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A structural model of green construction finance adoption in Kenya

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ABSTRACT

This study investigates the adoption of Green Construction Finance (GCF) and its determinants within Kenya's construction industry. Utilizing a quantitative approach, data were collected from 55 registered property developers and analyzed using Partial Least Squares Structural Equation Modelling (PLS-SEM). The findings reveal a nascent GCF landscape characterized by a stark paradox: while 98% of developers express a conceptual willingness to adopt green practices, actual uptake is restricted to a mere 1.03%. The structural model indicates that the eight theorized determinants, awareness, accessibility, institutional, financial, environmental, technical, risk, and socio-cultural factors, collectively explain only 5.95% (R^2=0.0595) of the variance in adoption. Critically, the analysis identifies a "barrier bundle" effect, where a lack of discriminant validity and high multicollinearity among constructs suggest that stakeholders perceive regulatory, financial, and risk-related hurdles as a single monolithic obstacle. Notably, environmental factors exhibit a negative path coefficient (-0.6313), implying they are currently viewed as cost burdens rather than value drivers. The study concludes that piecemeal interventions are insufficient; a holistic, systemic strategy is required to de-risk the sector and move beyond the current state of statistical fragility toward meaningful, sustainable construction uptake.

1. Introduction

The global construction and built environment sectors are at a critical juncture in the pursuit of the United Nations' 2030 Agenda for Sustainable Development. As of 2024, the building sector remains a primary driver of the climate crisis, accounting for approximately 32% of global energy consumption and contributing to 34% of global CO_2 emissions (United Nations, 2024). Despite a record-high $8.2 trillion in global sustainable finance in 2024, an 17% increase from the previous year, a stark geographical imbalance persists; over 90% of clean energy investment since 2021 has occurred in advanced economies, while Africa continues to capture only 3% of sustainable investment flows (UNEP, 2021).

In Kenya, the transition toward a green economy is supported by a robust legal framework, including the Green Building Code (2022) and the Climate Change Green and Resilient Buildings Regulations 2023, which aim to establish a specialized unit to oversee green building certification and rating systems (FSD Africa, 2024). Furthermore, the Finance Act 2023 has introduced incentives such as zero-rated import duty and the removal of VAT on renewable energy components to de-risk green adoption for developers (Osano, 2024).

However, a significant "implementation gap" exists. Recent empirical evidence (Musingi et al., 2025) indicates that GCF uptake in Kenya is extremely low, averaging only 1.06% of projects among architects and developers. Based on that study, while 98% of developers express a willingness to recommend GCF, the actual adoption is stifled by high investment costs and a lack of domestic capital. This study seeks to bridge this gap by establishing a measurement model that evaluates the determinants of GCF adoption and addresses the systemic "barrier bundles" that characterize the Kenyan construction landscape.

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2. Literature Review

2.1 Concept of Green Finance

The debate surrounding green financing is very active currently. ‘Financing green’ and ‘greening finance’ are two other terminologies that are currently being used in reference to this concept. The former refers to the financing of projects that contribute or intend to contribute to the conservation, restoration, and sustainable use of biodiversity and its services to people (The World Bank, 2025). Meanwhile, ‘greening finance’ is focused on directing financial flows away from projects with a negative impact on biodiversity and ecosystems, and towards projects that mitigate the negative impact or pursue positive environmental impact as a co-benefit. However, these concepts are two sides of the same coin, and they enable a response to the climatic challenge by providing an opportunity for improved coherence and depth in efforts to achieve restoration of ecosystems (Global Landscapes Forum, 2021).

There is no precise and commonly agreed-upon definition for green finance. Either most articles on the subject do not attempt to define it, or the definitions provided vary greatly (Lindenberg, 2014). According to Höhne et al. (2012), green finance is a broad term that can be used to describe financial investments for sustainable development initiatives, projects, products, and policies. Zadek and Flynn (2014) argued that green finance and green investment can be used interchangeably, though the former is wider in scope as it includes operational costs associated with green investments. In the banking sector, green finance can be defined as financial products and services that consider environmental factors during lending decision-making, ex-post monitoring, and risk management processes, provided to encourage ecologically responsible investments and support low-carbon technologies, industries, projects, and businesses (Turner, 2016). Green finance is that which promotes better environmental and sustainable outcomes, using various financial instruments such as loans, debt structures, and different investments (Kripa & Ilollari, 2023). Simply put, green finance is an investment or loan that promotes environmentally positive activities, such as the purchase of ecologically friendly goods and services or the construction of green infrastructure (Kelkar, 2023; Wire, 2024). From the foregoing, green finance could be described as having three components; (i) the financing of private and public green investments, (ii) the financing of public policies that encourage the implementation of environmentally conscious projects and initiatives, and (iii) components of the financial system that deal specifically with green investments, including their specific legal, economic, and institutional framework conditions.

2.2 Green Construction Project Financing

Despite the good accounts of green buildings, the construction research community is yet to holistically develop, investigate, and promote the ideal financing models that align with this innovative building model (Akomea-Frimpong et al., 2022). The authors further assert that green construction is still funded by traditional project financing models, which happen to be out of touch with the core principles of green building, coupled with numerous regulatory and practice limitations (Agliardi & Agliardi, 2019). Moreover, the green building model is still in its developmental stages in vast parts globally, and research on it remains limited, including the suitable financing models such as green finance tailored for green buildings (Wuni et al., 2019).

2.2.1 Global Perspective

According to Persefoni (2024), between 2012 and 2021, green financing grew more than 100-fold from $5.4 billion to $540 billion globally. This growth is partly attributed to the growing recognition of the various environmental crises, and specifically, the climate crisis. Foreign and domestic private finance is increasingly flowing into green construction globally. In the years between 2017 and 2021, green debt financing had a twentyfold increase, from about $10 billion to a record high of $230 billion (World Economic Forum, 2021). Green bonds accounted for about 70 percent of that financing; however, some emerging debt instruments, such as green sustainability bonds and loans, have been experiencing faster growth as shown in Fig. 1.

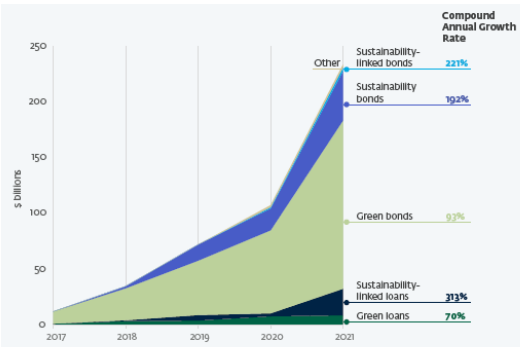

Fig. 1. Global Private Green Debt Finance

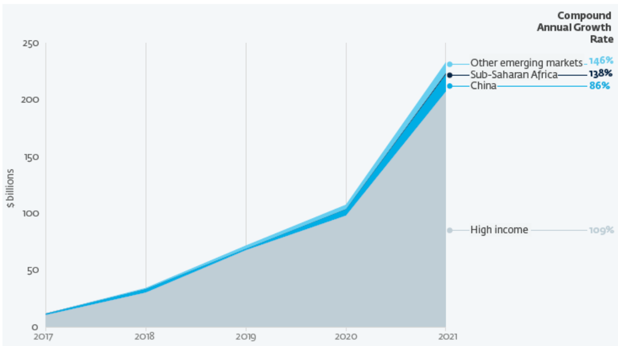

Fig. 2. Global domestic and foreign private green debt finance

Source: (IFC, 2023a)

Equity instruments are infrequently used, though Real Estate Investment Trusts (REITS) have the potential to scale the financing of green construction and operations (IEA, 2023). Other innovative tools of green finance, such as carbon retirement portfolios and transition bonds, are almost non-existent in developing countries (World Bank, 2022). These countries are mostly missing out on these growing flows of private green finance for greening construction. Since 2017, they have issued only 10 percent of total global green debt financing (World Steel Association, 2021). However, there is still hope. According to IFC (2022) private green debt finance for green construction has been growing faster in Sub-Saharan Africa, even though such finance is still extremely low, as shown in Fig. 2.

About 90 percent of this green construction financing in 2021 globally was channelled to green buildings rather than to "hard-to-abate" construction materials such as cement and steel, which account for approximately 19 percent of the global carbon emissions (World Green Building Council, 2022). According to the World Economic Forum (2022a), out of the total private green debt finance for green building issued in developing countries, about 54 percent was issued in the Caribbean and Latin America, followed by the Pacific and East Asia (19 percent), and Central Asia and Europe (12 percent). The Middle East, South Asia, North Africa, and Sub-Saharan Africa together issued only 15 percent (IFC, 2023b). Within Sub-Saharan Africa, South Africa accounts for about 75 percent of this financing (World Economic Forum, 2022b).

In 2021, green construction project financing registered an unprecedented high of about $27 billion globally, with 70 percent of that going to decarbonization of construction materials. Steel and cement each received about 50 percent of the total green finance for construction materials, with the share of steel growing more rapidly since 2019 (World Economic Forum, 2021). Green loans are the most preferred instruments for financing the decarbonization of construction materials, representing about 86 percent of total financing; however, green bond issuance increased seven-fold between 2019–2021.208 (World Green Building Council, 2022).

2.2.2 Kenyan Perspective

Kenya's green building market development has progressed steadily. The certified green building market was 3 percent of new buildings in 2020 (IFC, 2021b). Most of these certified buildings were offices and high-income housing. As of 2020, there were several Real Estate Investment Trusts (REITs), but the market did not record any green building construction loans or mortgage products. Though the government has a green economy strategy, the implementation and impact of these green building targets on market development are yet to be seen (IFC, 2021b).

In Kenya, sources of green finance are primarily external grants and loans from international public institutions; however, the national government also disburses billions of shillings from its revenue to climate and green-related projects (Were et al., 2022). Analysis of national budget data shows that for the fiscal years 2017/18 and 2019/20, the government disbursed KShs 414.23 billion and KShs 427.24 billion, respectively, to climate change sectors. On average, 40% of these funds were raised domestically, and 60% came from international sources. Out of these funds, the actual investment into green projects was KShs 103 billion in 2017/2018 and KShs 120 billion in 2018/2019. The extent of private sector contributions to green finance is not exactly known but is conservatively estimated at an average of KShs 100 billion per year. Out of this investment, it is estimated that KShs 30 billion is sourced domestically and KShs 70 billion is from international organizations.

Acorn Holding Limited was the first private entity to benefit from the green bond issue in 2019, where it was able to raise KShs. 4.3 billion ($40.5 million) to construct to develop affordable, environmentally friendly student hostels (Odhiambo & Amayo, 2024). The Qwetu Hostels are built using climate-resilient designs, are green and resource-efficient, and adhere to the EDGE requirements.

The IFC, in collaboration with the International Housing Solutions (IHS), established the IHS Green Housing Fund, whose aim is to provide financial support to investors of green affordable houses (Odhiambo & Amayo, 2024). The houses must meet the IFC's EDGE standards, which advocate for the efficient use of energy, water, and construction materials. The fund seeks to invest in 5,000 newly developed, green, affordable properties with an initial focus on Nairobi County and other selected counties in Kenya.

2.2.3 Challenges Facing GCF

The low levels of foreign and domestic private capital for green construction in developing countries could be partly explained by market failures within green finance and construction value chains (World Economic Forum, 2021). These failures are often more prominent and widespread in low-income countries. For example, the fragmented structure of the construction industry, the presence of informational imbalances between the segments of the industry and policymakers, extremely localized regulations, and the prevalence of small and medium-sized construction companies hinder finance for green construction (World Bank, 2022). Financial decisions mostly involve multiple stakeholders such as developers and owners, investors, construction professionals, and materials producers, with conflicting interests. Further, in the absence of green codes, regulations, and standards, investors face difficulty in identifying investment opportunities in green construction (World Bank, 2021). Small and medium-sized developers, particularly in economies characterized by high levels of informality, also face financial constraints for green construction. Additionally, the lack of skilled workers in green construction techniques further constrains the potential for investments in green construction (World Economic Forum, 2022b).

Green construction alternatives may also appear to be more expensive than they ought to be due to the current market prices failing to reflect the social costs imposed by emissions from conventional construction methods and materials, thereby reducing expected returns for green construction projects (World Economic Forum, 2022a). Consumers and investors may be reluctant or unable to pay an initial extra cost of 1 to 5 percent for green buildings compared to traditional ones, especially in affordable housing intended for lower income households. This is even more challenging in low-income countries that have a few commercially viable green construction investments (World Steel Association, 2021). Further, the lack of comprehensive data on default rates and the monetary benefits of green construction investment portfolios also plays a role in reduced investment in green construction (World Bank, 2021). Financial markets also tend to underprice climate risk which includes issues such as economic losses resulting from climate hazards (WBCSD/Arup Group Limited, 2021). For instance, residential property values frequently fail to consider the risks of extreme climatic events, even in cases when such information is public (World Bank, 2020). This increases the capital costs for green buildings relative to traditional alternatives. This problem can be more severe in developing countries geographically exposed to frequent catastrophic disasters and lacking well-structured financial and insurance markets (World Economic Forum, 2022b).

Private investors may encounter high costs associated with measuring and monitoring environmental performance in green construction projects, especially in “hard-to-abate” materials such as cement and steel (IFC, 2023a). These costs are usually high in developing economies due to lower transparency, inadequate governance and disclosure standards, weaker regulations, and insufficient technical capabilities for the issuance and regulation of green financial instruments (IFC, 2021a). Developing countries may also face constraints in supply. There is often a limited number of viable green construction projects to finance in these markets (IMF, 2021). This could be attributed to the absence of innovation, lack of economies of scale, limited green technical capacity for implementation, and limited concessional finance resources (IMF, 2022). Regulatory, currency, macroeconomic, and political risks, coupled with volatility, can also increase costs, hence reducing the profitability of green construction investments (Ul Haq & Doumbia, 2022).

2.3 Determinants of Green Construction Project Finance Adoption

The adoption of Green Construction Finance (GCF) is influenced by a multi-dimensional array of factors that range from individual stakeholder awareness to systemic institutional frameworks. Based on the literature review, these determinants are categorized into eight key domains:

2.3.1 Extent of Awareness

Awareness serves as a critical cognitive driver for adoption (Debrah et al., 2024). While general awareness of green building exists, many developers and construction firms—particularly smaller players—lack a detailed understanding of available green finance products, eligibility criteria, and specialized application processes (Sossou & Moyeyegue, 2024).

2.3.2 Availability and Accessibility

Even when green finance products exist, their practical uptake is often hindered by accessibility barriers. These include complex application processes, high transaction costs, and strict eligibility requirements that may exclude smaller developers (Haque & Murtaz, 2018). Furthermore, the limited geographical reach of green finance providers remains a significant constraint (Gulzar et al., 2024).

2.3.3 Institutional and Regulatory Factors

The regulatory environment provides the structural foundation for GCF. Supportive policies such as green building codes, tax incentives, and green procurement regulations are essential to encourage adoption (Abdullah & Keshminder, 2020). However, gaps in institutional capacity and poor coordination among government agencies, such as the Central Bank and Ministries of Environment and Housing, can impede the effective implementation of these policies (Macharia et al., 2024).

2.3.4 Financial and Cost-related Factors

High initial capital costs remain a primary barrier, as green construction typically requires a larger upfront investment compared to traditional methods (Hayee, 2025). This is often exacerbated by "split incentives," where the developer bears the high initial cost while the long-term benefits (e.g., lower utility bills) accrue to the tenant, creating a financial disincentive for the project owner (Gulzar et al., 2024).

2.3.5 Environmental Factors

Environmental concerns and sustainability awareness act as motivating drivers. Key indicators include a project's commitment to pollution prevention, resource efficiency (energy and water), material reuse, and safe waste disposal methods (Debrah et al., 2022). These factors are often driven by global climate change urgency and national environmental regulations (Khan et al., 2023).

2.3.6 Technological and Technical Factors

The availability of technological innovations, such as on-site renewable energy and digital tools (e.g., BIM), improves project feasibility and reduces implementation risks (Tran et al., 2020). However, the lack of a standardized knowledge database and a shortage of skilled human resources can weaken the positive impact of technical readiness (Wang et al., 2018).

2.3.7 Risk-related Factors

Perceptions of risk—including financial, operational, and regulatory uncertainties—permeate all decision-making processes (Debrah et al., 2022). Developers often cite economic variability, potential technology failures, and supply chain vulnerabilities as major deterrents. Risk mitigation instruments, such as loan guarantees, are critical to bolstering financier and developer confidence (Kariuki, 2023).

2.3.8 Social and Cultural Factors

Adoption is also influenced by market demand, social legitimacy, and peer influence within the industry (Russo et al., 2021). Building trust and demonstrating the broader social benefits of green buildings (e.g., occupant well-being) are essential for fostering a cultural shift toward sustainable construction practices (Sangiorgi & Schopohl, 2021).

3. Methodology

3.1 Research Design

This research adopted the survey research design. This entails the collection of quantitative or quantifiable data on more than one case, and at a single point in time, in connection with two or more variables, which are then examined to detect patterns of association, among other relationships (Czaja & Blair, 1996). Once the target population had been identified, an appropriate sample was drawn for data collection. Once the extent of adoption of GCF and its determinants had been established based on the sample, a generalization was made about the entire population.

3.2 Target Population and Sampling Procedures

The study targeted registered property developers in Kenya, who constituted the unit of analysis. Developers were selected because they serve as primary decision-makers and implementers of construction projects, positioning them as key demand-side actors in GCF. According to the Kenya Property Developers Association (KPDA) (2025) online register, 69 developers were registered as of 12 March 2025 (KPDA, 2025). Given this relatively small population, the study adopted a census approach, distributing questionnaires to all 69 firms. A total of 55 responses were received, yielding a response rate of 79.7%, which was considered adequate for analysis. Although some missing values in responses were observed, their impact was minimal. Of the 68 questions, 62 had complete responses (n = 55), three had one missing value (n = 54), and another three had two missing values (n = 53). Consequently, no imputation or corrective measures were undertaken.

3.3. Data Collection

Data was collected using questionnaires administered to registered property developers in June 2025. The questionnaire was divided into two parts. The first part requested demographic data regarding the years of existence and the total number of projects undertaken by participating firms. The second part measured the following determinants of green construction uptake: extent of awareness, availability and accessibility, institutional and regulatory related factors, financial and cost-related factors, environmental-related factors, technological and technical-related factors, risk-related factors, as well as social and cultural-related factors. A total of 68 indicators were used to measure the eight determinants based on the following 7-pointLikert scale: 1=Strongly Disagree, 2=Disagree, 3=Somewhat Disagree,4=Neutral, 5=Somewhat Agree, 6=Agree, and 7=Strongly Agree. Based on the provided scale, the developers were requested to indicate their level of agreement with a series of statements.

3.4. Data Analysis

The Partial Least Squares Structural Equation Modelling (PLS-SEM) method was selected as the analytical tool for the inferential statistics. This choice was well-justified given the nature of the research, which aims to investigate a complex model with multiple constructs and indicator variables. PLS-SEM is a component-based approach that is particularly suitable for exploratory research where the theoretical framework is still developing or is based on an underdeveloped theory (Hair et al., 2022). Unlike covariance-based SEM (CB-SEM), PLS-SEM is a predictive causal approach that prioritizes prediction over model fit (Dijkstra & Henseler, 2015). The adoption of PLS-SEM was adopted because the issue of green construction finance is relatively new, and not much has been written about its determinants and interrelationships. A key advantage of PLS-SEM is its robustness to data that does not conform to normal distribution assumptions and its ability to provide reliable results even with small sample sizes (Benitez et al., 2020). The study adopted ADANCO software, which uses a consistent PLS-SEM algorithm according to Henseler (2016). The algorithm computes measurement and structural relationships separately and iteratively, a process that is well-suited for the complexity of the research model under consideration (Müller et al., 2018).

3.5 Ethical Considerations

First, a letter of introduction was obtained from the Jomo Kenyatta University of Agriculture and Technology (JKUAT). The researcher then obtained a research permit from the National Commission for Science, Technology & Innovation (NACOSTI). These two documents were used by the researcher and research assistants for identification purposes. The study participants were informed that their participation in the study was voluntary, anonymous, and confidential, and that non-participation would not affect them in any way. Furthermore, they were informed that even when they consented to participate, they were free to withdraw their participation at any time during the study without any consequences. All aspects of the research were explained to the participants. Further, the information obtained during this research was treated with confidentiality. To help achieve anonymity of the data gathered during the survey, personal data such as names was omitted from the data collection instruments.

4. Findings and Discussion

4.1 Developers' Profile

4.1.1 Professional Experience

In assessing the tenure of developer firms within Kenya's construction industry, respondents were asked to indicate the length of time their firms had been operating. The results have been presented in Figure 3. Notably, there were no firms with less than 11 years of operational experience in the sample. This is because zero responses were recorded for both the 1–5 years and 6–10 years categories. Consequently, all responding firms had over a decade of experience within the Kenyan construction industry. The experience profile of the sample is heavily skewed towards long-established developer firms. Over two-thirds of the firms (67.3%) have been operating for more than 15 years, with 32.7% having over 25 years in the industry. This distribution indicates a mature respondent base with extensive exposure to market cycles, regulatory frameworks, and established business practices.

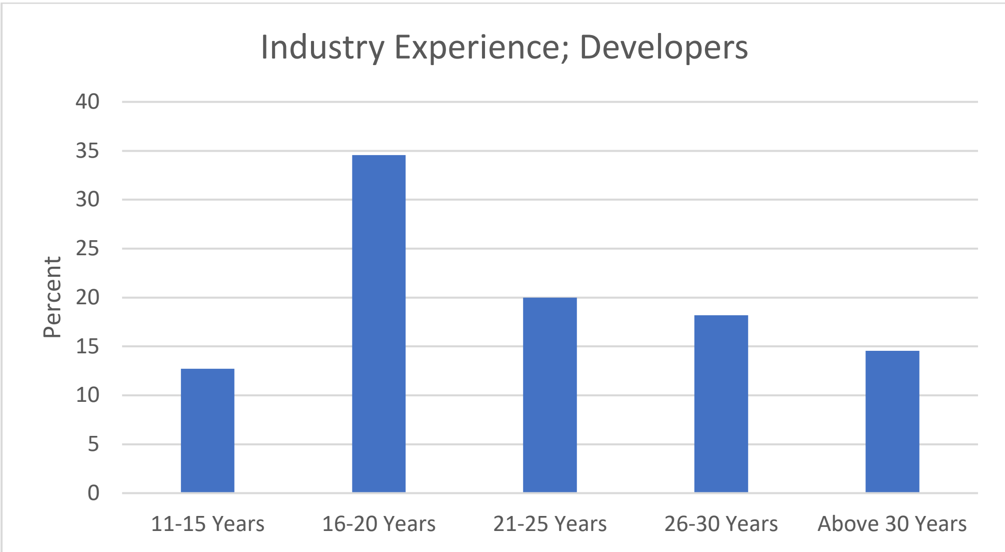

Fig. 3. Developer Firms' Professional Experience

Source (Fieldwork, 2025)

Mature firms are more likely to have accumulated significant institutional knowledge, robust financial resources, and the capacity to absorb new innovations, including adoption of GCF (Yin et al., 2018; Zhou et al., 2013). Their responses are therefore expected to reflect a high level of operational and sectoral insight. While stability can facilitate investment in green initiatives, longstanding firms may also be more set in traditional financing and construction practices, possibly exhibiting resistance to novel mechanisms unless incentivized or compelled by market or regulatory shifts (Jørgensen & Messner, 2010; Osei-Kyei et al., 2018).

The absence of firms established in the last 10 years means the dataset does not capture the perspectives or challenges unique to newer, possibly more agile or innovative firms. Zuo et al. (2012) suggest that such firms may demonstrate greater flexibility and willingness to experiment with emerging financial instruments, and their exclusion could limit the generalizability of findings to the entire industry. Given that established firms often act as industry leaders and trend-setters, their buy-in is critical for widespread adoption of green finance practices. However, policies aiming to facilitate GCF uptake should also consider the needs and potential contributions of emerging firms, which are not represented in this sample.

Previous research emphasizes both the advantages and challenges associated with firm maturity in adopting new industry practices. Osei-Kyei et al. (2018) found that experienced firms generally have greater resource capacity and are better equipped to implement sustainable innovations. Yin et al. (2018) reported that larger and older firms are more open to green finance, but inertia in established routines can impede rapid change. In contrast, Zuo et al. (2012) observed that new and younger firms contribute disproportionately to innovation uptake and industry transformation due to their openness to novel ideas.

4.1.2 Number of Green Financed Construction Projects

An overwhelming majority of developers have not used green financial instruments for any of their projects. The results presented in Fig. 4 showed that 83.6% (n=46) of developers had not undertaken any green-financed projects, 10.9% (n=6) and 3.6% (n=2) had completed one and two such projects, respectively. Only 1.8% (n=1) had undertaken three green-financed projects within that timeframe. Therefore, in total, the respondents had undertaken 13 green-financed building projects in the last five years. As shown in Figure 5, the number of green-financed buildings as a proportion of the total number of projects undertaken by developers (n=1,265) is 1.03%.

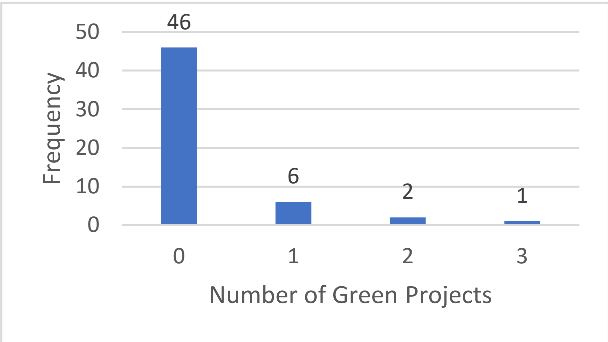

Fig. 4. Total Number of Green-Financed Projects Undertaken by Developers
Source (Fieldwork, 2025)

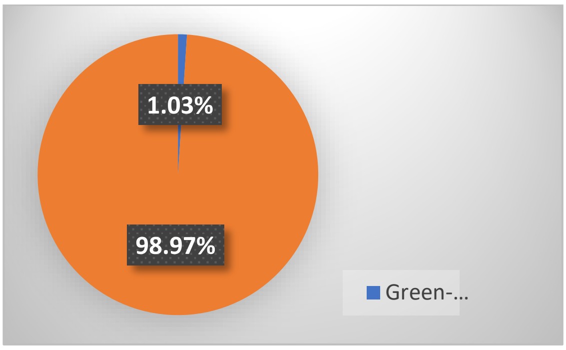

Fig. 5. Proportion of Green Financed Building Projects Undertaken by Developers

The GCF adoption of 1.03% indicates that the use of green financial instruments in building projects in Kenya is extremely limited, with the vast majority of developers and architects having no direct experience. This finding is consistent with broader trends in Kenya and many emerging markets, where the green finance ecosystem, especially in the real estate sector, is just emerging and immature. The results point towards an infant green finance ecosystem in Kenya's construction industry. According to Afriwise (2025), Kenya is in the early stages of green finance adoption within construction, with pilot bonds and targeted bank products only recently entering the market. Previous research (Odhiambo & Amayo, 2024) has shown that, even with increasing policy attention and the introduction of products such as green bonds and green mortgages, actual market penetration is limited. Several studies have identified key barriers behind this limited uptake. First, there is limited awareness and expertise. According to Darko et al. (2017), developers in most African and developing market contexts lack sufficient knowledge about the availability, requirements, and benefits of green financial products. Second, there is perceived complexity coupled with uncertain returns. According to Chang et al. (2015), green finance options are sometimes perceived as complex, with unclear short-term financial benefits, leading to risk aversion among developers. The third barrier is an underdeveloped product market. Until recently, Kenya had only a handful of green bonds issued and few mainstream financial institutions actively promoting green loans targeted at property development. Ngare (2025) points out that the struggle to attract significant access to green financing is due to multiple barriers, including complex regulatory requirements, limited access to diverse financial instruments, and a lack of capacity to develop investable projects.

Though the early adopters of GCF are rare, they're significant, and their experiences may help drive broader market acceptance. The presence of even a few green-financed projects indicates that market structures, however limited, do exist and can be leveraged with further support. Early adopters can showcase feasibility and help reduce perceived risk among peer firms, supporting the "demonstration effect" described in adoption literature. To enhance uptake, concerted efforts are needed to address informational, financial, and regulatory barriers.

4.1.3 Likelihood of Recommending Adoption of GCF to Other Developers

Developers were asked to rate the likelihood that they would recommend green financing options to others in the construction industry using a 7-point Likert scale from "extremely unlikely" to "extremely likely." In contrast to the results reported on the extent of GCF uptake, the obtained responses demonstrated overwhelmingly positive sentiment toward recommending green finance. With only a single (1.8%) respondent indicating neutral, all the others (98.2%) selected between likely and extremely likely, as shown in Fig. 6.

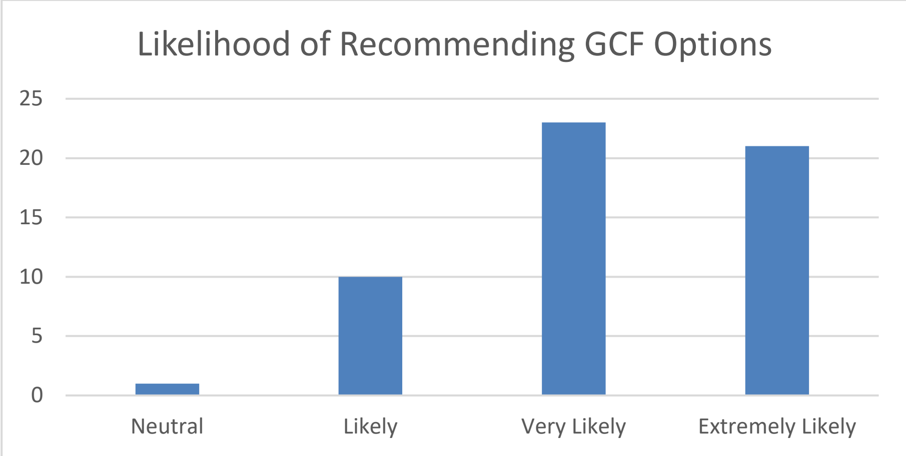

Fig. 6. Likelihood of Recommending Adoption of GCF

Source (Fieldwork, 2025)

Approximately 98% of developers indicated a positive inclination ("likely," "very likely," or "extremely likely") toward recommending green financing options, suggesting strong confidence and satisfaction among those engaged in green finance projects. This enthusiasm reflects a receptive and optimistic stakeholder base that can be leveraged to accelerate the adoption of green finance products in Kenya's construction industry. Willingness to recommend is critical in driving peer influence and wider diffusion of innovative financial products (Rogers, 2003). Developers who actively endorse green finance can stimulate demand among industry actors, financial institutions, and investors, further expanding the green finance ecosystem. This aligns with insights from emerging market studies, which highlight word-of-mouth and peer recommendation as pivotal for overcoming initial market inertia in green building finance (Darko et al., 2017).

The positive developer attitude corresponds with Kenya's growing institutional support for green finance. Initiatives such as the IFC's Green Housing Fund, Kenya's Green Bond programme, and the Guarantee Facility under the Environment Facility (EEF) provide critical technical assistance, credit enhancement, and risk mitigation that increase developer confidence (KGBS, 2025; Ollerenshaw, 2025). Although the actual uptake remains very low as demonstrated in this study, the strong positive recommendation sentiment signals that where green finance is experienced, it is valued, making education, capacity building, and risk-sharing mechanisms crucial to broaden access.

4.2 Confirmatory Factor Analysis Results

Since research on green construction finance (GCF) is relatively new, the current study aimed to investigate potential relationships among all the variables. This was achieved through a measurement model (Figure 7) executed via the Confirmatory Factor Analysis (CFA) function in ADANCO software. The measurement model comprises nine latent constructs, all interacting with each other as dependent (endogenous) and independent (exogenous) variables. The operationalization of these constructs and their associated indicators is detailed in Table 1.

Table 1

Construct Operationalization

Code	Construct	Indicators	Indicators (Measured attributes)
EA	Extent of Awareness of GCF	7	EA1, EA2, EA3, EA4, EA5, EA6, EA7
AA	Availability and Accessibility of GCF	6	AA1, AA2, AA3, AA4, AA5, AA6
IRF	Institutional and Regulatory Factors	9	IRF1, IRF2, IRF3, IRF4, IRF5, IRF6, IRF7, IRF8, IRF9
FCF	Financial and cost-related Factors	7	FCF1, FCF2, FCF3, FCF4, FCF5, FCF6, FCF7
EF	Environmental Factors	9	EF1, EF2, EF3, EF4, EF5, EF6, EF7, EF8, EF9
TTF	Technological and Technical Factors	10	TTF1, TTF2, TTF3, TTF4, TTF5, TTF6, TTF7, TTF8, TTF9, TTF10
RF	Risk Factors	11	RF1, RF2, RF3, RF4, RF5, RF6, RF7, RF8, RF9, RF10, RF11
SCF	Social and Cultural Factors	9	SCF1, SCF2, SCF3, SCF4, SCF5, SCF6, SCF7, SCF8, SCF9
GCF	Adoption of GCF	1	GCF

Source: (Fieldwork, 2025)

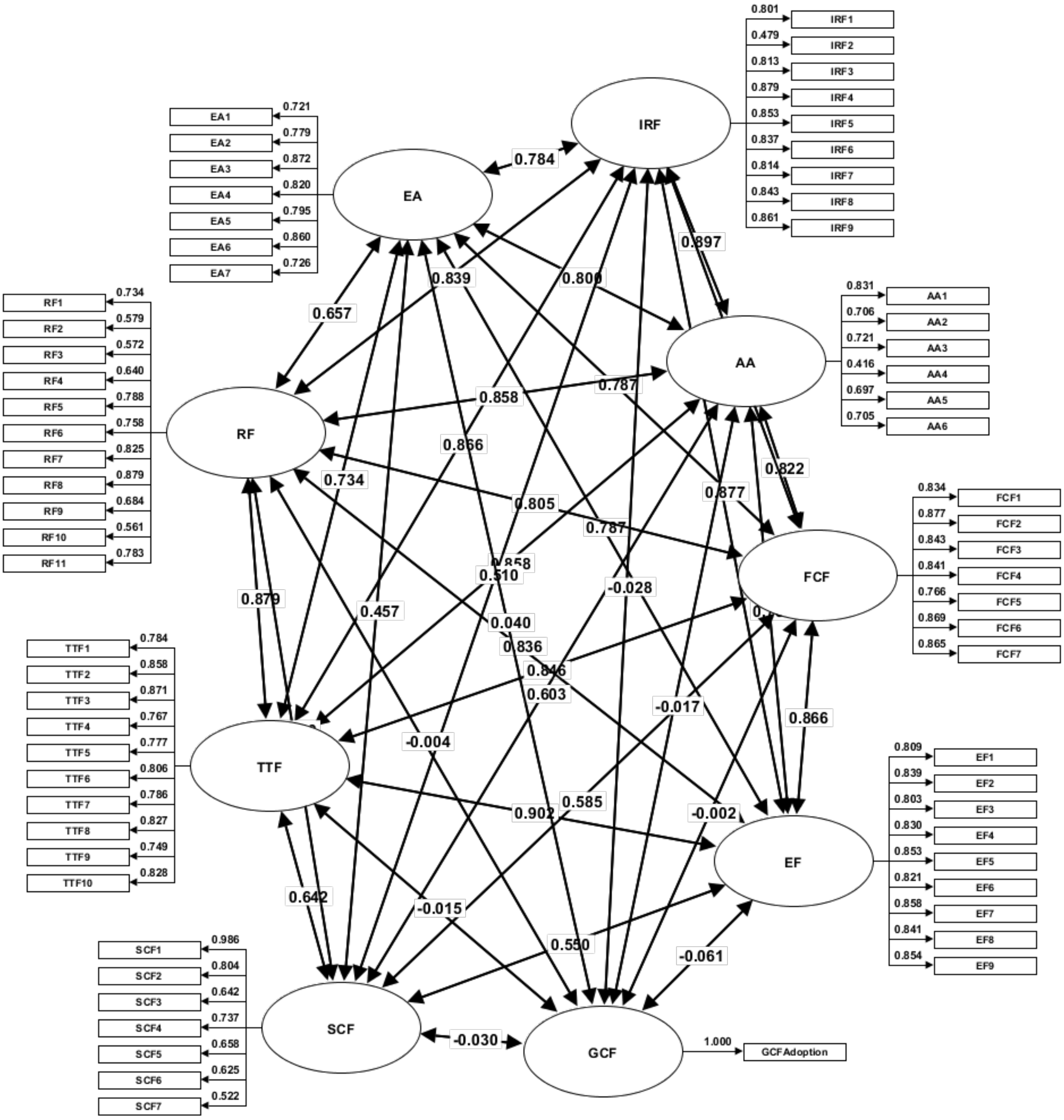

Fig. 7. Graphical representation of the modified measurement model (CFA output)
Source: (Fieldwork, 2025)

4.2.1 Goodness of Model Fit

The ADANCO output provides the Standardized Root Mean Square Residual (SRMR) as the key indicator of model fit. The SRMR measures the average discrepancy between the observed and the model-implied correlation matrices, whereby a lower value indicates a better fit (Cheah et al., 2018). The measurement model achieved an SRMR (Standardized Root Mean Squared Residual) of 0.0867 (Table 2), which is below the specified threshold of 0.1 (Benitez et al., 2020; Dijkstra & Henseler, 2015; Henseler, 2016), indicating an acceptable model fit, suggesting the model adequately reproduces the observed data relationships. The second SRMR value was for the modified measurement model after the three problematic indicators (those with low factor loadings) were removed.

Table 2
Goodness of model fit (saturated model)

Index	Initial model	Modified model	Threshold
SRMR	0.0867	0.0850	≤0.1

Source: (Fieldwork, 2025)

Since the SRMR value falls within the acceptable range, it provides initial evidence that the model adequately represents the empirical data. This suggests that the measurement model is a valid representation of the relationships among the constructs and their indicators.

4.2.2 Construct Reliability and Internal Consistency

Construct reliability evaluates the internal consistency of the indicators measuring each latent variable. Three metrics were used to measure the construct reliability. These are: Dijkstra-Henselers rho, Joreskog's rho (also known as composite reliability), and Cronbach's alpha. While a general threshold of >0.70 is recommended for all three, values between 0.60 and 0.70 are considered acceptable in exploratory research, and those exceeding 0.95 suggest multicollinearity or indicator redundancy (Dijkstra & Henseler, 2015; Hair et al., 2022). As seen on Table 3, all the values were within the acceptable limits, indicating very good internal consistency. The only exception was for the GCF adoption variable, which had a value of 1.0 because it was only measured using a single indicator.

Table 3

Construct Reliability

Construct	Dijkstra-Henseler's rho (ρ_A)	Jöreskog's rho (ρ_c)	Cronbach's alpha(α)
Extent of Awareness of GCF	0.9270	0.9243	0.9251
Availability and Accessibility of GCF	0.8582	0.8414	0.8439
Institutional and Regulatory Factors	0.9490	0.9424	0.9393
Financial and cost-related Factors	0.9457	0.9449	0.9451
Environmental Factors	0.9540	0.9538	0.9538
Technological and Technical Factors	0.9497	0.9488	0.9486
Risk Factors	0.9273	0.9194	0.9203
Social and Cultural Factors	0.8975	0.8414	0.8453
Adoption of GCF	1.0000	1.0000	

Source: (Fieldwork, 2025)

4.2.3 Indicator Reliability and Factor Loadings

Indicator reliability assesses the extent to which a construct explains the variance of its individual indicators. This is determined by the outer loadings, with a preferred threshold of >0.70 (Sarstedt et al., 2011). Loadings between 0.40 and 0.70 may be acceptable in some cases, provided their removal does not negatively impact other validity metrics (Henseler, 2016; Rodriguez-Entrena et al., 2018). Indicators with loadings below 0.40 should be removed (Hair et al., 2022). The results of the factor loadings (Appendix I) revealed significant issues with several constructs. In availability and accessibility (AA), indicator AA4 has a loading of 0.4159, falling below the ideal 0.70 threshold. Among the institutional and regulatory factors (IRF), indicator IRF2 has a low loading of 0.4807. Among the risk factors (RF), indicators RF2 (0.5812), RF3 (0.5741), RF4 (0.6376), and RF10 (0.5638) all fail to meet the 0.70 threshold. Lastly, it is important to point out that social and cultural factors (SCF) were the most problematic, with a majority of the indicators failing to meet the threshold. SCF3 (0.6334), SCF5 (0.6487), SCF6 (0.6174), SCF7 (0.5160), SCF8 (0.3133), and SCF9 (0.0918) all have inadequate loadings, with the last two being extremely poor and falling well below the 0.40 threshold for removal. The two indicators were removed from the model accordingly. Figure 7 thus presents the modified measurement model, while the initial model is presented in Appendix II. The factor loadings for the modified measurement model are presented in Appendix IV

4.2.4 Convergent Validity

Convergent validity ensures that a construct is effectively capturing the variance of its indicators (Henseler et al., 2015). This was assessed using the Average Variance Extracted (AVE), with a recommended threshold of >0.50 (Müller et al., 2018; Nitzl et al., 2016). An AVE value above this threshold signifies that the construct explains more than 50% of the variance of its indicators (Hair et al., 2022). As shown in Table 4, all the AVE values were > 0.5, except for availability and accessibility (AA=0.4777) and social and cultural factors (SCF=0.4088), indicating acceptable convergent validity with some weaknesses. These findings are a direct consequence of the low indicator loadings identified in the previous section. The poor performance of the individual indicators for AA and SCF collectively pulls down the AVE for their respective constructs. Once the two problematic indicators were deleted, all the AVE values were more than 0.5, as shown in the added column in Table 4, indicating that convergent validity had been achieved.

Table 4

Convergent Validity

Code	Construct	AVE (Initial model)	AVE (Modified model)
EA	Extent of Awareness of GCF	0.6368	0.6369
AA	Availability and Accessibility of GCF	0.4777	0.5142
IRF	Institutional and Regulatory Factors	0.6498	0.6499
FCF	Financial and Cost-related Factors	0.7104	0.7104
EF	Environmental Factors	0.6963	0.6963
TTF	Technological and Technical Factors	0.6498	0.6498
RF	Risk Factors	0.5143	0.5139
SCF	Social and Cultural Factors	0.4088	0.5240
GCF	Adoption of GCF	1.0000	1.0000

Source: (Fieldwork, 2025)

4.2.5 Discriminant Validity

Discriminant validity ensures that a construct is conceptually distinct from other constructs in the model (Henseler, 2016). This was evaluated using two key criteria: the Heterotrait-Monotrait Ratio (HTMT) and the Fornell-Larcker criterion. Based on the HTMT criterion, the HTMT values should be below the conservative threshold of 0.85, or below 0.90 for conceptually similar constructs (Henseler et al., 2015). As seen in Table 5, the HTMT correlation values between IRF and FCF (0.9092), EF and TTF (0.9013), IRF and TTF (0.8698), and AA and IRF (0.8902) exceeded the recommended thresholds, indicating a lack of discriminant validity between these pairs of constructs.

Table 5

Discriminant Validity: Heterotrait-Monotrait Ratio of Correlations (HTMT)

Construct	EA	AA	IRF	FCF	EF	TTF	RF	SCF	GCF
EA									
AA	0.7718								
IRF	0.7821	0.8902							
FCF	0.7831	0.8038	0.9092						
EF	0.7855	0.7788	0.8787	0.8654					
TTF	0.7281	0.8527	0.8698	0.8446	0.9013				
RF	0.6431	0.846	0.8363	0.7966	0.8269	0.8717			
SCF	0.4108	0.6256	0.4807	0.5413	0.543	0.6173	0.7223		
GCF	0.0433	0.0255	0.0313	0	0.0617	0.0156	0.0062	0.0747	

Source: (Fieldwork, 2025)

According to the Fornell-Larcker criterion, the square root of a construct's AVE (its diagonal value in the table) must be greater than its correlation with all other constructs in the row and column (Müller et al., 2018). As presented in Table 6, the AVE for AA (0.4777) is lower than its correlations with IRF (0.8044), FCF (0.6764), EF (0.6208), TTF (0.7359), and RF (0.7365). also, the AVE for IRF (0.6498) is lower than its correlation with FCF (0.8327). lastly, the AVE for FCF (0.7104) is lower than its correlation with IRF (0.8327).

Table 6

Discriminant Validity: Fornell-Larcker Criterion

Construct	EA	AA	IRF	FCF	EF	TTF	RF	SCF	GCF
EA	0.6368								
AA	0.6402	0.4777							
IRF	0.614	0.8044	0.6498						
FCF	0.6188	0.6764	0.8327	0.7104					
EF	0.6194	0.6208	0.7686	0.7504	0.6963				
TTF	0.539	0.7359	0.7504	0.715	0.8141	0.6498			
RF	0.4308	0.7365	0.7033	0.6484	0.6987	0.7717	0.5143		
SCF	0.2082	0.3848	0.2625	0.3407	0.3141	0.4186	0.5193	0.4088	
GCF	0.0016	0.0003	0.0008	0	0.0037	0.0002	0	0.0021	1

Source: (Fieldwork, 2025)

The failure of both discriminant validity tests suggests a fundamental conceptual problem. The respondents likely do not perceive these factors (institutional/regulatory, financial, environmental, and risk) as distinct concepts. This is not just a statistical issue; it reflects the real-world complexity of a nascent market. In such an environment, an underdeveloped institutional framework (IRF) directly translates into higher financial costs (FCF) and increased risk perceptions (RF) for potential investors. The lack of conceptual distinction is a reflection of this interconnected reality, where a "barrier bundle" (Tarkhanova et al., 2020) of intertwined challenges exist rather than a set of isolated determinants.

4.2.6 Indicator Multicollinearity

Multicollinearity is a statistical phenomenon where two or more predictor variables in a multiple regression model are highly correlated (Hair et al., 2022). In reflective measurement models like the one in this study, it is assessed using Variance Inflation Factors (VIFs), with a VIF > 5 being a common threshold for concern, and a VIF > 10 indicating a serious problem (Sarstedt et al., 2011). The results presented in Appendix III reveal the presence of multicollinearity at the indicator level. Indicators IRF4 (8.8924), IRF5 (6.4703), EF2 (7.5346), EF8 (6.2283), TTF2 (9.0448), TTF3 (10.8928), RF5 (6.1900), and SCF4 (6.2259) were all above 5, though only one indicator had severe multicollinearity exceeding 10. These high VIFs are a direct consequence of the lack of discriminant validity. When constructs are not distinct, their underlying indicators will be highly correlated, leading to inflated VIFs. This compromises the stability and reliability of the regression coefficients in the structural model, making their interpretation unreliable (Rodriguez-Entrena et al., 2018). The collinearity indicates that the model is statistically fragile and that the conceptualization of the determinants as separate variables is problematic in this context.

These multicollinearity findings align with the strong determinants' interrelationships findings from the bivariate correlation analysis and the lack of discriminant validity and multicollinearity among the constructs. This means that respondents do not conceptually differentiate between these factors. The data does not support the idea that these are distinct drivers of GCF adoption. This empirical finding aligns with a significant body of literature on green finance barriers in developing countries. Research has repeatedly identified that obstacles like financial constraints, weak policy structures, and high-risk perceptions do not exist in isolation (Addy et al., 2020). Instead, they are part of a larger, interconnected "barrier bundle" that must be addressed systemically (Mensah et al., 2024). An insufficient institutional framework, for example, makes it challenging to provide clear financial incentives and leads to a higher perception of risk, as earlier shown by the strong correlation between IRF, FCF, and RF in this study's data.

4.3 A Structural Model for Explaining the Uptake of GCF in Kenya

The structural model analysis evaluates the hypothesized relationships between the constructs. This section interprets the model's explanatory power and the specific path coefficients, which represent the strength and direction of these relationships. The structural model (Figure 8) comprises nine latent constructs, with "Adoption of GCF" (GCF) as the dependent (endogenous) variable and eight constructs as its independent (exogenous) determinants. The model posits that these eight constructs collectively influence the adoption of green construction finance. However, conceptualized interactions among the independent variables (GCF determinants) were also explored.

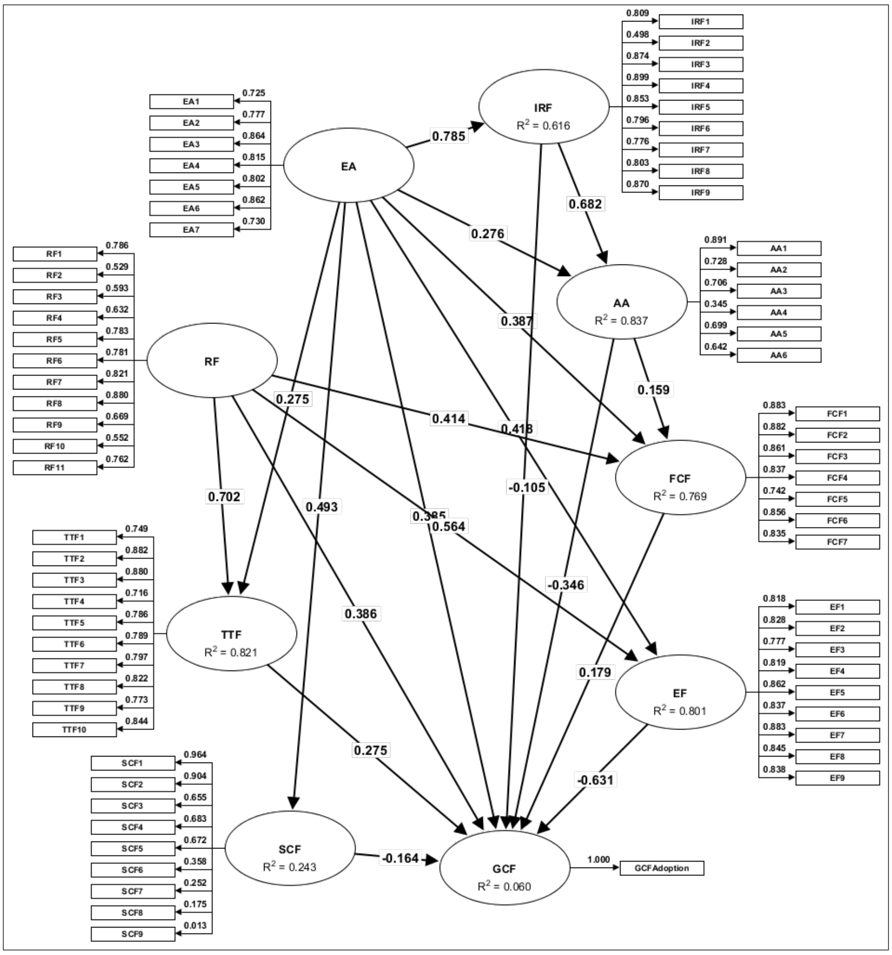

Fig. 8. Graphical representation of the structural model (Path analysis)

Source: (Fieldwork, 2025)

4.3.1 Coefficient of Determination (R²)

The R-squared (R^2) value for the endogenous variable indicates the proportion of its variance that is explained by the independent variables (Cohen, 1988). A higher R^2 indicates a greater explanatory power. Results presented in Table 7 show that the R^2 for the "Adoption of GCF" construct is 0.0595, and the adjusted R^2 is 0.0232. Falk and Miller (1992) recommended a minimum of 0.10 for the variance explained to be considered adequate. The R^2 value of 0.0595 was therefore deemed extremely low. It signifies that the eight proposed determinants collectively explain only 5.95% of the variance in GCF adoption in Kenya. However, the results also revealed strong relationships among the determinants in cases where some of them were treated as dependent (endogenous) variables. This is seen in R-Squared values as high as 0.8.

Table 7
Coefficient of Determination (R-Squared)

Code	Construct	R^2	Adjusted R^2
AA	Availability and Accessibility of GCF	0.8368	0.8335
IRF	Institutional and Regulatory Factors	0.6163	0.6124
FCF	Financial and Cost-related Factors	0.7692	0.7619
EF	Environmental factors	0.8009	0.7968
TTF	Technological and Technical-related Factors	0.8206	0.8169
SCF	Social and cultural-related Factors	0.2434	0.2356
GCF	Adoption of Green Construction Finance	0.0595	0.0232

The main reason for the extremely low R^2 is due to the data patterns observed in the descriptive statistics, where the determinants are generally perceived positively (normal distribution with a mean > 3) but GCF adoption is extremely low and skewed towards the bottom of the scale (mostly 1s and 2s). The fact that the determinants' scores are high but GCF adoption is low directly explains why the PLS-SEM structural model has an extremely low coefficient of determination (R^2=0.0595). The R-squared value measures how well the independent variables explain the variance in the dependent variable. In this case, the independent variables (determinants) simply are not varying in a way that aligns with the dependent variable (GCF adoption). The positive perceptions of the determinants are not translating into a positive outcome of adoption. The model is statistically correct in showing a weak explanatory power because, empirically, the proposed relationships are not yet in effect. The model is essentially demonstrating that the measured factors are not the primary drivers of the very small amount of adoption that currently exists in the Kenyan green finance market.

The extremely low R^2 is a profound finding. It suggests that the current adoption of GCF in Kenya is not driven by the rational and systematic influence of the eight studied factors. Instead, it is likely being suppressed by a more powerful, and perhaps un-modeled, "barrier bundle" of intertwined challenges. The data confirms that issues like inadequate institutional frameworks and high perceived risk are not isolated problems but are highly correlated with each other, forming a complex web of obstacles. The few projects that have adopted GCF might be driven by exceptional circumstances, such as a one-off government mandate or the influence of a small number of key market players, which would not be captured in a broad survey of determinants.

The findings demonstrate "*necessary but not sufficient*" conditions. They suggest that the studied determinants are necessary preconditions for adoption, but they are not sufficient on their own. For example, a high level of awareness is a necessary starting point, but without the "last-mile" support of clear financial incentives or de-risking mechanisms, adoption will not follow. The survey data show that this first step (awareness/perception) has been achieved, but the market has yet to overcome the systemic obstacles needed for widespread adoption.

Therefore, the study is not a failure of theory but a powerful empirical demonstration of the challenges of a developing market. It shows that even when the theoretical pieces of the puzzle (the determinants) are in place, real-world constraints can prevent them from driving the expected outcomes. The findings from both the PLS-SEM and bivariate correlation analysis serve as a critical alert to policymakers and stakeholders: a holistic, systemic approach is needed to move the Kenyan market beyond its nascent stage.

4.3.2 Path Coefficients: Direct, Indirect, and Total Effects

The path coefficients represent the standardized regression weights, with values close to +1 indicating a strong positive relationship and values close to -1 indicating a strong negative one (Hair et al., 2017). Detailed results of the path coefficients (direct, indirect, and total effects) have been presented in Appendices XVIII, XIX, XX, and XXI. Table 8 presents a summary of these coefficients, revealing several interesting relationships.

Table 8
Summary of Path Coefficients and Effects on GCF

Independent Variable	Direct Effects	Indirect Effects	Total Effects	Cohen's f^2
Extent of Awareness of GCF (EA)	0.3854	-0.5396	-0.1542	0.0332
Availability and Accessibility of GCF (AA)	-0.3457	0.0284	-0.3173	0.0116
Institutional and Regulatory Factors (IRF)	-0.1046	-0.2165	-0.3210	0.0009
Financial and cost-related Factors (FCF)	0.1789	-	0.1789	0.0044
Environmental Factors (EF)	-0.6313	-	-0.6313	0.0420
Technological and Technical Factors (TTF)	0.2748	-	0.2748	0.0090
Risk Factors (RF)	0.3863	-0.0887	0.2977	0.0193
Social and Cultural Factors (SCF)	-0.1638	-	-0.1638	0.0110

The analysis of the path coefficients uncovers some surprising and counterintuitive relationships. First is the counterintuitive effect of environmental factors (EF). The most striking finding is the strong negative path coefficient from environmental factors (EF) to GCF Adoption, with a value of -0.6313. This contradicts the typical assumption that a focus on environmental issues would drive GCF adoption. This unexpected result suggests that in the context of Kenya, environmental concerns are not viewed as an incentive but rather as a barrier or an added cost (Addy et al., 2020; Barua, 2020). For a developing market, the primary focus for firms may be on economic viability and managing risk. In this light, "going green" may be perceived as a financial luxury or a burdensome external imposition, aligning with literature that cites high initial costs and a lack of financial incentives as key obstacles (Addy et al., 2020; Tarkhanova et al., 2020).

The results also revealed the suppression effect of awareness (EA). The total effect of the extent of awareness (EA) on GCF Adoption is -0.1542, even though the direct path is a positive 0.3854. This indicates a suppression effect, where a strong negative indirect effect is suppressing the positive direct relationship. Tracing the paths reveals a major component of this effect: the path from EA to RF is a strong 0.6543, and RF has a negative indirect effect on GCF adoption (-0.0887). This means that while greater awareness directly encourages GCF adoption, it also significantly increases the perception of risk associated with green projects. In a risk-averse environment, this heightened awareness of poor financial returns or regulatory uncertainty may actually hinder adoption, effectively creating a counter-productive dynamic.

Additionally, the model also shows predominantly weak or negative total effects from other key constructs on GCF adoption, including availability and accessibility (AA, -0.3173), institutional and regulatory factors (IRF, -0.3210), and social and cultural factors (SCF, -0.1638). The positive effects from FCF and TTF are negligible (0.1789 and 0.2748, respectively). These findings further underscore the study's initial low R^2; the proposed determinants do not have a strong, straightforward, positive influence on GCF adoption in Kenya. The weak, and often negative, effects may be linked to the fact that the constructs themselves are not conceptually distinct.

The findings of this study resonate with and, at times, challenge, the broader literature on green finance barriers. The high degree of collinearity and the failure of discriminant validity among the institutional/regulatory, financial, and risk factors align with research that identifies a cluster of interconnected barriers in the adoption of green finance (Addy et al., 2020; Tarkhanova et al., 2020). Scholars have noted that poor financial returns, a lack of financial incentives, and an underdeveloped regulatory framework are not isolated obstacles but are part of a larger, systemic problem (Addy et al., 2020).

The most significant departure from the literature is the finding that environmental factors have a negative influence on GCF adoption. This challenges the common assumption that environmental awareness automatically translates into pro-environmental behaviour by firms. Instead, the finding suggests a need for a more nuanced theoretical model, particularly in developing economies, where economic viability may take precedence over environmental considerations (Barua, 2020). The results indicate that green initiatives are perceived as a cost or a risk rather than a competitive advantage. his contrasts with studies that find that when economic benefits like long-term cost savings, enhanced brand reputation, and new market opportunities are clearly communicated, environmental factors can become a positive driver (Liu et al., 2024).

5. Conclusions and Recommendations

The transition of the Kenyan construction sector towards a green economy is characterized by a significant "implementation gap" between conceptual willingness and practical adoption. While 98% of developers express support for Green Construction Finance (GCF), actual uptake is restricted to just 1.03% of projects. Based on the results of the structural model analysis, the following conclusions and recommendations are presented:

5.1 Conclusions

The most critical finding of the structural model is that the eight theorized determinants collectively explain only 5.95% (R^2=0.0595) of the variance in GCF adoption. This indicates that adoption is not currently driven by the rational and systematic influence of independent factors. Instead, it is suppressed by an un-modeled "barrier bundle"—a complex, interconnected web of institutional, financial, and risk-related obstacles that function as a single monolithic deterrent rather than isolated challenges.

The structural model reveals a strong negative path coefficient from environmental factors to GCF adoption (-0.6313). This suggests that in Kenya, environmental requirements are not perceived as incentives but as burdensome financial luxuries or added costs that threaten a project's economic viability.

While greater awareness directly encourages GCF adoption, the structural model identifies a counter-productive dynamic where increased awareness also significantly heightens the perception of risk. In a risk-averse environment, this heightened awareness of regulatory uncertainty or poor returns serves as a "suppression effect," effectively hindering the very adoption it aims to promote.

The failure of discriminant validity and the presence of high multicollinearity (VIFs > 5 and 10) for many indicators suggest that the current first-order theoretical model is too simplistic. The model confirms that the measured factors are currently "necessary but not sufficient" preconditions; awareness exists, but it fails to translate into adoption without systemic "last-mile" support.

5.2 Recommendations

The study offers the following recommendations for future research and practice:

5.2.1 Recommendations for Policy and Market Strategy

- **Shift to systemic policy interventions:** Policymakers must move away from piecemeal interventions that focus on a single determinant (e.g., only awareness). Because the barriers are part of an inseparable bundle, a holistic strategy is required that simultaneously streamlines institutional frameworks, provides clear financial incentives, and implements de-risking mechanisms like loan guarantees.
- **Economic alignment of green requirements:** To reverse the negative influence of environmental factors, stakeholders must reframe "green" as an economic advantage. This requires the government to introduce substantial financial offsets—such as the tax-related incentives introduced in the Finance Act 2023—to mitigate the perceived "green premium" and protect developers' profit margins.
- **Risk mitigation as the primary driver:** Since risk perception is a major suppressor of adoption, financial institutions and the government must prioritize risk-mitigation instruments. Providing standardized data on the performance and default rates of green projects can help lower the heightened risk perceptions often brought about by increased awareness.

5.2.2 Methodological Recommendations for Future Research

- **Adoption of Higher-Order Constructs:** Researchers should abandon first-order models that treat determinants as independent. Future studies should utilize **higher-order latent constructs** to better capture the systemic reality where institutional, financial, and risk factors are fused into a singular "barrier bundle".
- **Context-Specific Scale Development:** There is an urgent need to develop and validate new measurement instruments that move beyond traditional linear models to capture the idiosyncratic drivers and "un-modeled" market failures prevalent in emerging African economies.

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Disclosure statement

The authors report there are no competing interests to declare.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author.

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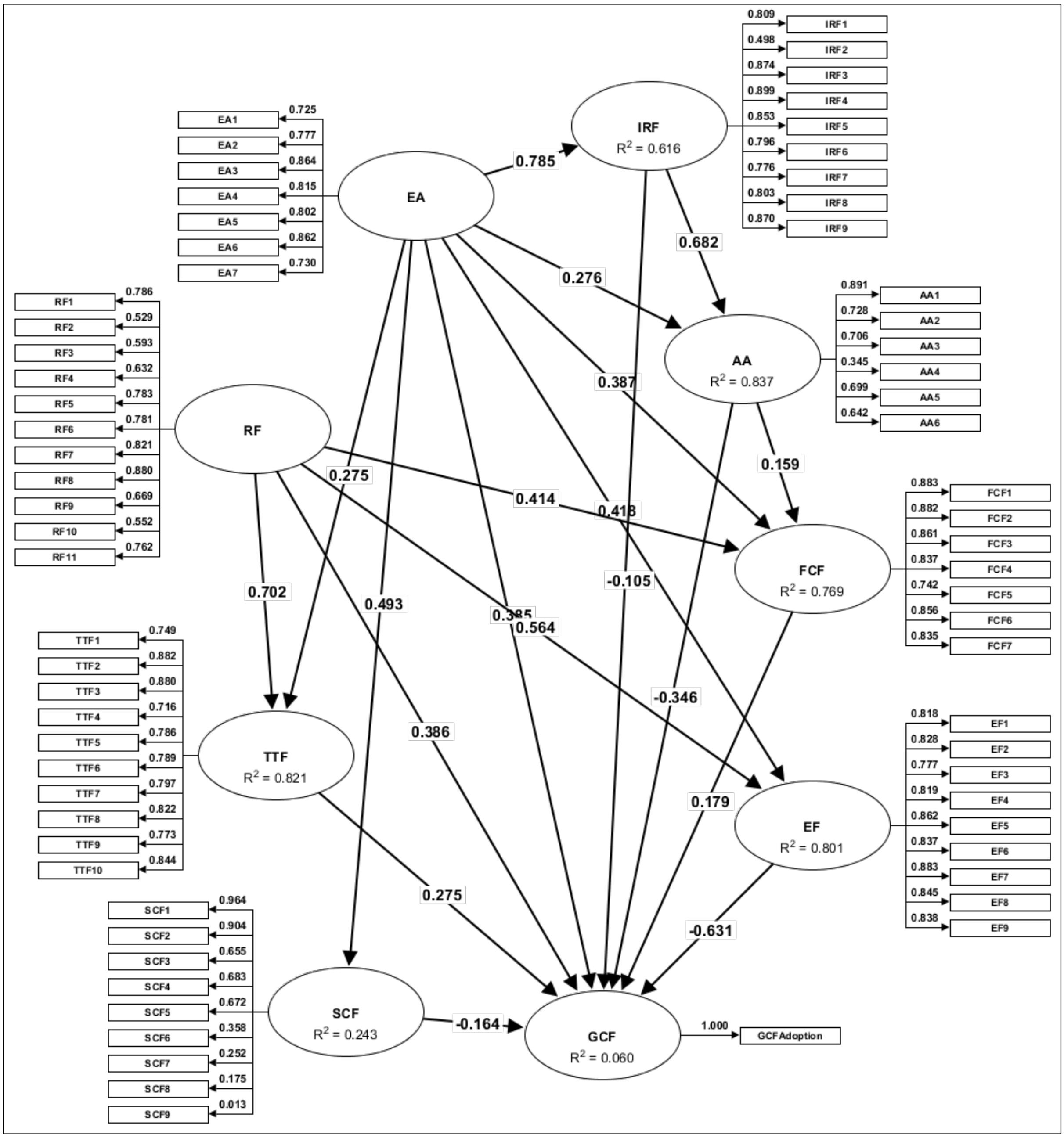
Appendices

Appendix I: Factor Loadings (Initial Measurement Model)

Indicator	EA	AA	IRF	FCF	EF	TTF	RF	SCF	GCF
GCFAdoption									1
EA1	0.7207								
EA2	0.7786								
EA3	0.8728								
EA4	0.8195								
EA5	0.7951								
EA6	0.8595								
EA7	0.7262								
AA1		0.8292							
AA2		0.7062							
AA3		0.7216							
AA4		0.4159							
AA5		0.6976							
AA6		0.7067							
IRF1			0.8028						
IRF2			0.4807						
IRF3			0.8121						
IRF4			0.8788						

IRF5			0.8521						
IRF6			0.8374						
IRF7			0.8136						
IRF8			0.8423						
IRF9			0.8613						
FCF1				0.8331					
FCF2				0.8754					
FCF3				0.8447					
FCF4				0.8401					
FCF5				0.7671					
FCF6				0.869					
FCF7				0.8656					
EF1					0.8084				
EF2					0.8378				
EF3					0.802				
EF4					0.8311				
EF5					0.8535				
EF6					0.8211				
EF7					0.8585				
EF8					0.8419				
EF9					0.8539				
TTF1						0.7829			
TTF2						0.8576			
TTF3						0.8712			
TTF4						0.7678			
TTF5						0.7759			
TTF6						0.8054			
TTF7						0.7856			
TTF8						0.8276			
TTF9						0.7494			
TTF10						0.8288			
RF1							0.734		
RF2							0.5812		
RF3							0.5741		
RF4							0.6376		
RF5							0.7844		
RF6							0.7598		
RF7							0.8262		
RF8							0.8792		
RF9							0.684		
RF10							0.5638		
RF11							0.7817		
SCF1								0.9723	
SCF2								0.793	
SCF3								0.6334	
SCF4								0.7272	
SCF5								0.6487	
SCF6								0.6174	
SCF7								0.516	
SCF8								0.3133	
SCF9								0.0918	

Appendix II: Initial Structural Model



Appendix III: Indicator Multicollinearity/Variance Inflation Factors (VIF)

Indicator	EA	AA	IRF	FCF	EF	TTF	RF	SCF	GCF
GCFAdoption									1
EA1	4.6279								
EA2	5.6821								
EA3	3.7815								
EA4	2.4533								
EA5	6.6726								
EA6	7.0089								
EA7	3.7237								
AA1		2.5032							
AA2		2.0729							
AA3		2.4302							
AA4		1.6321							
AA5		1.6057							
AA6		2.2245							
IRF1			2.8479						
IRF2			1.7054						

IRF3			3.2812						
IRF4			8.8924						
IRF5			6.4703						
IRF6			4.2381						
IRF7			3.7953						
IRF8			4.4108						
IRF9			5.0756						
FCF1				4.0866					
FCF2				5.1558					
FCF3				3.2911					
FCF4				5.9357					
FCF5				4.2771					
FCF6				4.6377					
FCF7				1.9738					
EF1					4.9952				
EF2					7.5346				
EF3					4.3284				
EF4					3.5527				
EF5					4.9538				
EF6					4.5951				
EF7					5.3242				
EF8					6.2283				
EF9					5.4041				
TTF1						4.8776			
TTF2						9.0448			
TTF3						10.8928			
TTF4						3.5201			
TTF5						5.4301			
TTF6						5.3569			
TTF7						2.4162			
TTF8						4.3221			
TTF9						3.2532			
TTF10						5.366			
RF1							5.1631		
RF2							2.3645		
RF3							3.2422		
RF4							5.3807		
RF5							6.19		
RF6							6.2314		
RF7							4.2042		
RF8							3.6682		
RF9							2.2365		
RF10							3.0604		
RF11							2.3639		
SCF1								1.5408	
SCF2								1.6283	
SCF3								3.9536	
SCF4								6.2259	
SCF5								4.9269	
SCF6								4.368	
SCF7								4.8926	
SCF8								2.5354	
SCF9								2.1943	

Appendix IV: Factor Loadings (Modified Measurement Model)

Indicator	EA	AA	IRF	FCF	EF	TTF	RF	SCF	GCF
GCFAdoption									1
EA1	0.7213								
EA2	0.7787								
EA3	0.872								
EA4	0.8196								
EA5	0.7953								
EA6	0.8596								
EA7	0.726								
AA1		0.8309							
AA2		0.7064							
AA3		0.7211							
AA4		0.4157							
AA5		0.6971							
AA6		0.7054							
IRF1			0.8015						

IRF2			0.4794						
IRF3			0.8134						
IRF4			0.8787						
IRF5			0.8526						
IRF6			0.8373						
IRF7			0.8136						
IRF8			0.8432						
IRF9			0.861						
FCF1				0.8337					
FCF2				0.8765					
FCF3				0.8432					
FCF4				0.841					
FCF5				0.7662					
FCF6				0.8693					
FCF7				0.8653					
EF1					0.8095				
EF2					0.8391				
EF3					0.8027				
EF4					0.8296				
EF5					0.8533				
EF6					0.8213				
EF7					0.8576				
EF8					0.8415				
EF9					0.8538				
TTF1						0.784			
TTF2						0.8583			
TTF3						0.8712			
TTF4						0.7669			
TTF5						0.7768			
TTF6						0.8056			
TTF7						0.7856			
TTF8						0.827			
TTF9						0.7486			
TTF10						0.8284			
RF1							0.7336		
RF2							0.5795		
RF3							0.5716		
RF4							0.6399		
RF5							0.7876		
RF6							0.7578		
RF7							0.8254		
RF8							0.8786		
RF9							0.6844		
RF10							0.5606		
RF11							0.7834		
SCF1								0.986	
SCF2								0.8044	
SCF3								0.6415	
SCF4								0.7372	
SCF5								0.6583	
SCF6								0.6247	
SCF7								0.5219	

Appendix V: Path Coefficients-Direct Effects (Structural Model)

Independent variable	Dependent variable						
	AA	IRF	FCF	EF	TTF	SCF	GCF
EA	0.2757	0.7851	0.387	0.4182	0.2747	0.4933	0.3854
AA			0.1588				-0.3457
IRF	0.6823						-0.1046
FCF							0.1789
EF							-0.6313
TTF							0.2748
RF			0.4145	0.5635	0.702		0.3863
SCF							-0.1638

Appendix VI: Path Coefficients-Total Effects (Structural Model)

	Dependent variable

Independent variable	AA	IRF	FCF	EF	TTF	SCF	GCF
EA	0.8113	0.7851	0.5158	0.4182	0.2747	0.4933	-0.1542
AA			0.1588				-0.3173
IRF	0.6823		0.1083				-0.321
FCF							0.1789
EF							-0.6313
TTF							0.2748
RF			0.4145	0.5635	0.702		0.2977
SCF							-0.1638

Appendix VII: Path Coefficients-Indirect Effects (Structural Model)

Independent variable	Dependent variable						
	AA	IRF	FCF	EF	TTF	SCF	GCF
EA	0.5356		0.1288				-0.5396
AA							0.0284
IRF			0.1083				-0.2165
FCF							
EF							
TTF							
RF							-0.0887
SCF							

Appendix VIII: Path Coefficients-Effect Overview (Structural Model)

Effect	Beta	Indirect effects	Total effect	Cohen's f^2
EA -> AA	0.2757	0.5356	0.8113	0.1787
EA -> IRF	0.7851		0.7851	1.6065
EA -> FCF	0.387	0.1288	0.5158	0.2177
EA -> EF	0.4182		0.4182	0.5024
EA -> TTF	0.2747		0.2747	0.2404
EA -> SCF	0.4933		0.4933	0.3216
EA -> GCF	0.3854	-0.5396	-0.1542	0.0332
AA -> FCF	0.1588		0.1588	0.017
AA -> GCF	-0.3457	0.0284	-0.3173	0.0116
IRF -> AA	0.6823		0.6823	1.0944
IRF -> FCF		0.1083	0.1083	
IRF -> GCF	-0.1046	-0.2165	-0.321	0.0009
FCF -> GCF	0.1789		0.1789	0.0044
EF -> GCF	-0.6313		-0.6313	0.042
TTF -> GCF	0.2748		0.2748	0.009
RF -> FCF	0.4145		0.4145	0.1944
RF -> EF	0.5635		0.5635	0.912
RF -> TTF	0.702		0.702	1.5708
RF -> GCF	0.3863	-0.0887	0.2977	0.0193
SCF -> GCF	-0.1638		-0.1638	0.011