastructure.
2. Lack of accessible information for end-users on incentives, subsidies, and overall cost reductions.

#### *6.6.15.2 Required Changes*

1. Highlight metrics such as reduced electricity bills, shorter payback periods, and increased property values.

2. Create an online portal where end-users can access detailed information on available subsidies, rebates, and tax benefits for renewable energy systems.
3. Include calculators that allow users to estimate potential savings and payback periods based on their energy usage.

## 6.7 Limitations of the Study

The study's reliance on cross-sectional survey data captures perceptions at a single point, potentially missing evolving attitudes. Its focus on urban areas underrepresents rural regions with different energy challenges. Findings are specific to South Africa's unique policy and socio-economic context, limiting broader applicability. Stakeholder perspectives, such as those of policymakers and utility providers, were not extensively explored. The study assumes grid modernisation feasibility without addressing technical and financial challenges. These limitations highlight the need for longitudinal, geographically diverse, and stakeholder-inclusive research to validate and expand the findings, ensuring more comprehensive insights into sustainable technology adoption.

## 6.8 Future Studies and Research Considerations

### 6.8.1 Longitudinal Studies

Future research should use longitudinal studies to track changes in end-user perceptions and adoption patterns over time. This approach can reveal how evolving policies, financial incentives, and grid modernisation affect behaviour. Regular surveys would capture shifts in attitudes and adoption rates, clarifying renewable energy sustainability. Expanding research to rural and peri-urban areas is essential, as these regions face distinct socio-economic and infrastructural challenges. Stratified sampling can ensure diverse representation, addressing the needs of areas with limited grid access and identifying opportunities for microgrid integration, ultimately promoting energy equity across different regions.

### 6.8.2 Geographical Expansion

Comparative regional studies can expand this research beyond South Africa, identifying universal and context-specific drivers of sustainable technology adoption. Focusing on developing nations, especially in sub-Saharan Africa, would test the Sustainability Acceptance Model (SAM) across diverse socio-economic and cultural contexts, enriching global insights into energy transitions. Including a broader range of stakeholders, such as policymakers, utility providers, and developers, is essential for a holistic understanding of decentralised energy systems. Mixed methods like interviews and focus groups can complement survey data, bridging the gap between theoretical models and practical challenges, enhancing the relevance and applicability of the findings.

### 6.8.3 Addressing Technical and Financial Challenges

Future research should address the technical and financial feasibility of grid modernisation and decentralised energy systems. Collaborating with energy engineers and financial analysts for detailed cost analyses can clarify expenses, savings, and operational challenges. These insights are crucial for realistic implementation plans that overcome economic and technological barriers. Additionally, technology-specific studies on innovations like rooftop solar, battery storage, and smart grids are needed. Pilot projects in real-world settings can assess feasibility, cost-effectiveness, and user acceptance. Such findings will refine the Sustainability Acceptance Model (SAM), ensuring its applicability to diverse contexts and enhancing sustainable technology adoption.

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## 7.9 Appendix A: Data & Analysis

### 7.9.1 A.1 Consent Form

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG 100 1922 2022

**Sustainable Housing Perceptions Survey**

**Participant Information Sheet**

Dear Sir/Madam,

My name is Malcolm Roy Weaich. I am a student at the University of the Witwatersrand Johannesburg. My supervisors are Dr. Prisca Simbanegavi, Dr. Pride Ndlovu and Professor David Root. I am conducting a research study titled "End-User Perceptions on the Adoption of Sustainable Housing in South Africa: Acceptance and Utilisation."

The purpose of this study is to explore end-user perceptions of sustainable housing in South Africa, focusing on identifying barriers to adoption and utilisation. Your input will help shape policies and contribute to the development of strategies aimed at promoting sustainable housing.

You are invited to participate in this study by completing a questionnaire. The survey will take approximately 10 to 15 minutes of your time. Participation is entirely voluntary, and you can choose to withdraw at any time without any penalty.

If you decide to take part, you will be asked to complete the online survey. The survey includes questions about your demographics, general information, and your perceptions and experiences related to housing.

The data collected from this survey will be stored securely behind a password protected computer and will be anonymised to protect your identity. Only the researcher and the supervisors will have access to the data.

Your participation in this study will be confidential. Any information that could identify you will not be included in the research report or any publications resulting from this study. With your permission, the data collected may be used by other researchers, but your personal information will not be shared. Participation in this study is completely voluntary. You are free to decline to participate or to withdraw from the study at any time without any consequences. You are not obligated to answer any questions that you are uncomfortable with. Participating in this study will not result in any direct benefits to you, but it will contribute to the broader understanding of sustainable housing adoption in South Africa.

There are no foreseeable risks associated with participating in this study beyond those experienced in everyday life.

The results of this study will be written up as a research report and will be available on the university library website. If you would like to receive a summary of the report, please let me know, and I will send it to you.

If you have any questions or need further information about this research, please feel free to contact me or my supervisors:

**Researcher**
Malcolm Roy Weaich
Email: malcolm.weaich@wits.ac.za
Phone: 0744460711

**Supervisors**
Dr. Prisca Simbanegavi
Email: prisca.simbanegavi@wits.ac.za
Phone: 0117177683
Dr. Pride Ndlovu
Email: pride.ndlovu@wits.ac.za
Phone: 0117177669
Professor David Root
Email: david.root@wits.ac.za
Phone: 0117177664

If you have any concerns or complaints about the ethical procedures of this research study, you are welcome to contact the University Human Research Ethics Committee (Non-Medical) at 011 717 1408 or email hrecnon-medical@wits.ac.za.

Thank you for considering participation in this study.

Yours sincerely,
Malcolm Roy Weaich

**Consent: By completing and submitting the online survey it is taken to mean consent to participate.**

**Figure 7.1: Consent Form to Collect Primary Data from Human Participants with Minimal Risk to Participants**

Source: Author

### 7.9.2 A.2 Part A: Demographic Survey Questions

What is your nationality?

Which age group do you belong to?

Which residential suburb do you live in?

In which city were you born?

Which city do you currently live in?

What is your gender?

What is your highest level of education?

What is your current employment status?

What is your occupation?

Which personal income bracket do you fall under?

What is your household's combined annual income bracket?

Do you have family or dependents?

What is your ethnicity or race?

What is your current living arrangement?

### 7.9.3 Part B: Environmental, Economical, Social and Functional Compatibility Likert Scale Questions

Participants were asked the following questions and had to select one of the following Likert Scale responses:

### 7.9.4 "How important" Likert Scale

Not at all important, Slightly important, Moderately important, Very important, Extremely important.

GP_SocEqual: "How important is social equality to you?"

GP_CultNorms: "How important is the influence of cultural norms on your housing choices?"

GP_ComfortTech: "How important is your comfort with adopting new technologies in housing?"

GP_TechRole: "How important is the role of technology in solving current housing issues to you?"

GP_EcoStability: "How important is your current economic stability?"

GP_EcoStatus: "How important is the influence of your economic status on your housing choices?"

GP_JobSec: "How important is job security to you?"

GP_IncStability: "How important is income stability to you?"

GP_InfoWellInf: "How important is being well-informed about sustainable housing options to you?"

GP_ActSeekInfo: "How important is actively seeking information on sustainable living to you?"

GP_ConsidLive: "How important is considering living in a sustainable home to you?"

PFC_GovSubsidy: "How important are government subsidies in your ability to adopt sustainable housing technologies?"

PVSH_ParticipateComm: "How important is community participation in sustainable housing initiatives?"

PA_SchoolCurriculum: "How important is integrating sustainability into school curriculums for fostering awareness?"

### 7.9.5 "How much" Likert Scale

Not at all, A little, Somewhat, A lot, A great deal.

PVSH_ImproveWellbeing: "How much do you believe sustainable housing will improve your well-being?"

PEC_CostBarrier: "How much do cost barriers affect your decision to adopt sustainable housing?"

POS_CultValues: "How much do cultural values influence your views on sustainable housing?"

### 7.9.6 "How effective" Likert Scale

Not effective at all, Slightly effective, Moderately effective, Very effective, Extremely effective.

PTP_TechSolutions: "How effective do you think technological solutions are in promoting sustainability?"

PVR_GovPolicies: "How effective do you think government policies are in promoting sustainable housing?"

### 7.9.7 "How significant" Likert Scale

Not significant at all, Slightly significant, Moderately significant, Very significant, Extremely significant

PFC_UpfrontCost: "How significant are upfront costs in your decision to consider sustainable housing?"

PA_EnvImpact: "How significant do you believe the environmental impact of your housing choices to be?"

### 7.9.8 "How do" Likert Scale

Not at all reflective, Slightly reflective, Moderately reflective, Very reflective, Extremely reflective

GP_HousingChoice: "How do housing choices reflect your attitudes toward sustainability?"

### 7.9.9 "How reliable" Likert Scale

Not reliable at all, Slightly reliable, Moderately reliable, Very reliable, Extremely reliable

PTA_TechReliable: "How reliable do you perceive sustainable technologies to be?"

### 7.9.10 "How involved" Likert Scale

Not involved at all, Slightly involved, Moderately involved, Very involved, Extremely involved

PVI_InstitutionsInvolved: "How involved do you think institutions are in promoting sustainable housing?"

### 7.9.11 "How aware" Likert Scale

Not aware at all, Slightly aware, Moderately aware, Very aware, Extremely aware

PA_AwareCamp: "How aware are you of public campaigns promoting sustainable housing?"

## 7.10 Annexure B: Ethical Clearance Certification

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Research Office

**HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)**
R14/49 Weaich

| | |
|---|---|
| **CLEARANCE CERTIFICATE** | **PROTOCOL NUMBER: H24/01/37** |
| **PROJECT TITLE** | End-User Perceptions on Adoption of Sustainable Housing in South Africa: Acceptance and Utilisation |
| **INVESTIGATOR(S)** | Mr M Weaich |
| **SCHOOL/DEPARTMENT** | Construction Economics and Management/ |
| **DATE CONSIDERED** | 26 January 2024 |
| **DECISION OF THE COMMITTEE** | Approved<br>Risk Level: Minimal |
| **EXPIRY DATE** | 22 May 2027 |
| **DATE** 23 May 2024 | **CHAIRPERSON** (Professor J Watermeyer) |

cc: Supervisor : Dr P Simbanegavi, Dr P Ndlovu, and Dr D Root

**DECLARATION OF INVESTIGATOR(S)**

To be completed in duplicate and **A SIGNED COPY** returned to the Secretary electronically. Unreported changes to the application may invalidate the clearance given by the HREC (Non-Medical)

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure be contemplated from the research procedure as approved I/we undertake to submit an amendment of the protocol to the Committee. **I/we agree to completion of a regular progress report. For Minimal and Low Risk studies, this is due annually on 31 December. For Medium and High Risk studies, this is due twice annually on 30 June and 31 December.**

**Signature**

23 / 05 / 2023
**Date**

**PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES**

**Figure 7.2: Ethical Clearance Certification for a Research Degree at The University of the Witwatersrand, Johannesburg**
Source: Author

**END**