



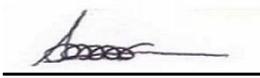
VILNIAUS UNIVERSITETO  
VERSLO MOKYKLA

**INTERNATIONAL PROJECT MANAGEMENT**

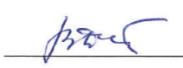
*Azim Chowdhury*

**THE FINAL MASTER'S THESIS**

<b>TVARUMAS PROJEKTŲ VALDYME: ŽALIOJO PROJEKTŲ VALDYMO SISTEMA</b>	<b>SUSTAINABILITY IN PROJECT MANAGEMENT: A FRAMEWORK FOR GREEN PROJECT MANAGEMENT</b>
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Name, surname, academic title,  
scientific degree of the supervisor

Vilnius, 2025

## **SUMMARY**

### **VILNIUS UNIVERSITY BUSINESS SCHOOL**

#### **SUSTAINABILITY IN PROJECT MANAGEMENT: A FRAMEWORK FOR GREEN PROJECT MANAGEMENT**

Supervisor of MA thesis - assoc. prof. Danguolė Oželienė.

Thesis writing MA thesis - in 2025, Vilnius.

Scope of MA thesis - 78 pages

Tables in MA thesis - 18 pcs.

Page count in MA thesis -2 pages.

Number of Literature and sources - 60 items.

This master thesis aims at developing and empirically establishing an elaborate model of application of Green Project Management (GPM) techniques in a bid to incorporate environmental, social, and economic sustainability in the management of construction projects in Bangladesh.

**Key research Methodology:** The study is based on a quantitative research design. The construction professionals, who were targeted by the use of structured questionnaires to collect primary data, included project managers, engineers, architects, and sustainability officers. The data were analyzed using a Partial Least Squares Structural Equation Modelling (PLS-SEM) using the MS Excel and SmartPLS software.

The thesis is divided in 3 major sections: Chapter one will give a theoretical foundation on a sustainable project management based on Triple Bottom Line views, literature analysis, models, frameworks, and findings of the case study on sustainability in the construction industry. The second chapter explains the research methodology and it consists of the research design, conceptual framework, methods of data collection, measurement of variables, and the methods of analysis. The third chapter presents and explains the results of the analysis, empirical, and recommendations on how sustainable integration can be enhanced in the Bangladesh construction project management practices. More so, the paper shows that Green Project Management is relevant in the mediation effect between the sustainability and

the project success, which means that sustainability initiatives generate more successful outcomes of project implementation where they are systematically incorporated in project planning, performance processes, monitoring, and controlling. According to the report, these barriers are the primary ones; they include high costs of implementation, inadequate technological capacity, lack of institutional enforcement, and ignorance among small contractors. The paper goes on to posit that sustainability needs to be incorporated in the construction project management so that long term project success, climate resilience, and equitable development of Bangladesh can be realized. The results of this study are still in print.

**SANTRAUKA**

**VILNIAUS UNIVERSITETO VERSLO MOKYKLA**

**TVARUMAS PROJEKTŲ VALDYME: ŽALIOJO PROJEKTŲ VALDYMO SISTEMA**

Magistro darbo vadovas - assoc. prof. Danguolė Ozelienė.

Magistro darbo rašymas - 2025 m., Vilnius.

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Puslapių skaičius magistro darbe - 2 puslapiai.

Literatūros ir šaltinių skaičius - 60 pavadinimų.

Šio magistro darbo tikslas – sukurti ir empiriškai nustatyti išsamų žaliųjų projektų valdymo (ŽPVV) metodų taikymo modelį, siekiant integruoti aplinkosauginį, socialinį ir ekonominį tvarumą į statybos projektų valdymą Bangladeše.

Pagrindinė tyrimo metodologija: tyrimas pagrįstas kiekybiniu tyrimo dizainu. Statybos specialistai, kuriems buvo naudojami struktūrizuoti klausimynai pirminiams duomenims rinkti, apėmė projektų vadovus, inžinierius, architektus ir tvarumo pareigūnus. Duomenys buvo analizuojami naudojant dalinį mažiausių kvadratų struktūrinį lygčių modeliavimą (PLS-SEM), naudojant MS Excel ir SmartPLS programinę įrangą.

Darbas suskirstytas į 3 pagrindines dalis: pirmame skyriuje pateikiamas teorinis tvaraus projektų valdymo pagrindas, pagrįstas trijų rodiklių požūriais, literatūros analize, modeliais, sistemomis ir tvarumo statybų pramonėje atvejo tyrimo išvadomis. Antrame skyriuje paaiškinama tyrimo metodologija, kurią sudaro tyrimo planas, konceptualus pagrindas, duomenų rinkimo metodai, kintamųjų matavimas ir analizės metodai. Trečiame skyriuje pateikiami ir paaiškinami analizės rezultatai, empiriniai tyrimai ir rekomendacijos, kaip galima sustiprinti tvarų integravimą Bangladešo statybos projektų valdymo praktikoje. Be to, straipsnyje parodoma, kad žaliojo projektų valdymas yra svarbus tarpininkaujant tarp tvarumo ir projekto sėkmės, o tai reiškia, kad tvarumo iniciatyvos duoda sėkmingesnių projekto įgyvendinimo rezultatų, kai jos sistemingai įtraukiamos į projekto planavimą, vykdymo procesus, stebėseną ir kontrolę. Tyrimo rezultatai leidžia teigti, kad šios kliūtys yra pagrindinės; tai didelės įgyvendinimo išlaidos, nepakankami technologiniai pajėgumai, institucinio vykdymo stoka ir mažų rangovų neišmanymas. Straipsnyje toliau teigiama, kad tvarumas turi

būti įtrauktas į statybos projektų valdymą, kad būtų galima pasiekti ilgalaikę projekto sėkmę, atsparumą klimato kaitai ir teisingą Bangladešo vystymąsi. Šio tyrimo rezultatai gali būti publikuojami.

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## **LIST OF ABBREVIATIONS**

AI – Artificial Intelligence

BIM – Building Information Modelling

BNBC – Bangladesh National Building Code

COP26 – 26th Conference of the Parties

CSR – Corporate Social Responsibility

EDGE – Excellence in Design for Greater Efficiencies

EGV – Earned Green Value

EIA – Environmental Impact Assessment

EVM – Earned Value Management

GDP – Gross Domestic Product

GPM – Green Project Management

IRSF – Integrated Risk–Sustainability Framework

ISO – International Organization for Standardization

IoT – Internet of Things

LCA – Life Cycle Assessment

LDC – Least Developed Country

LEED – Leadership in Energy and Environmental Design

NGO – Non-Governmental Organization

PLS-SEM – Partial Least Squares Structural Equation Modelling

PPP – Public–Private Partnership

RMG – Ready-Made Garments

SDG – Sustainable Development Goal

SEA – Socioeconomic and Environmental Assessment

SPM – Sustainable Project Management

TBL – Triple Bottom Line

UN – United Nations

UNSDGs – United Nations Sustainable Development Goals

## INTRODUCTION

**Relevance of the Study.** The research is relevant as it fills the gap in the need to integrate sustainability into the project management, especially in the capital heavy industries such as the construction industry. The traditional project management has long been focused on the Iron Triangle of cost, scope, and time. Despite its value, it never takes social justice, long-term economic sustainability, or climatic resilience into account (Richard, 2024; Štok, 2025). By embracing the triple bottom line of environmental, social, and economic goals, sustainability-driven programs, on the other hand, move success from short-term interventions (Elkington, 1997; Armenia, 2019).

Bangladesh will face ever-increasing social injustice, vulnerability to climate change, and urbanization because of this relevance. The built environment is the largest driver of environmental degradation and over-exploitation of resources. The absence of a comprehensive framework to embrace sustainability in all phases of the project development life cycle (Hossain, 2023; Chowdhury, 2018). Environmental compliance or green developments detached from economic and social costs has become the de facto current practices (Shahriar, 2022; Banaduc, 2022). Disjointed thinking prevents long-term value creation.

By incorporating sustainability concepts into the phases of initiation, planning, execution, monitoring, and closure, this prospective framework closes the gap. It is necessary not only to increase corporate benefits but also to distinguish corporate benefits from those of other stakeholders that have become relevant to global development goals, such as the Sustainable Development Goals of the United Nations, which are permeating governance, industry standards, and stakeholder expectations (Khalifeh, 2025; Ahmadu, 2025).

Many stakeholders can benefit from this research. Its recommendations can be used by policymakers to enhance the capability and regulatory framework. Practitioners receive practical advice on how to apply Sustainable Project Management (SPM) and Green Project Management (GPM) to become more resilient, egalitarian, and efficient (Ajayi, 2025; Richard, 2024). Adopting sustainability reduces environmental impacts for businesses while increasing their long-term legitimacy and economic competitiveness (Rahman, 2022; Banaduc, 2022).

By making theory practical, this research contribution offers a Bangladesh manual on sustainable project management and has implications for academic research as well as practical development.

**Research Question:** How can a broad framework be established to provide systematic inclusion of environment, society, and economy factors in all phases of project management in Bangladeshi construction projects to balance dispersed approaches and neglect of long-term effects?

**Research Aim:** To develop a straightforward and all-encompassing conceptual framework for sustainable project management by integrating environmental, social, and economic sustainability principles throughout the project life cycle in order to support appropriate decision-making and the long-term sustainability of any project.

**Research Objectives:**

1. To examine ways in which sustainability concepts may be used in every phase of the process of managing projects.
2. To elaborate innovative techniques and best practices regarding sustainable management of green projects successfully.
3. To consider stakeholders, resources, and technology in the pursuit of sustainable project success.
4. To form a framework to include sustainability in project planning, carrying out, and running.
5. To recommend to organizations how to maximize sustainability performance in project management.

**Methods applied in the Thesis.** The study uses a quantitative approach to investigate how environmental, social, and economic sustainability affects project success in Bangladeshi construction enterprises using the Green Project Management (GPM) concept. Additionally, questionnaires were designed to collect data. To guarantee that the responders experienced the intended experience, random sampling was used. Partial Least Squares Structural Equation Modelling (PLS-SEM) was used to identify the data in order to assess the validity, reliability, and presumed relationships. By strengthening the link between the practice and the construction sustainability theory, the methodology offers factual proof of how the sustainability philosophy may be methodically integrated into project management.

**Structure of the Thesis.** The thesis has three chapters. The former, Theoretical Framework of Sustainable Project Management: A Triple Bottom Line Perspective is an in-depth literature review elucidating the research problem and illustrating why project management and sustainability should be combined. It defines the conceptual model, the research gap, and significant theories, models, and case studies. The second is “Research Methodology,” which outlines the quantitative study design, survey data collecting, and data analysis using PLS-SEM. The final section, “Research Results,” presents and explains the findings, looks at hypotheses, and offers recommendations for improving Bangladeshi construction project management's incorporation of sustainability.

**Use of Artificial Intelligence Tools.** Artificial intelligence tools had applied in a small and assistive format when preparing this thesis. The language refinement was done with the help of AI-based tools (e.g., ChatGPT), which helped the writer to make the text clearer and more professional, arrange ideas, and structure the text. They did not involve the use of the tools to create original research data, analyze the results, and write the core academic content on their own. The author did all the theoretical development, data collection, data analysis and conclusions.

# 1. SUSTAINABLE PROJECT MANAGEMENT THEORETICAL FRAMEWORK: A TRIPLE BOTTOM LINE VIEW

## 1.1. Sustainability in Project Management: Conceptual Underpinnings and Development

Due to concerns from throughout the world over social inequality, ecological destruction of biodiversity, and global warming, sustainability is increasingly taking centre stage in project management. The “Iron Triangle” of cost, time, and scope, which has historically defined traditional project management, is no longer sufficient to handle such interwoven difficulties (Štok, 2025). To achieve these goals, two competing methods—Green Project Management (GPM) and Sustainable Project Management (SPM)—have surfaced in the literature.

GPM is focused on reducing environmental footprints by eco-efficiency, conservation, and low-carbon activities (Richard, 2024). It is commonly applied to the extraction industries such as manufacturing and construction, where sustainable resource use, energy-efficient technologies, and waste reduction are business-as-usual (M. R. I. Chowdhury, 2018). Due to its propensity to ignore broader social and economic facets of sustainability, critics believe that GPM's goals are too limited (Banaduc, 2022).

On the other hand, SPM integrates the triple bottom line, which unifies economic, social, and environmental goals in all facets of project management (Armenia, 2019). This follows the more stated “People, Planet, Profit” strategy of Elkington, which focuses on long-term social, financial, and environmental benefits. To illustrate, an infrastructure development led by SPM would not only be emission-reducing, but also economically viable, fair, and just (Khalifeh, 2025). Scholars recognize that in all things green, these measures are being undertaken to be green but not all green endeavors are sustainable as environmental efficiency without economic viability or social justice is lacking (Shahriar, 2022; Khalifeh, 2025).

While green project management (GPM) is concerned with short-term compliance, strategic program management (SPM) is concerned with long-term planned integration (Hossain 2023). The shift is anchored on Sustainable Development Goals (SDGs) thus making sustainability a strategic priority of the organization (Richard, 2024; Ahmadu, 2025). Though increasing, frameworks are differentiated and nuanced, particularly in developing countries where institutional and governance barriers dominate (Hossain, 2023; Ghafari, 2025).

SPM and GPM are similar but different. GPM encourages responsible environment care, whilst SPM fosters overall business sustainability with the triple bottom line. The thesis in this paper sees the SPM as its broad framework and situates the GPM as another useful model but one that is incomplete. This concern is particularly based on the high-speed development experience of Bangladesh as well as its climate exposure and socio-economic threats.

Throughout time, project managers have slowly but surely become more sensitive to the environment and socio-economic aspects. And in the latest phase, which began a few years ago, there was a lot of focus on actually changing the organizations, transforming them into sustainable ones. In the 20th century, there was a first wave that focused on eco-efficiency. In the latter part of the 20th century, factory pollution and global warming became a cause. During this period, the application of sustainability was essentially reducing the use of resources, waste, and pollution standards (Udodiugwu, 2025). Initiatives, like those in the construction and energy sectors, were upgrades that saved costs and ensured compliance, not any kind of sustainability front-runner (Ajayi, 2025). Although the Leadership in Energy and Environmental Design (LEED) program and Bangladesh's eco-friendly building rules improved energy performance and water management, their attention to social and economic issues has remained restricted (Chowdhury, 2018).

The second wave follows Elkington's (1997) triple bottom line (TBL) to understand sustainability, and encompasses economic performance, social justice and environmental goals. The project management used at this level recognized that projects impact the environment, community, and economy. According to Armenia in 2019, there were some major Characteristics like- Lifecycle costing, stakeholder involvement, corporate responsibility. For example, Indonesia's Readymade Garments (RMG) sector began taking up workers' safety and rights in addition to environmental standards (Khalifeh, 2025). The project successfully connected project management with Corporate Social Responsibility (CSR) and the United Nations Sustainable Development Goals (UNSDGs), despite the difficulties in the present wave.

The Non-Government Organization (NGO) world has adopted the third wave as a strategic and institutional entanglement of sustainability. In this case, sustainability is locked into governance, business models and stakeholder networks. Development projects are necessary to carry out global initiatives such as the Sustainable

Development Goals (SDGs) and the Paris Climate Accord (Hossain, 2023). At present, the RMG sector in Bangladesh is facing buyer-driven pressure and government initiatives for green supply chain (Habib, 2025). This phase sees a shift from interventions in a single project to changes in system with cross-sectoral collaboration, institutional change, and capacity development.

Taken together, the three waves describe how sustainability has been transformed from compliance with the environment to governance enabling complete systems for sustainable development in vulnerable environments as in Bangladesh.

## **1.2. Comprehending Green and Sustainable Project Management (GPM and SPM) and Including Sustainability in Project Management**

Two novel ideas that are currently impacting development policy are green project management and sustainable project management. Both presumes the harmonization between environmental sustainability, economic viability, and social justice, which are otherwise regarded as pillars of sustainability. There is a difference between similarity and interchange of words. Their application is particularly pertinent to developing countries like Bangladesh. Moreover, Urbanization, Industrialization, and Climate Vulnerability Exposures need such applications.

Green projects focus on sustainable use of resources and human well-being. Ajayi (2025) states that they use sustainable environment practice from the planning phase to finishing phase in all the activities to avoid any damage to the environment, claim low carbon footprint and high usage of renewable as well. Green projects not only save the world or conserves the environment but also meet human basic needs (Shahriar and Shahriar, 2023). In the case of construction and shelter, sustainability assures durability in the long run.

According to Ghafari and Samaei (2025), a great number of green projects is required for megacities which are urbanized and polluted. Projects must exceed regulatory minimums to create livable and sustainable urban systems using clean transport, green infrastructure, and renewable energy sources. These initiatives improve air quality, boost biodiversity, and create a healthier urban climate. Heinbach conceived the Earned Green Value model in 2017, which helps measure sustainability of projects. It measures environmental benefit in addition to the classic cost, time, and scope

drivers so that managers can quantify sustainability performance objectively. This is a big step towards implementing ecological responsibility in project management.

However, Masum and Training (2024) note that, in Least-Developed Countries (LDCs), institutional deficiencies and lack of skills undermines the efficient management of green projects. In the same fashion, Kader and Ullah (2020) contend that political interference and poor funding as well as corruption make them sluggish or bring to a halt. Despite these people in 2019's limitations, the gain in terms of resource conservation, pollution reduction or public health has no limit and therefore green projects are essential for the success of SDGs.

Anwara (2025) warns that adopting an environmental measure without considering its economic and social impacts will lead to inequality and economic burden. The Bangladeshi clothing industry is an example of how using renewable energy along with wastewater treatment and energy-efficient machines can achieve sustained balance. Through such methods, competitiveness is maintained without harming the environment. Pantaloni et al. (2025) similarly envision care of the olive grove in Ancona as a model of nature-heritage convergence. Sustainability means connecting ecological ideas, economic imperatives and cultural practices for a better future of humankind.

Green project management (GPM) and sustainable project management (SPM) are two related paradigms that have emerged because of interest in environmental degradation. While SPM and GPM are similar ideas, their applications differ. SPM goes beyond GPM's emphasis on enhancing environmental performance. Throughout the course of the project, it considers not only the environmental effects but also the social and economic ones. By conserving energy, cutting waste, preventing pollution, and according to the law, GPM aims to lessen its effects on the environment.

According to Cut Yusnar (2025), directives from standards such as ISO 14001 and LEED are the basis for the application of GPM. GPM for the construction sector of Bangladesh promotes renewable materials, energy-efficient design, and proper waste management. Its widespread usage is, however, stopped short. According to Chowdhury (2018), high compliance costs, weak enforcement and limited technical know-how are major barriers. Banaduc (2022) adds to that already existing understanding that the green focus of GPM never focuses on social and economic elements thus failing to work toward developing a totally holistic strategy for

sustainability. Ecological, social, and economic sustainability are all part of the triple bottom line approach. For project management, this is typical (Muppala, 2025).

It includes long-term monitoring of the environmental, social, and financial performance using lifecycle costing and EGV, amongst others (Griep, 2025). SPM places not just environmental sustainability but also social inclusion, ethical employment, and financial strength. A Socioeconomic and Environmental Assessment (SEA) is crucial for Bangladesh. This is because it impacts the alignment of projects with wider national goals. These goals include poverty alleviation, climate resilience and so on. According to Hossain (2023), SPM is considered the most effective tool for Bangladesh because of its very rapid urbanization and extreme vulnerability to climate hazard exposure. It makes national plans SDG-compliant.

This ensures that infrastructure, housing, and industrial development are geared to world sustainability and the needs of citizens. Because SPM is combining economic and social considerations, sustainability is changing from a green imperative to a development agenda. Even though the details differ a little, GPM and SPM are complementary systems. GPM takes care of the environmental basis while SPM ensures the economic and social basis. Integrating GPM within an inclusive SPM system will ensure that green projects also enjoy the returns of equity, resilience, and profit. According to Khalifeh (2025), this hybrid can help to ensure the equitable development of Bangladesh's building and construction industry economy for establishing green but financially viable cities.

Such convergence takes manifestation in green-oriented projects decarbonization and use of renewable energy becoming inclusive sustainable projects that include the well-being of the employees, their affordability and long-term sustainability of the economics. The project management practice is being transformed to be more environmental, socially acceptable and economically viable. Sustainable project management and green project management are two similar directions to sustainable development. Green projects are eco-friendly and they strive to become energy efficient and well resource using. SPM is beneficial to the environment, but it also integrates the ethical, social, and economic interests. They collectively have an overall model of sustainable development. Bangladesh is encountering severe exposure to environmental and urbanization crisis. The use of GPM and SPM can help to redefine project management as a tool of national resilience. Bangladesh can grow in accordance to the SDGs through the combination of environmental sustainability,

economic viability, and social justice. Also, although GPM guarantees that the projects they honor and respect natural environment, SPM guarantees that communities and economic growth are also maintained. The combined synthesis of these two methods therefore represents the future of project management. In the future, every project will not only achieve its performance goals but also make a constructive contribution to more sustainable project management. Organizational construction project management is based on the project life cycle, which includes planning, initiating, carrying out, monitoring, and closure.

Historically, it has focused on scope, cost, and time. Increasingly, however, it faces demands for sustainability. In Bangladesh urbanization, climate exposure and social inequality make this particularly pressing (Kadir, 2023). Sustainability, if integrated through all processes and the supply chain, will yield the necessary dividends.

At the start of any project, the feasibility study, the project charter ensures sustainability. In Bangladesh for example, where uncontrolled growth causes flooding and strains infrastructure, Environmental Impact Assessments (EIAs) reveal environmental risks (Ali, 2024). Stakeholder consultations at this level help avoid legal controversy or resistance over displacement, health, and equity issues (Shahriar, 2022).

Planning is when promises become design, buying and risk management promise. The focus of sustainable procurement to limit carbon footprints, on the other hand, is on low-carbon cement, certified products, and local suppliers (Stokke, 2022). Lifecycle costing urges not to focus on short term cost reduction but long-term sustainability. Disruptions arising from climate disasters like cyclones and floods, as well as labor disturbances need to be included in risks management as evident from the Rana Plaza incident (Mechler, 2025; Sameh, 2024).

Sustainability pledges become a reality during implementation through green building methods, renewable sources of energy, water efficiency, and tight workers' conditions (Khan, 2025). Modern technology such as digital twins and Industry 5.0 automation enhance performance but need to be complimented with capacity building and leadership as they are faced with budget and technical challenges (Sadiq, 2025). The monitoring phase goes beyond time and cost to track social and environmental effects. Such measures as Earned Green Value (EGV) (Rahman, 2023), electronic dashboards, and stakeholder reports are more open (Richard, 2024).

Lastly, closure propagates sustainability by extending it through the rehabilitation of the site, post-project audit, and assessment by the community, so that lessons are shifted to subsequent projects (Thounaojam et al., 2025). Life cycle integrated sustainability facilitates construction projects in Bangladesh to provide infrastructure with a stress on resilience, equity, and climate-resilient urbanization.

### **1.3. Sustainable Project Management Success Criteria and Influencing Factors**

The coherence of leadership, policy, and resources today determines how project management may grow sustainably. These three drivers will determine whether sustainability initiatives remain lofty rhetoric or are to be realized in the form of measurable action.

Leadership is a motivation force, a reflection of culture and operating choice in the organization. According to Ajayi (2025), wise leadership injects ecological sensitivity and social obligation into decision making to balance the short-term limitations of project delivery with the sustainable gains in the social and environmental sphere in the long run. Smart leadership doesn't just restrict the application of sustainable technology (installation of solar panels or low-carbon materials which leads to a continuous cycle of improvement of sustainability on site). According to managers Shahriar (2022) and Hossain (2023), sustainability performance can be tracked in the project by managers using sustainability tools, such as Earned Green Value (EGV) and Life Cycle Assessment (LCA). The policies become the basis of incorporating sustainability at all the project life cycle processes, procurement and planning, as well as the implementation and monitoring processes. Good policies will ensure that there is a systematic assessment of economic, social and environmental aspects at every stage of the project.

In Bangladesh, the Environmental Impact Assessments are a legal provision in large projects. A study, however, by Anwara in 2025 shows that their selective and patchy application has not yielded much in terms of tangible sustainability benefits. The trend of regulatory institutions at the international level in terms of sustainability is taking shape at the international levels as in carbon pricing, clean energy policies and international climate agreements such as 26th Conference of the Parties (COP26) agreements. The institutes are held responsible by the policies. They demand

organizations to go out to cleaner alternatives. This is achieved by connecting the environmental performance and economic prosperity. Policy and leadership cannot endure without finance, human resources and technical capacities. It will require enough investment in the implementation of green materials and technologies and environmental monitoring systems.

This can involve experts to compare sustainability data, perform lifecycle analysis and provide adequate management of environmental performance indicators. The transparency and efficiency of sustainable project management through remote sensing, real-time monitoring of carbon, etc, can be realized with the assistance of BIM and new generation tools. But wherever working with the Bangladesh case, the resource limit would spoil all this. Finances, technical capabilities, and infrastructure shortage tend to overpower policy will and leadership commitment, and implementation gaps fall out. The ultimate attainment of sustainability in project management requires a coordinated strategy in which resources define enablers, policy defines the framework, and leadership defines the vision. Sustainability will continue to be an ideal requirement rather than a practical reality in the absence of such congruence. In Bangladesh, the green projects have been met with sheer challenges in the shape of poor planning, ineffective procurement mechanisms and poor risk management capability (Shahriar & Shahriar, 2024).

Sustainability elements in planning reduce delays and cost overruns by far, surprisingly so in the case of climate-responsiveness projects such as urban megaprojects. Also, inclusion of the broader public—as Anwara (2025) was certain—makes the projects socially responsible and minimum risk for local resistance. It also ensures equal distribution of resources.

The “iron triangle” of cost, time, and quality was traditionally used to determine success, with a focus on efficiency and delivery. By emphasizing the performance characteristics of social, environmental, and economic performance, the well-known traditional theory was forced to embrace the era of sustainable development. Integration from the very, very beginning is now no longer an option but an imperative, according to Ali and Sameh (2024). The inclusion early enough by the green designs, the life cycle assessments, and the sustainable procurements makes streamlined not only the environmental performance but also prevents the big minefields like the regulatory non-compliance, the supply chain disruptions, and the societal backlash. The incorporation by the energy efficiency, resilience in the very long term, and

stakeholders' trust are good indicators toward the final project success under the conditions. It is during the planning phase that sustainability goals are set by lifecycle costing and stakeholder engagement—two processes that broker the social with the technical in every project (Amin et al., 2025). By embracing the industry partners, regulators, as well as the surrounding societies, during the initial planning process, the project heads will be able to foresee the potential environmental/environmental or societal rows by designing inclusive solutions. The lifecycle costing, however, makes the economic decisions consider the environment cost factors, such as the carbon disposals as well as the wastes, instead of the short-term economic gain only. The process generates an overall equilibrium between the cost-effectiveness alongside the sustainability.

Technological revolution is disruptive during the implementation stage. The technologies like Internet of Things (IoT), blockchain, and smart manufacturing technologies allow the organizations to maximize energy consumption, minimize wastages, and provide transparent supply chain. The technologies give the data in the real time, so decisions are well informed, sustainability ambitions are achieved without loss of efficiency in the operations. The measurement tools—like the Earned Green Value (EGV) and performance dashboards by the real time—enable the project managers to track the emissions, the consumption of resources, the stakes by the stakeholders intermittently (Obiuto et al., 2024). In Bangladesh, the green projects have been confronted with daunting challenges in the guise of inadequate planning, inefficient procedures in procurement along with weak capacity in risk management (Shahriar & Shahriar, 2024).

It considerably reduces delays and cost overruns if sustainability factors are incorporated in planning (more so for climate-responsiveness projects like urban megaprojects). Anwara (2025) believes that adding the public makes social responsibility projects and resistance from local people minimal risk. It also ensures equitable allocation of resources. In addition to completion, sustainable success is also assessed by their end-of-closure performance by the carbon footprints minimized, resources divided fairly, and provision made to sustained economic development. Today's metrics for their evaluation consider SDG compliance, eco-friendly buildings like LEED, conservation of biodiversity, as well as business model resilience (Rahman et al., 2022; Pantaloni et al., 2025). Success is also determined for the case of Bangladesh based on environmental policy compliance alongside institutional

performance (Hossain et al., 2023). Lastly, sustainable project management re-designs success by achieving sustained balance between people, planet, as well as prosperity. It also re-defines the paradigm from temporary delivery to the long-term creation of value by ensuring that projects add substantive value to the preservation of the environment, societal justice, as well as economic resilience.

#### **1.4. Aspects of Sustainability in the Building Industry**

One of the most resource-intensive sectors in the world, the building industry shapes the environment, society, and economy. While it provides the long-awaited infrastructure, shelter, and industrial facilities, it also consumes gigantic amounts of resources and produces massive waste and emissions (Zhao & Liu, 2025). In Bangladesh, the sector is both problem and promise: it supports urbanization and employment, but entails inequality, pollution, and inefficiency (Junayed, 2025). Sustainability in the sector ought to be a balance of economic, social, and environmental factors.

##### **1.4.1. Environmental Dimension**

Nearly 40% of global energy-related emissions are produced by the construction industry, mostly because of on-site energy use, material transportation, and cement manufacture. Land degradation, water pollution, and biodiversity loss are accelerated by Bangladesh's urbanization because of ineffective Environmental Impact Assessments (EIAs) (Md Nurul Kadir, 2023). Low-carbon materials, renewable energy, recycling, and energy-efficient building are in short supply, particularly for small-scale developers. Regulations must be strengthened, and eco-certification promoted. With these issues, the environmental aspect also includes encouraging resource efficiency through enhanced material design and management.

Green building involves recycling of aggregates, fly ash in concrete, and locally available low-impact renewable materials such as bamboo and jute composites. Passive solar orientation, extra insulation, and passive design techniques can also lower heating and cooling energy consumption by significant degrees. The project design must incorporate green roofs, rainwater collection, recycling waste systems so that ecological impacts are minimized. Tools of Life Cycle Assessment (LCA) can allow for quantified environmental performance during all stages of construction. As urbanization multiplies, environmental sustainability must be incorporated into

planning processes so that the cities of Bangladesh can be made sustainable, carbon footprint reduced and leached of ecological damage.

#### **1.4.2. Social Dimension**

Many workers are displaced because they are forced to flee their homes. In addition, they are exposed to dangerous work conditions. Further, they are often victims of discriminatory treatment in access to housing. The Rana Plaza disaster exposed the consequences of weak labor protection (Alam, 2025). Green construction pays utmost attention to the safety and health of workers, fair payment, and gender equity. Make infrastructure and housing developments fairer and refuse to displace people. Encouraging social responsibility during project stages helps ensure fairness and inclusive development (Md Al Amin, 2025).

Similarly, the social element helps engender communal participation and activism throughout every stage of the project. Construction must not any longer be at the cost of the poor for sustainable development. Communities participate in the planning and decision-making of development projects to enhance acceptance and reduce conflict. It also helps benefits reach the most affected. Safer jobsites and better conditions are created from increased safety training and protective gear along with more equitable employment practices. By training women for jobs in construction, providing equal pay, and an enabling work environment, gender equality can be achieved. Other elements of social sustainability include making public space accessible, providing affordable housing especially for low-income families, and building health-, safety-, and well-being-promoting infrastructures. By applying ethics and justice to project management, Bangladesh can ensure economic development goes together with social harmony and justice.

#### **1.4.3. Economic Dimension**

Construction plays a vital role in the nation's GDP. However, construction activities are marred by corruption, inefficiency, and cost-cutting. It is natural for short-term contracting to raise long-term cost. Implementation of new technology including automation and digital twins, productive improvement and lifecycle costing will all be part of the economic sustainability (Fantozzi, 2025). Construction which is integrated with SDGs supports sustainable and resilient cities.

To achieve economic resilience on a scalable basis requires investing in innovation, human resources, and technology countermeasures. Using Building Information Modelling (BIM), prefabrication and modular construction can improve productivity,

reduce waste, and improve cost certainty. Emphasis on lifecycle costing requires buildings to be placed next to one another not only on capital cost bases but also on their maintenance and operating expenses over lifecycle. Laying bare the process of purchasing goods and services can reduce corrupt practices. Moreover, encouraging local industries to form sustainable materials stimulate local value chain and lessen dependent on imported materials. Tax credits and bonds connected to sustainability are green finance vehicles that can reassure the private sector. When construction development is in line with economic sustainability, profit generation is possible without compromising.

#### **1.4.4. Interlinks and Challenges**

Sustainability depends on three things: environment, society, and economy. Environmental innovation can enhance social prosperity and economic value and vice versa. Sustainability also depends on technology. Without technology, it is hard to achieve sustainability. Wanton regulation, restricted funding and ignorance still tend to rule. (Hossain, 2023). The government, industry and civil society will have to coordinate intricately to bust these barriers so that Bangladesh's construction sector can adopt sustainability.

Based on this assumption, added value in one means added capacity in the other due to social, environmental, and economic interdependence. Utilizing eco-friendly materials lessens adverse environmental effects. It creates a lot of jobs for people working at green enterprises. It also helps to improve the local economy. Protecting workers and paying them fairly increases productivity and quality of work. Integrated sustainable development experiences significant obstacles such as poor institutional arrangement, technical lack, and poor coordination of the government institutions. Green technology is expensive and thus cannot be adopted by small and medium-sized contractors. Public unawareness is one of the obstacles that prevent a change of attitude. The multi-stakeholder approach is crucial in the struggle of these challenges.

Government agencies should be subject to much more stringent regulations safeguarding the environment and giving incentives. The trade associations should contribute towards the eco-certification like the Excellence in Design in Greater Efficiencies (EDGE) or Leadership in Energy and Environment Design (LEED). Sustainability in architectural and engineering programs should be incorporated in technical schools/ colleges. A partnership between the government and business is

required to spur system changes using innovation and investments. The implementation of sustainability principles in the planning and up to the demolition of the construction value-chain will transform the industry in Bangladesh into one that will enable national development and climate ambitions: facilitating resilience, inclusiveness and low-carbon development

### **1.5. Sustainable Project Management Frameworks and Models**

Elkington came up with the Triple Bottom Line (TBL) in 1997, and it introduces projects with the challenge of integrating sustainability. This applies the conventional parameters of cost, time, and scope to the environmental accountability, social equity, and the sustainability of the ecosystem. TBL reduces carbon footprint, buys green materials, treats the workers fairly, and makes economic activities viable in its construction activities in the building centre. It is detailed and all round making it a norm and standardized business sustainability reporting and policy development. Its application in daily project activity is however still daunting with a problem of measurement and cross cutting of stakeholder interest. Even within Bangladesh, although there are not so many such developmental projects that follow environmental regulations—e.g., emissions reduction or waste management—social inclusiveness or the fair distribution of value is less of an issue. Therefore, TBL implementation is still more symbolic in nature with lower realization at the operational level. To overcome this constraint, Earned Green Value (EGV) arrived as a wider approach that extends classical Earned Value Management (EVM) with the inclusion of sustainability performance measurement.

EGV allows project managers to measure environmental and social achievements—e.g., reduction in carbon footprint, recycling percentages, or societal impacts—alongside monetary performance (Chileshe, 2018). An expanded perspective on project success is provided by the numerical relationship between performance management and sustainability. Nonetheless, in Bangladesh, EGV implementation remains theoretical as a result of poor digital infrastructure, inefficient reliable data gathering mechanisms, and non-existent sustainability reporting mechanisms. Absence of monitoring tools and necessary competence means that the framework remains to capitalize on its potential. Scrum project management also has been

transformed to construct sustainability in construction based on flexibility, stakeholder engagement, and feedback (Ali, 2024).

Agile's cyclic nature supports frequent updating according to environmental conditions, people's attitudes, or regulatory updates, thereby supporting resilience. Changes to the design halfway through the project, for example, can happen to address unforeseen climate threats or shortages of materials. The construction industry of Bangladesh, with its cost-oriented and hierarchical culture, is a hindrance to Agile practices. The model requires transparency, trust, and empowered leadership—ingredients not typically found in conventional construction firms geared toward timelines and cost rather than flexibility. Finally, Integrated Risk–Sustainability Frameworks (IRSFs) integrate risk management and sustainability frameworks and manage environmental, social, technical, and financial risks simultaneously (Rasoul Ghafari, 2025). Bangladesh is among the countries where recurrent climate hazards, social conflicts, and governance problems impact project performance, and thus such frameworks are highly relevant. Though relevant, they are still applied irregularly owing to poor institutional capacity, decentralization, and poor awareness.

In total, though Triple Bottom Line (TBL), Earned Green Value (EGV), Agile, and Integrated Risk–Sustainability Framework (IRSF) models offer successful means of construction management being responsive to sustainability, their implementation in the Bangladeshi context is hindered by structural inefficiency, cultural resistance, and technical inadequacy. Until then, industry investment in building capacity, upgrading technology, and strengthening governance, the philosophy of sustainability cannot be implemented on a day-to-day basis.

### **1.6. Case Study Evidence in Construction Sustainability**

Case studies provide informed perspectives on how sustainability principles are being applied on building schemes currently, where this has been a success and where some kind of improvement is required. They illustrate the potential applications of theoretical models like the Triple Bottom Line or Earned Green Value, but they also point out areas where these models are lacking in real-world applications. Bangladesh evidence and overseas sources of evidence create a useful comparative model.

**Table 1***Case Study Evidence in Construction Sustainability*

Region	Project/ Case	Key Sustainability Features	Challenges	What the Case Study Shows	Why It Is Important	Source
Bangladesh	Green RMG Factories (Dhaka & Gazipur)	Attained LEED Platinum certification through renewable energy, wastewater recycling, and energy-efficient systems.	Limited replication due to high cost and lack of technical knowledge among smaller firms.	Demonstrates the feasibility of sustainable construction in developing economies when leadership and certification incentives exist.	Provides a model for integrating green construction standards into Bangladesh's industrial sector.	Sinha (2019)
	Hatirjheel Integrated Development Project (Dhaka)	Integrated flood control, transportation, and beautification with some environmental and social elements.	Weak long-term maintenance and insufficient community participation.	Shows the potential of multi-purpose urban projects but highlights the need for robust governance and sustainability monitoring.	Illustrates the importance of long-term planning and participatory management for sustainable infrastructure.	Ishayet Alam (2025)
	Purbachal New Town Project	Large-scale housing emphasizing sustainable urban	Deforestation, poor waste management, and lack of	Highlights how rapid urbanization can undermine sustainability	Serves as a warning for integrating environmental safeguards	—

		development principles.	affordable housing reduced sustainability impact.	ty when environmental and social aspects are overlooked.	and social equity in mega housing projects.	
	Padma Multipurpose Bridge Project	Mega-infrastructure project boosting national connectivity and trade.	Lacked sufficient climate resilience, displacement management, and transparent governance.	Reveals the gap between economic ambition and sustainability execution in Bangladesh.	Stresses the need to embed social and environmental accountability in large-scale national projects.	Choudhury (2023)
International	Milan Heritage Urban Regeneration (Italy)	Combined heritage conservation with sustainable design and public engagement.	Balancing modern development with historical preservation remains difficult.	Demonstrates integration of cultural and environmental sustainability in urban renewal.	Provides a blueprint for sustainable urban transformation without erasing cultural identity.	Julia Nerantzia Tzortzi (2022)
	Kibera Public Space Project (Kenya)	Developed community-led infrastructure using renewable energy, sanitation systems, and local empowerment.	Dependent on continued community involvement for maintenance.	Shows that grassroots participation can drive sustainability even in low-resource settings.	Emphasizes social sustainability and SDG alignment through community-driven development.	Emily Christley (2021)

	Masdar City (UAE)	Built as a zero-carbon city with renewable energy, sustainable mobility, and innovation hubs.	Struggles with high costs and scaling challenges.	Demonstrates the technological potential of sustainable urban design.	Offers lessons for technology-driven green urban planning in emerging economies.	Chopra (2020)
	London 2012 Olympics Infrastructure (UK)	Focused on brownfield regeneration, renewable energy, and inclusive community planning.	Managing sustainability legacy after event completion remains challenging.	Showcases a holistic integration of sustainability in large-scale event construction.	Sets a global benchmark for sustainable infrastructure and inclusive planning.	Farideh Baroghi (2024)
	Singapore's Marina Barrage	Integrated flood control, water supply, and recreation through multifunctional infrastructure.	Complex inter-agency coordination required.	Illustrates how engineering innovation can enhance environmental resilience.	Highlights the value of multifunctional design in maximizing environmental, social, and economic returns.	Baro (2022)

Source: Compiled by the author

## 1.7. Governance & Institutional Role and Emerging Trends in Sustainable Construction

### 1.7.1. Governance & Institutional Role

Governance and institutional activities play a pivotal role in incorporating sustainability in construction activities. Institutional coordination ensures Bangladeshi sustainable practices are effective since, in Bangladesh, environmental concerns and urbanization coincide. Governments determine the construction sustainability by developing regulations and laws, which private entities put into practice by investing and

designing. NGOs and community groups also impose accountability and environmental responsibility. Weak enforcement, corruption, and poor incentives, however, severely disable attainment. This part examines how all these institutions affect the sustainability of construction projects in Bangladesh and how the limitations that curtail their efficacy (Ishayet Alam, 2025).

**Institutional governance** is the cornerstone of the construction project's sustainability pathway. Sustainability can be ingrained as a fundamental element in every stage of the project's life cycle through good practices for institutions. The government, corporate sector, and non-governmental organizations all play very different roles in the construction industry when the environmental and societal footprints overlap the construction timetable (Gabriela Banaduc, 2022).

**Governments** also influence construction sustainability through the imposition of building codes, regulatory policy, and urban planning law. A survey method is adopted as the primary data collection instrument. Both the Bangladesh National Building Code (BNBC) and the Building Construction Act include provisions for safety and environmental requirements in Bangladesh, however they are typically not strictly implemented (Md Nurul Kadir, 2023). While some projects—like those sponsored by international donors—follow environmental principles to the letter, most local projects circumvent Environmental Impact Assessments (EIAs) because of corruption or poor monitoring. Public–private partnerships (PPPs) for infrastructure are also growing, offering the potential for sustainable innovation but threatening to undermine transparency and accountability (Md. Abdul Kader, 2020).

**Non-governmental organizations (NGOs) and civil society groups** are the custodians and representatives of sustainability in the construction industry. Transnational NGOs periodically bargain green norms, monitor implementation, and warn concerned communities regarding large-scale projects. NGOs have, for instance, promoted workers' safety, environmental quality, and participatory urban planning. NGO power in Bangladesh would, however, traditionally be project-oriented rather than structural because they usually lack official power in regulatory systems (Eias Al Humdan, 2024).

**Private stakeholders—builders, contractors, and financiers**—have to implement policies. Green consumer demand, international buyer requirements in the ready-made garments sector, and the green certification status icon (e.g., LEED) are further incentives for private sector embracing of sustainability standards (Amin Yasin

Khalifeh, 2025). But local contractors typically view sustainable approaches as being too costly or risky and therefore less likely to implement them (Nayeem Shahriar, 2022). Without stronger incentives or disincentives, green building continues to concentrate on banner projects, with low-scale projects being only within the sustainability agenda.

### **1.7.2. Emerging Trends in Sustainable Construction**

The construction industry is being transformed at breakneck speed with new technologies, methods, and models that redefine the ways sustainability is integrated in projects. New trends transcend environmentalism to embrace social and economic needs and provide hands-on tools for breaking down traditional barriers in the industry. Four of the most significant coming changes are digitalization, schemes of certification, climate resilience, and principles of circular economy.

The revolution of construction has opened new doors to maximize sustainability. Industry 5.0, smart sensors, and Building Information Modelling (BIM) are examples of technologies that will be used throughout the project life cycle to aid data-driven decision making. An example is the BIM which can be used in the simulation of energy use, carbon footprint, and material consumption before the construction activities are started, reducing wastage and rework (Nure Alam Khan, 2025). Digital twins and smart sensors also support tracking of on-site energy and water consumption as well as the capability to adjust in real-time to meet sustainability objectives. Though adoption in Bangladesh is presently limited by skill and cost limitations, digitalization has enormous potential to increase efficiency and reduce environmental cost. To provide empirical evidence of the effectiveness of sustainable project management techniques to enhance performance and achieve acceptable environmental and social performances within the nation's construction industry, integrative research design balances methodological sophistication with contextual suitability (Creswell, 2018; Hair, 2021; Sarstedt, 2019).

## **2. RESEARCH METHODOLOGY**

The approach employed in this study to address the research issues is described in this chapter. It provides a brief description of the topic selection and how the final thesis is completed. Lastly, this chapter introduces all the tools, methods, and techniques employed under this research to finalize the ultimate thesis.

### **2.1. Design and Methodology of Research**

#### **2.1.1. Design of Research**

To account for the relationships between the aspects of sustainability, GPM Green practices, and construction project success, it includes a quantitative study design. The quantitative design provides for systematic quantification of the variables, testing the hypotheses statistically, objective testing of casual relationship, thereby the result is repeatable, and generalizable to analogous settings (Laura J. Duckett, 2021). The approach makes it possible to systematically examine how GPM practices and sustainability principles—environmental, social, and economic—affect project performance.

Surveys are carried out among construction project key stakeholders as well as project managers for the collection of quantitative data illustrating their perception as well as adoption of sustainability-focused project management practice. The method allows for comparability as well as similarity among respondents, e.g., collection of as given set of opinions, covering diversified project dynamics as well as organizational settings (James M. Lyneis, 2007). It also provides an overview on the incorporation of sustainability aspects during planning, implementation, as well as evaluation processes employed on projects. Partial Least Squares Structural Equation Modelling (PLS-SEM) is used in data analysis study to validate the conceptual framework. When estimating complicated models with heterogeneous independent, dependent, and mediating variables, the PLS-SEM is especially useful (Marko Sarstedt, 2020). PLS-SEM can accommodate small and medium-sized samples and does not require data to meet the assumption of multivariate normality, making PLS-SEM appropriate for exploratory studies targeting developing economies such as Bangladesh (Islam, Uddin, & Rahman, 2024). Also, PLS-SEM allows analyzing the mediation effects, which is the first point of focus in determining the indirect impact of GPM practices on the project success in the context of sustainability. Integrative research design is a combination of such a methodological rigor and applicability to the context to generate empirical data that sustainable project management can be used to improve

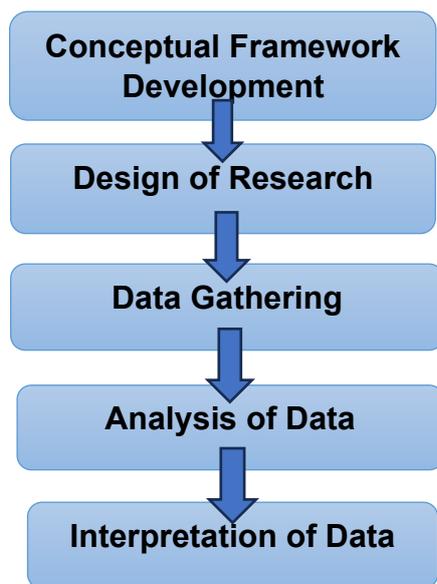
performance and attain desirable environmental and social performance in the construct industry (Creswell, 2018; Hair, 2021; Sarstedt, 2019).

### 2.1.2. Research Phases

The researchers conducted a multi-stage investigation to examine the application of sustainability in the management of construction projects in Bangladesh. The research study tried to follow a systematic structure that breaks down the quantitative variables to improve the analytic rigor since sustainability is a multidisciplinary and multi faceted. The results of the study are formulated throughout the literature review section to the results interpretation to ensure that the study findings are valid, reliable, and practical. The steps of the research phrase are presented in Figure 1 below.

**Figure 1**

*Research Phrase*



*Source:* Compiled by the author

**Phase 1: Literature Review and Development of Conceptual Framework:** The first activity was undertaking the extensive reading from case studies, reports, and research papers that have been presented across on project management and sustainability. The goal was to obtain an idea of the conceptual frameworks that make up the Triple Bottom Line (TBL), Green Project Management (GPM), and Sustainable Project Management (SPM). This reading led to the identification of research article gaps and the conceptual framework, wich included study-guiding hypotheses.

**Phase 2: Research Design and Instrument Development:** During this phase, research design was developed with the objective to arrive at the quantitative approach. Structured questionnaire was prepared for collecting data on the integration of sustainability issues by Bangladesh's construction industry.

**Phase 3: Data Collection:** Survey data were collected from construction professionals including project managers, engineers, architects, and sustainability officers by conducting purposive sampling to collect the required expertise. Questionnaires were distributed hard copy and electronically. Ethical standards, including informed consent, confidentiality, and voluntary involvement were strictly observed.

**Phase 4: Data Analysis:** PLS SEM was used to establish the measurement model construct validity and reliability, structural relationship between the sustainability dimensions, Green Project Management techniques and project success. The succession of GPM towards linking the sustainability factors and the project outcomes also subjected mediation to test.

**Phase 5: Interpretation, Conclusion, and Recommendations:** The data analysis results were interpreted in terms of theoretical framework and study goals in the final stage. The findings were contrasted with the existing knowledge to confirm the contributions of the research.

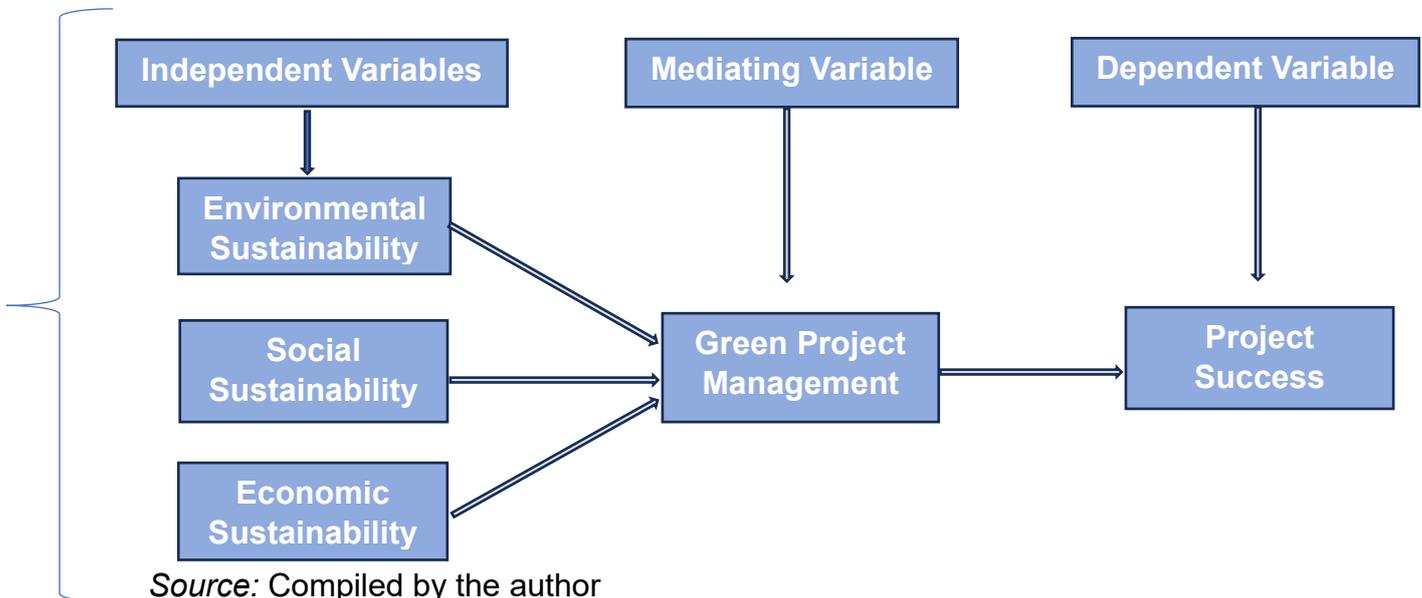
## **2.2. Conceptual Framework for the Study**

**Research Gap:** Although there are many studies on project management and sustainability, most of them are not clear about how to apply sustainability in each step of a project. Many studies focus only on one area, such as the environment or cost savings, but not the full picture. Also, there is a lack of complete frameworks that show how to manage green projects from the beginning to the end. Because of this, there is still a need to create a clear and practical guide for managing projects in a sustainable way.

To explain the relationship between sustainability factors, Green Project Management (GPM), and project success in the construction sector, this study develops a quantitative conceptual model. The Triple Bottom Line (TBL) theory and sustainability integration models that pinpoint the environment, society, and economics as the primary forces behind sustainable project performance are the foundation of the methodology.

**Figure 2**

*Conceptual Framework for Integrating Sustainability into Construction Project Management*



Environmental sustainability, social sustainability, and economic sustainability are the three independent variables in this model. The variables include long-term financing for construction projects, community well-being, and the degree of eco-efficiency implementation.

The mediating variable is chosen to be green project management (GPM). GPM is the term used to describe the integration of sustainability concepts into various project processes, such as risk management, stakeholder management, green procurement, and lifecycle costing. GPM is the central facilitator that turns sustainability concepts into measurable project results.

The measure of a project's success transcends cost, time, and scope; we can also refer to it as "project triangle" is dependent variable. This research success also includes stakeholder satisfaction, feasibility, and compliance to Sustainable Development Goals (SDGs).

According to this model it is inferred that sustainability dimensions have a positive effect on GPM which subsequently continues to influence project success. Additionally, GPM uses green project management techniques to mediate attention to evaluate the direct or indirect effects of sustainability on project success.

Partial Least Squares Structural Equation Modelling (PLS-SEM), which is suitable for complex models with latent components, mediator effects, and relatively small to medium sample sizes, was used to empirically test the suggested model. PLS-SEM enables both measurement reliability (through outer model analysis) and structural relationships (through inner model analysis) to be evaluated.

Developed hypotheses:

- **Hypothesis-1 (H1):** Adopting Green Project Management (GPM) techniques is positively impacted by the incorporation of environmental sustainability at several stages of the project life cycle (initiation, planning, execution, monitoring, and closing).
- **Hypothesis-2 (H2):** The adoption of GPM practices is positively impacted by the incorporation of social sustainability into project life cycle phases.
- **Hypothesis-3 (H3):** Adopting GPM techniques is positively impacted by including economic sustainability into project life cycle phases.
- **Hypothesis-4 (H4):** There is a great positive effect of the application of GPM techniques to project success which is not limited to scope, time and cost but to long term sustainability outcome.
- **Hypothesis-5 (H5):** The GPM techniques act as an intervening variable between the environmental, social, and economic elements of the sustainability and project success, showing the practical delivery of sustainability into construction project management.

## **2.3. Data Collection Method and Analysis Technique**

### **2.3.1. Population and Sampling**

The target population will be professionals who work on the administration of construction projects in Bangladesh including site engineers, project and architects and consultants as well as sustainability officers because they participate in the planning, decision, and execution phases. Random sampling allowed the respondents to possess adequate experience and knowledge in areas of sustainability in construction projects. Primary data was gathered through systematic Likert-scale questionnaires in field surveys to seek standardized responses from many people. Minimum sample size determination has done through power analysis based on the PLS-SEM “10 times rule” with an objective of receiving a minimum of 150 valid

responses from the survey (Huat, 2025). Interview results have employed for interpretation and findings triangulation. The minimum estimate of the necessary sample size, which is 150, would be enough given the intricacy of the study's conceptual framework. Furthermore, the sample size is a good mix of representativeness and feasibility. Therefore, the responses of project managers, engineers, architects, and sustainability officers of a number of Bangladesh construction sites were consulted. This could be taken care of within the time and resources.

### **2.3.2. Data Collection Method**

The quantitative approach would be applied in the study to understand the application of sustainability in project management building. Primary data collection in the study was carried out using an official survey questionnaire which had a five point Likert scale (1 = strongly disagree, 5 = strongly agree). This scale was borrowed out of the already tested research tools on the area of project management and sustainability that are applicable in the construction sector in Bangladesh. It provides consistency and appropriateness to statistical analysis by PLS-SEM. To support the findings, Likert-scale questions were required to engage more detailed information concerning sustainability practices and concerns. Survey triangulation brings about validity. The data collection was rigorous because the standards such as voluntary compliance, informed consent, anonymity, and confidentiality were employed.

### **2.3.3. Data Analysis Technique**

In the present study, the relationship between the dimensions of sustainability, GPM practices and project success is analyzed through a rigorous method of data analysis using SmartPLS, a set of Partial Least Squares Structural Equation Modelling (PLS-SEM) tools. This method of analysis is most effective in cases when an investigator is done on complex models with multiple latent structures. It is so because it allows one to assess both measurement validity and measurement reliability and structural correlations.

**Table 2:***Data Analysis Techniques*

<b>Stage</b>	<b>Analysis Component</b>	<b>Statistical Techniques / Indicators</b>	<b>Purpose / Expected Outcome</b>
<b>Stage-1: Measurement Model Evaluation</b>	Reliability Testing	Composite Reliability (CR) and Cronbach's Alpha	To evaluate the constructions' dependability and internal consistency.
	Convergent Validity	Extracted Average Variance (AVE)	To verify that each concept adequately accounts for the variance of its indicators.
	Discriminant Validity	Fornell-Larcker Criterion-Heterotrait-Monotrait (HTMT) Ratios	To ensure constructs are distinct from each other and measure unique dimensions.
<b>Stage-2: Structural Model Evaluation</b>	Path Coefficients & Significance	Bootstrapping (5,000 resamples)	To test hypothesized relationships between variables for significance.
	Model Explanatory Power	Coefficient of Determination ( $R^2$ )	To calculate the percentage of variance that the model can account for.
	Size of the Effect	$f^2$ Statistics	To investigate if the relationship between sustainability aspects and project success is mediated by

			Green Project Management (GPM).
	Variance Inflation Factor	Collinearity Statistics (VIF)	To estimate multicollinearity behavior between predictor constructs and to make sure that independent variables are not overly correlated and that this will bias estimates of the path coefficients.
<b>Mediation Analysis</b>	Testing Indirect Effects	Bootstrapping mediation procedure	To investigate if the relationship between sustainability aspects and project success is mediated by Green Project Management (GPM).

Source: Compiled by the author

#### 2.3.4. Overview of the Research Participants

The participants of the research were building project managers of a number of organizations in Bangladesh. Project managers, site engineers, architects, consultants, and sustainability officers with experience in planning, executing, or incorporating sustainability into construction projects were included. Respondents were purposively chosen such that respondents had proper exposure to the concerned sustainability practices of the construction industry.

Partial Least Squares Structural Equation Modelling (PLS-SEM) was used to plan 150 participants to meet statistical requirements. Most participants were consulting businesses, government infrastructure agencies, and medium-sized to large-scale construction corporations. There were five to fifteen years of professional project

management expertise, which ensured informed and practical answers. Demographic data were of a kind that the interviewees were diverse in age, education, and organizational status so that treatment of implementation view has been facilitated in a balanced manner.

**Table 3:**  
*General Data Collection of Study Participants*

<b>Category</b>	<b>Variable</b>	<b>Response Options / Measurement</b>	<b>Purpose</b>
Demographic Information	Gender	Male / Female / Prefer not to say	To understand gender representation among participants
	Age Group	20–29 / 30–39 / 40–49 / 50 and above	To identify the age distribution of respondents
	Level of Education	Bachelor’s / Master’s / PhD/ Diploma	To assess the academic qualifications of participants
Professional Background	Job Title / Position	Project Manager / Engineer / Architect / Consultant / Sustainability Officer / Other	To categorize respondents by their professional roles
	Years of Experience	Less than 5 / 5–10 / 11–15 / Over 15 years	To gauge professional experience levels
	Type of Organization	Public Sector / Private Sector / NGO / Joint Venture	To distinguish organizational backgrounds
	Size of Organization	Small (1–50 workers), Medium (51–250 workers), and Large (251+)	To understand firm size and capacity

Project Information	Type of Projects Involved	Residential / Commercial / Infrastructure / Industrial / Other	To identify the nature of projects managed
	Involvement in Sustainability Practices	Yes / No	To check exposure to sustainability-oriented projects
	Awareness of Green Project Management (GPM)	High / Moderate / Low / None	To measure familiarity with GPM principles
Additional Information	Participation in Sustainability Training	Yes / No	To determine training or certification in sustainability
	Interest in Future Sustainable Practices	High / Moderate / Low	To assess willingness to adopt sustainability in future projects

Source: The author's compilation

The participants' overall profile is likewise varied, with interviews possessing both business acumen and appropriate technical expertise, so that the study was able to give an overall picture of sustainability implementation of construction stakeholders of Bangladesh.

#### 2.4. Variable Measurement

The below table illustrates the variables and measurement items applied in this research to measure the connection among sustainability dimensions, green project management, and project success within the construction sector. A five-point Likert scale, ranging from “strongly disagree” (1) to “strongly agree” (5), is used to identify each variable. The core elements of sustainable construction practices can be

measured using independent variables related to environmental, social, and economic sustainability. The degree to which sustainability is included into project planning, execution, and monitoring is one of the mediator variables for green project management. The dependent variable, project success, evaluates the outcome in terms of stakeholder satisfaction, achievement of sustainability goals, and adherence to time and budget constraints. This ordered measurement scheme offers clarity, consistency, and reliability to study interrelationships among the main constructs of the study.

**Table 4:**  
*The Measurement of Variables*

<b>Variables</b>	<b>Items / Statements (Examples)</b>	<b>Unit of Measurement</b>
<b>Independent Variables</b>		
Environmental Sustainability	Use of eco-friendly materials	Likert Scale (1–5)
	Appropriate methods for managing garbage	Likert Scale (1–5)
	Energy-saving techniques in projects	Likert Scale (1–5)
	Reduction of carbon emissions	Likert Scale (1–5)
	Implementation of recycling initiatives	Likert Scale (1–5)
	Use of renewable energy sources	Likert Scale (1–5)
	Environmental compliance and certification	Likert Scale (1–5)
Social Sustainability	Ensuring workplace safety	Likert Scale (1–5)
	Providing fair wages to employees	Likert Scale (1–5)
	Promoting gender equality and diversity	Likert Scale (1–5)
	Supporting community welfare projects	Likert Scale (1–5)
	Employee training and capacity building	Likert Scale (1–5)

	Maintaining ethical labor practices	Likert Scale (1–5)
	Ensuring employee well-being and satisfaction	Likert Scale (1–5)
Economic Sustainability	Effective budget control	Likert Scale (1–5)
	Ensuring cost efficiency in operations	Likert Scale (1–5)
	Generating long-term economic value	Likert Scale (1–5)
	Managing financial risks effectively	Likert Scale (1–5)
	Strategic investment in innovation	Likert Scale (1–5)
	Optimizing resource allocation	Likert Scale (1–5)
	Maintaining profitability while being sustainable	Likert Scale (1–5)
<b>Mediating Variable</b>		
Green Project Management	Clearly defined sustainability objectives	Likert Scale (1–5)
	Effective risk management	Likert Scale (1–5)
	Regular monitoring and evaluation	Likert Scale (1–5)
	Efficient resource utilization	Likert Scale (1–5)
	Integration of green practices in project plans	Likert Scale (1–5)
	Stakeholder communication and reporting	Likert Scale (1–5)
	Team training on sustainable management	Likert Scale (1–5)
<b>Dependent Variable</b>		
Project Success	Stakeholder satisfaction	Likert Scale (1–5)
	Reaching sustainable goals	Likert Scale (1–5)
	Project completed on time and within budget	Likert Scale (1–5)
	High-quality project results performance	Likert Scale (1–5)
	Reaching the project's goals	Likert Scale (1–5)

	Client and community acceptance	Likert Scale (1–5)
	Long-term benefits and impact	Likert Scale (1–5)

Source: Compiled by the author

## 2.5. Limitations of the Research

All study research is afflicted by some constraints that may impact interpretation and generalizability of findings. Identification of constraints allows transparency, increases credibility for the research, and enables future avenues for enhancement. The research carried out in this study, which was focused on sustainability and success in Bangladesh’s construction industry, was also afflicted by a variety of methodological as well as contextual limitations. These include industry and geographic scope, data collection methods, sample size, study design, and resources available. The difficulty of measurement and understanding the context of some constructs like “social sustainability” and “project success” poses additional challenges. The following section outlines these broad limitations in detail to have a clearly outlined understanding of what the study includes and excludes.

- **Industry and Geographic Coverage:**

The research only allows for the construction sector in the nation of Bangladesh, so this will not automatically transfer practices from other sectors or from nations with varying regulatory, economic, or cultural conditions. Therefore, generalizability is somewhat limited.

- **Data Collection Procedure:**

The research is reliant primarily on the data from the structured questionnaires based on the principle of self-reporting. These are prone to respondents’ subjective perception, bias, or social desirability, thus the possibility of false outcomes.

- **Sample Size and Representation:**

Although the sample was large enough for statistical needs for PLS-SEM, the sample potentially did not incorporate the full diversity of construction industry stakeholders. Larger samples would have been better for representativeness as well as improved confidence in the conclusions.

- **Cross-Sectional Nature of the Study:**

Cross-Sectional Elements of the Research Work The study utilized the cross-section method, where data is captured at a single point. The approach makes it impossible to monitor the long-term success of the initiatives or the evolution of sustainable practices. A longitudinal study would have given data on changing trends alongside lasting influence.

- **Resource and Time Constraints:**

With restriction of scarce finance as well as time, the study was unable to incorporate the larger set of case studies as well as wider field studies than the current project sites. The restriction foreclosed the possibility to witness contextual variation as well as qualitative nuance.

- **Information Restrictions:**

Some such phenomena are multifaceted and vague like “project success” and “social sustainability.” Their operationalization based on the Likert scale by standardized items will lose their contextual variation alongside their qualitative nuance in project settings.

## **2.6. Timeline and Resources**

The research was conducted over an average twelve-month period, divided into the main phases to permit systematic work. The approach makes it impossible to monitor the long-term success of the initiatives or the evolution of sustainable practices. Material as well as human resources were capitalized upon by the study. The most crucial resources were the access to research journals, databases, and institutional libraries during the conduct of the review of the literature. Statistical as well as quantitative testing was conducted by the software tools Microsoft Excel as well as SmartPLS. Questionnaires were also made utilization of the material resources like communication tools, transportation, and printing. Academic supervision, peer review, as well as institutional facilities, also assisted the study so that the study is carried out successfully (Creswell, 2018; Hair J. F., 2021).

## **2.7. Ethical Considerations**

The research is largely committed to maintaining the highest standard possible of ethical considerations in all the stages of the research process. Ethical integrity is the cornerstone on which this research is established, where the rights, confidentiality, and

well-being of the respondents are all safeguarded. All participants had a description of the aims, objectives, procedures, and advantages of the study to the researcher's professional practice in sustainable project management before their recruitment. That is for the provision of transparency with the goal of assurance and voluntary participation. There was informed consent from all the individuals prior to the collection of data. The participation was voluntary, with no coercion whatsoever at any given point. The participants were also informed that they can drop out of the study at any given point without penalty nor harm. That is out of respect for the individual's autonomy and pursuant to customary ethical practice within the academic field of research. Confidentiality as well as anonymity was strictly maintained. Data derived from questionnaires was treated very sensitively, such that no identifiable information- i.e., names, positions, nor any contact information-is retained by the dataset. The outcome was reported by an aggregated level, such that the response would not be traceable by respondents. There is the sense where all the outcomes would offer group knowledge rather than opinion, with each contributor's confidentiality maintained. Further, the data was employed for research purposes only. The data were safely saved with password-protected mechanisms such that no unauthorized utilization, abuse, nor disclosure will be determined. The data would be deposited/or destroyed in an ethical manner by adhering to institutional guidelines following the conclusion of an analysis reporting. Finally, the research would also seek ethical clearance by the affected institutional review body before data collection. All responsible conduct of research guidelines, namely respect for the dignity of humankind, openness, and confidentiality of information, would be properly respected to ensure strict adherence to the regulation policy, urban planning law, and building codes. The survey approach is taken as the key data collection tool is professional as well as academic ethics. All responsible conduct of research guidelines, including respect for the dignity of humankind, openness, and confidentiality of information, will be duly honored to maintain strict adherence to professional and academic ethics (Israel, 2020) (Resnik, 2018).

### 3. RESEARCH RESULT

To ascertain the impact of environmental, social, and economic sustainability as well as Green Project Management (GPM) practices on the success of projects within the construction industry in Bangladesh, this chapter analyses and analyses the empirical findings of the research. Based on quantitative data collected using structured questionnaires and analyzed using Partial Least Squares Structural Equation Modelling (PLS-SEM), the chapter provides an overview of how sustainability principles are currently integrated into construction project management and how each dimension affects project outcomes.

Within the case of Bangladesh that is rapidly transforming into an urban city and prone to climate disasters, sustainable project management is gaining relevance as it was defined in the previous chapters. However, it is not sufficient to contribute to sustainability and ensure its successful implementation. The level of sustainability of the translation into measurable project performance is grounded in the presence of clear project life cycle practices, organizational commitment and integration. Thus, to address the issue of enhancing the overall environmental, social, and economic contribution of the construction industry, it is necessary to gain a better insight into the aspects of the sustainability that impact GPM practices and, ultimately, project success, the most. The following primary research question served as the basis for the analysis presented in this chapter:

- To balance scattered approaches and disregard for long-term repercussions, how can a comprehensive framework be built to ensure systematic incorporation of environment, society, and economic concerns in all phases of project management in Bangladeshi building projects?

By using PLS-SEM to methodically evaluate the measurement model and structural model, the chapter provides statistically validated evidence on the relationship between the sustainability constructs, GPM practices, and project outcomes. In addition to examining the study's theories, the results offer some practical proof of how sustainability may be incorporated into Bangladeshi construction project management daily.

### 3.1. Environmental Sustainability

Ten indicators that included waste reduction, energy conservation, life cycle assessment (LCA) in building projects and pollution control, and sustainable material use in construction projects were used to measure the environmental sustainability construct. There is good indication dependability because all of the indicators have satisfactory loading values between 0.714 and 0.8, which are higher than the minimal value of 0.70.

Internal consistency dependability is demonstrated by Cronbach's Alpha of 0.912, Composite dependability (CR) = 0.927, and rho A = 0.914, both of which are higher than the intended criterion of 0.70. The Average Variance Extracted (AVE) = 0.56, which indicates that the Environmental Sustainability construct accounts for more than 56% of the variance in the indicators, further supports convergent validity.

The low HTMT ratios (all the ratios are lower than 0.90) indicate that EnS (Environmental Sustainability) has a high level of correlation with Economic Sustainability (0.798) and Stakeholder and Technology Integration (0.808), which was verified by the discriminant validity assessment (Fornell-Larcker and HTMT) measurement.

Stakeholder and technology integration are not important predictors of environmental sustainability in the structural model ( $b = 0.118$ ,  $p = 0.256$ ). This suggests that even though organizations participate in environmental behaviors, the adoption of cutting-edge sustainability technologies and improved stakeholder engagement do not significantly reflect those practices. Additionally, it has a negligible indirect impact on project success ( $b = 0.065$ ,  $p = 0.282$ ). These findings show that without improved stakeholder participation and technological mechanisms, environmental practices alone do not result in project success.

**Table 5:**

*Environmental Sustainability Mean and Standard Deviation (SD)*

Item	Environmental Sustainability Dimensions	Mean	SD
EnS_1	Eco-friendly / Recyclable Materials	4.56	0.58
EnS_2	Water & Energy-Saving Technologies	4.31	0.8
EnS_3	Construction Waste Recycling	4.57	0.61
EnS_4	Pollution-Minimization Guidelines	4.66	0.54

EnS_5	Environmental Monitoring	4.47	0.64
EnS_6	Renewable Energy Use	4.69	0.54
EnS_7	Ecosystem & Biodiversity Protection	4.31	0.66
EnS_8	Green Procurement Policies	4.08	0.86
EnS_9	Environmental Training	3.95	1.05
EnS_10	Environmental Performance Reporting	4.04	0.83

### 3.2. Social Sustainability

Social Sustainability was assessed with nine items that indicated safety, fair wages, community well-being, equal opportunities, interaction with the stakeholders and inclusiveness in the workplace. Construct indicates reliability is very high as the loadings of the construct are between 0.713 and 0.882 which is much higher than the recommended level.

With Cronbach's Alpha = 0.932, Composite dependability (CR) = 0.944, and rhoA = 0.937, the construct's internal consistency is high and indicates remarkable dependability. Additionally, it is discovered that convergent validity is attained at AVE = 0.651, meaning that the construct accounts for more than 65% of the variance in the indicators.

Social Sustainability too, has good but satisfactory correlations with the other constructs--e.g., with Eco Sustainability (0.773), Environmental Sustainability (0.808), and Project Success (0.508). Each of the HTMT values is less than 0.90 and goes to validate discriminant validity.

In the structural model, Social Sustainability has a strong impact on Stakeholder and Technology Integration ( $b = 0.369$ ,  $p = 0.001$ ). This implies that stakeholder collaboration, coordination and digital tools usage in project enhancement can be enhanced by socially responsible conduct, including safety regulations, community participation, equitable working conditions, and equitable treatment.

The same can be seen in Social Sustainability which showed a significant indirect influence on Project Success, using GPM ( $b = 0.202$ ,  $p = 0.002$ ). This means that although social practices are not specifically improved to improve the project outcomes, it is effective when it is effectively executed by increasing the stakeholder engagement and integrating technology.

**Table 6:***Social Sustainability Mean and Standard Deviation (SD)*

Item	Social Sustainability Dimension	Mean	SD
SS_1	Worker Safety Training	4.47	0.67
SS_2	Safety Gear & PPE	4.19	0.81
SS_3	Fair Wages	4.17	0.85
SS_4	Drinking Water & Sanitation	4.51	0.64
SS_5	Legal Working Hours	4.45	0.63
SS_8	Teamwork & Collaboration	4.4	0.73
SS_9	Community Well-being	4.36	0.73
SS_11	Community Engagement	4.29	0.73
SS_12	Cultural Respect & Inclusivity	4.35	0.67

### 3.3. Economic Sustainability

Ten indicators that comprised of cost efficiency, life-cycle costing, value engineering, local sourcing, resource optimization, and financial risk mitigation were used to measure Economic Sustainability. The indicator loadings range 0.752 to 0.844 which indicates good measurement.

With Cronbach's Alpha = 0.929, Composite Reliability = 0.94, and rho, A = 0.932, these construct values are quite dependable. 0.612 is a confirmation of high convergent validity. The sustainability pillars of economic sustainability have high levels of correlation with environmental sustainability (0.841) and social sustainability (0.74) illustrating the interdependence of sustainability pillars in construction projects.

Economic Sustainability is the most significant ( $b = 0.47$ ,  $p < 0.001$ ) influence on Stakeholder and Technology Integration in the structural model. This is an indication that projects that are well planned financially, cost controlled and resource efficient will be in a better position to embrace the use of sustainability technologies, ease of communication between stakeholders and adopting integrated management strategies.

Additionally, the GPM construct fully mediates the strong indirect influence of EcS (Economic Sustainability) on Project Success ( $b = 0.257$ ,  $p < 0.001$ ). This means that economic sustainability practices play a significant role in ensuring that outcomes are

achieved successfully, but mostly in enhancing coordination, use of technology and performances of managers in the project environment.

**Table 7:**

*Economic Sustainability Mean and Standard Deviation*

<b>Item</b>	<b>Economic Sustainability</b>	<b>Mean</b>	<b>SD</b>
EcS_1	Life-Cycle Cost Estimation	4.2	0.78
EcS_2	Cost-Efficiency	4.32	0.71
EcS_3	Local Supplier Preference	4.1	0.83
EcS_4	Long-Term Financial Impacts	4.3	0.75
EcS_5	Sustainable Design Savings	4.17	0.78
EcS_6	Optimized Resource Allocation	4.24	0.74
EcS_7	Value Engineering	4.22	0.76
EcS_8	Long-Term Profitability	4.18	0.77
EcS_9	Management Support for Sustainability Investments	4.11	0.71
EcS_10	Financial Risk Mitigation	4.18	0.74

### **3.4. Stakeholder and Technology Integration**

Stakeholder and Technology Integration Ten indicators of digital technologies, communication systems, data analytics, open stakeholder engagement, training, and sustainability monitoring tools were used to evaluate the structural model's main component. With a range of 0.702-0.874, the indicator loadings are high, indicating good indicator dependability.

With Cronbach's Alpha = 0.93, CR = 0.941, rho A = 0.933, and AVE = 0.616—all of which are higher than the typical levels—internal consistency is good. The model has one of the best relationships between GPM and other factors. The construct's R2 is 0.788, meaning that 78.8% of the variance in GPM can be explained by environmental, social, and economic sustainability. Stakeholder and Technology Integration (GPM) is the primary mediating variable in a sustainability-performance relationship, and it is a very powerful predictive model.

Economic Sustainability is the most effective predictor of GPM ( $b = 0.47, p < 0.001$ ). Social Sustainability is the second strongest ( $b = 0.369, p = 0.001$ ). Environmental sustainability is irrelevant ( $b = 0.118, p = 0.256$ ).

These findings underline the fact that financial planning, as well as social practices, reinforce the integration of stakeholders and technological use, whereas the environmental practices do not have a significant contribution to the integration unless they are reinforced by the other two.

**Table 8:**

*Stakeholder and Technology Integration Mean and Standard Deviation*

<b>Item</b>	<b>Stakeholder and Technology Integration</b>	<b>Mean</b>	<b>SD</b>
GPM_1	Stakeholder Consultation	4.58	0.63
GPM_2	Sustainability Goal Communication	4.54	0.66
GPM_3	Use of Digital Tools	4.54	0.66
GPM_4	Environmental & Cost Tracking Software	4.55	0.63
GPM_5	Technology Training	4.63	0.62
GPM_6	Technological Innovation	4.57	0.63
GPM_7	Transparent Communication	4.2	0.84
GPM_8	Clear Sustainability Roles	4.25	0.76
GPM_9	Data Analytics / IoT Use	4.19	0.86
GPM_10	Digital Knowledge Sharing	4.13	0.81

### **3.5. Project Success Indicators**

Project Success was quantified using twelve indicators that encompassed on time completion, cost performance, quality standards, community standards, environmental and social impact, teamwork, safety outcomes, and contribution to the national sustainability goals. The loadings of the indicators are between 0.704 and 0.874, which is a sign of high reliability.

Cronbach's Alpha = 0.923, Composite Reliability = 0.936, rho A = 0.935, and AVE = 0.62 all indicate strong internal consistency and excellent convergent validity. Because the structural model explains 30.1% of the variance ( $R^2 = 0.301$ ), it can forecast the Project Success with a moderate level of predictive accuracy. One of the most significant predictors of PS ( $b = 0.548$ ,  $p < 0.001$ ) is stakeholder and technology integration. It implies that the important elements that lead to a project's success in the construction business are the use of cutting-edge technology, effective communication, real-time monitoring, and successful stakeholder coordination.

The success of a project is not directly impacted by every aspect of sustainability. Conversely, GPM fully mediates their effect: Project Success Indicators (PS) for Economic Sustainability (indirect  $b = 0.257$ ,  $p < 0.001$ ) PS for social sustainability (indirect  $b = 0.202$ ,  $p = 0.002$ ) PS for environmental sustainability (indirect  $b = 0.065$ ,  $p = 0.282$ , not significant).

This validates the key position of stakeholder input and technology incorporation in the transformation of sustainability practices into practical project deliverables.

**Table 9:**

*Project Success Indicators Mean and Standard Deviation*

<b>Item</b>	<b>Project Success Indicators</b>	<b>Mean</b>	<b>SD</b>
PS_3	Quality Standards	4.71	0.54
PS_4	Stakeholder Satisfaction	4.69	0.58
PS_5	Company Reputation	4.72	0.58
PS_7	Community Social Benefits	4.61	0.64
PS_8	Low Health & Safety Incidents	4.6	0.62
PS_9	Team Coordination	4.69	0.57
PS_10	Long-Term Sustainability	4.19	0.86
PS_11	Knowledge Transfer	4.2	0.84
PS_12	Contribution to SDGs	4.54	0.66

### **3.6. PLS-SEM Analysis**

The results of the Partial Least Squares Structure Equation Modelling (PLS-SEM), which was used to examine the relationship between the primary research constructs, are displayed in this section. Because PLS-SEM is better suited to exploratory and predictive models, multifunctional structural relationships, and relatively small sample sizes, it is appropriate for this investigation (Chinnaraju, 2025). Additionally, it can evaluate the measurement model and the structural model at the same time and manage non-normal data (Ali, Rasoolimanesh, Sarstedt, Ringle, & Ryu, 2018). To examine the relationship between Environment, Social, and Economic Sustainability and Green Project Management (GPM), which subsequently influences Project Success, PLS-SEM was used as a method based on the conceptual framework.

It is done by applying the standard 3-step PLS-SEM strategy: (1) measurement model analysis to determine the validation and reliability; (2) structural model analysis to determine the multicollinearity, path significance, effect sizes, predictive accuracy, and model fit; and (3) mediation analysis (Matthews, 2017).

### **3.6.1. Measurement Model Evaluation**

Once the measurement model was tested and conclusively all constructs were found to have sufficient validity and reliability, the structural linkages were looked into. The model that was used to study the indicators in the studies was the PLS-SEM recommendations (Chinnararaju, 2025), which focused on the analysis of the indicators based on their reliability, internal consistency reliability, convergent validity, and discriminant validity. Outer loading was used to determine the dependability of the indicators; those with a value greater than 0.70 were used to explain more than half of the variance of its construct. In case their provision to construct validity did not increase, items with a 0.400 to 0.700 loading were maintained (Chinnararaju, 2025). The measurements of internal consistency were done through Cronbach Alpha and Composite Reliability (CR), where both were higher (Eduardo Jorge da Silva, 2018). The convergent validation was checked by the values of the Average Variance Extracted (AVE) which exceeded 0.50 and demonstrated that all the constructs were adequately represented by indicators (Gordon W. Cheung, 2024). Fornell-Larcker criterion and Heterotrait-Monotrait Ratio (HTMT) were used to test discriminant validity. These constructs were empirically different as a square root of AVE was higher than inter-constructs and HTMT were smaller than the recommended cutoffs of 0.85-0.90 (Gordon W. Cheung, 2024).

Overall, the measurement model was quite valid and dependable, which provides a solid basis for future structural model evaluations.

**Table 10:**

#### *Construct Reliability & Validity*

<b>Variables</b>	<b>Cronbach's alpha</b>	<b>Composite reliability (rho_a)</b>	<b>Composite reliability (rho_c)</b>	<b>Extracted Average Variance (AVE)</b>
EcS_	0.929	0.932	0.94	0.612
EnS_	0.912	0.914	0.927	0.56

GPM_	0.93	0.933	0.941	0.616
PS	0.923	0.935	0.936	0.62
SS_	0.932	0.937	0.944	0.651

All constructs have excellent internal consistency (Cronbach's alpha 0.912 or higher) and composite reliability (rho\_c 0.930.94 or higher), indicating that the items that make up a given latent construct measure the same construct. Convergent validity is demonstrated since all the AVE values are greater than 0.50 (0.56-0.651), meaning that the construct rather than the measurement error accounts for most of the variance of each item.

**Table 11:**

*Discriminant Validity*

<b>Variable</b>	<b>EcS_</b>	<b>EnS_</b>	<b>GPM_</b>	<b>PS</b>	<b>SS_</b>
<b>s</b>					
EcS_					
EnS_	0.906				
GPM_	0.902	0.864			
PS	0.501	0.524	0.572		
SS_	0.784	0.832	0.858	0.551	

Every construct satisfies the discriminant validity Fornell Larcker criterion. Each construct's square root of AVE (diagonal values: EcS = 0.906, EnS = 0.906, GPM = 0.864, PS = 0.572, SS = 0.784) is greater than its correlations with the other constructs. None of the inter-construct correlations are higher than their corresponding diagonals, despite several of them being rather strong, particularly between EcS and EnS and SS and GPM. This demonstrates that the variation between the constructs and their own indicators is greater than that of another construct. Overall, the results show that the measurement model achieves satisfactory discriminant validity and that the constructs are empirically distinguished.

### 3.6.2. Assessment of Structural Models

To test the proposed links between the constructs, the measuring model was examined, and the structural model evaluated. Collinearity, path significance, effect sizes, predictive accuracy, and model fit were all examined in accordance with the suggested PLS-SEM guidelines (Hair, Jeffrey J. Risher, & Ringle, 2019). Collinearity was tested using VIF, and a result of less than 5.0 indicated the absence of multicollinearity issues. The statistical significance of direct relationships in the calculation of path coefficients was tested using bootstrapping (with 5,000 resamples) (Sandra Streukens, 2016). Weak, moderate, and considerable levels of model explanatory power are represented by R2 values of 0.25, 0.50, and 0.75.

There was also the measurement of effect sizes ( $f^2$ ) which was determined as small, medium, and large in terms of thresholds, i.e., 0.02, 0.15, and 0.35. SRMR was used to check model fit, where values smaller than 0.08 are considered as good fit. Indirect path significance was used to evaluate the mediation effects by bootstrapping (Alexander M. Schoemann, 2024).

All things considered, these tests demonstrate the structural model's strength and support the hypothesis's relationship validity.

**Table 12:**

*Collinearity Statistics (VIF)*

Variable	VIF	Variables	VIF	Variables	VIF
EcS_1	2.442	EnS_6	2.256	PS_12	3.536
EcS_10	2.676	EnS_7	2.275	PS_3	1.874
EcS_2	2.159	EnS_8	2.258	PS_4	2.174
EcS_3	2.786	EnS_9	2.082	PS_5	2.237
EcS_4	3.018	GPM_1	3.013	PS_7	2.65
EcS_5	2.483	GPM_10	1.946	PS_8	4.12
EcS_6	2.998	GPM_2	2.577	PS_9	2.539
EcS_7	2.213	GPM_3	3.694	SS_1	3.509
EcS_8	2.327	GPM_4	2.389	SS_11	2.463
EcS_9	2.486	GPM_5	2.564	SS_12	2.602
EnS_1	2.082	GPM_6	2.08	SS_2	2.178

EnS_10	1.794	GPM_7	2.3	SS_3	2.402
EnS_2	2.024	GPM_8	1.878	SS_4	4.611
EnS_3	2.697	GPM_9	2.052	SS_5	1.808
EnS_4	2.256	PS_10	2.053	SS_8	2.671
EnS_5	2.657	PS_11	2.188	SS_9	2.997

Because individual predictor constructs shouldn't overlap excessively, which would skew the estimations of path coefficients, collinearity is another crucial factor to evaluate in PLS-SEM. According to Hair et al. (2019), collinearity is evaluated using the Variance Inflation Factor (VIF) when VIF is low, less than 5.0. Investigate A VIF of less than 3.3 is recommended in more cautious research settings to ensure minimal multicollinearity (Alhassan Umar Ahmad, 2021). VIF is a two-fold diagnostic criterion in PLS-SEM since values greater than 3.3 may indicate a common method bias (CMB) issue. When VIFs are greater than 5.0, it indicates that the predictors might be highly correlated and might invalidate the estimation of structural relationships (Hair, Jeffrey J. Risher, & Ringle, 2019). Therefore, to guarantee the estimation of the coefficient reliably and prevent problems of multicollinearity in the structural model, a range of VIF thresholds of 3.3 to 5.0 is broadly accepted in the modern methodological literature.

The majority of VIF values are substantially below what is generally regarded as a typical value and none of the indicators are above a VIF of 5, which is a sign that the issue of multicollinearity does not pose a problem in the sets of predictors. Only a few indicators (SS3 and PS7) have values that are close to or even more than 4, and this might indicate that some indicators collinear with others. Although this can slightly affect standard errors, there are not likely to be significant distortions of the structural model. With more restrictive diagnostic standards, more analysis of the outer loadings of the affected indicators might be justified and refinement or even elimination of items could be thought about in case of redundancy is found.

**Table 13:***Path Coefficients & Significance (Bootstrapping 5,000 resamples)*

<b>Variables</b>	<b>Original sample (O)</b>	<b>Sample mean (M)</b>	<b>Standard deviation (STDEV)</b>	<b>T statistics ( O/STDEV )</b>	<b>P values</b>
EcS_ -> GPM_	0.47	0.469	0.081	5.793	0
EnS_ -> GPM_	0.118	0.126	0.104	1.137	0.256
GPM_ -> PS	0.548	0.568	0.056	9.806	0
SS_ -> GPM_	0.369	0.362	0.112	3.281	0.001

Non-parametric bootstrapping is used to compare the values of PLS-SEM path coefficients, which show the direction and strength of the correlations between latent constructs (Hair, Jeffrey J. Risher, & Ringle, 2019). In order to get stable standard errors, t-values, and p-values without assuming that the data is normally distributed, the standard size of 5,000 subsamples is advised (Eias Al Humdan, 2024). According to Hair, Jeffrey J. Risher, and Ringle (2019), a path is considered statistically significant if its confidence interval does not include zero or if its T statistics is 1.96 and p value is 0.05. The procedure also helps with mediating analysis by taking into account total and indirect effects.

- Economic sustainability (EcS) has a considerable and statistically significant beneficial impact on green project management (GPM) (0.47,  $p < 0.001$ ). This suggests that improved green project management procedures are connected to improved economic sustainability practices.
- SS (Social Sustainability) has a significant positive impact on GPM ( $\beta = 0.369$ ,  $p = 0.001$ ), indicating that social practices are crucial to green management.
- EnS (Environmental Sustainability) has a direct, but statistically insignificant impact on GPM (802.2: 0.118,  $p = 0.256$ ). It means that, in this sample, the environmental practices are not directly related to an increase in effectiveness of green project management when economic and social sustainability should

be controlled. The non-significance may be the result of overlap with other constructs, measurement specifics or sample characteristics.

- There is a substantial and significant correlation between GPM and Project Success (PS) ( $= 0.548$ ,  $p = 0.001$ ), indicating that green project management is significantly predicted by project success.

**Table 14:**

*Coefficient of Determination ( $R^2$ )*

<b>Variables</b>	<b>R-square</b>	<b>R-square adjusted</b>
GPM_	0.788	0.784
PS	0.301	0.296

The Coefficient of Determination ( $R^2$ ), which shows how much of the variation of an endogenous construct is explained by the exogenous predictors, is one of the most important measures of predictive power in the PLS-SEM (Hair, Jeffrey J. Risher, & Ringle, 2019). Although  $R^2$  can be interpreted as high (0.67), average (0.33), and small (0.19), acceptable levels may vary depending on the field of study (Muhammad Irfan Nasution, 2020).

Hair et al. (2019) also highlights those greater values of  $R^2$  are an indication of greater explanatory power, yet above-average values can be a sign of overfitting.  $R^2$  of 0.25-0.50 is generally acceptable in the social science research, as human and organizational behavior is complex (Putra, 2022).

$R^2$  is, therefore, a focal measure of model quality and indicates the extent to which the structural model can be used to explain variance in dependent constructs.

- **GPM  $R^2 = 0.788$ :** An estimated 78.8% of the variance in green project management was explained by the combination of EcS, EnS, and SS. This is a very high degree of explanatory power, suggesting that the antecedents in the model are significant predictors of GPM in your sample.
- **PS  $R^2 = 0.301$ :** GPM describes approximately 30.1% of the explanatory variance of project success. This is moderate, the GPM is a significant predictor, yet the considerable variation in the success of projects cannot be explained by the GPM only (there are other predictors, e.g., project complexity, leadership, or external environment).

**Table 15:***f<sup>2</sup> Statistics*

<b>Variables</b>	<b>EcS_</b>	<b>EnS_</b>	<b>GPM_</b>	<b>PS</b>	<b>SS_</b>
EcS_			0.283		
EnS_			0.016		
GPM_				0.43	
PS					
SS_			0.24		

According to Jr., Marko Sarstedt, and Kuppelwieser (2014), the  $f^2$  statistic assesses each exogenous construct's contribution to the  $R^2$  value of an endogenous construct, demonstrating its relative impact on the structural model. Cohen's commonly used benchmarks indicate that tiny, medium, and high effect sizes are represented by  $f^2$  values of 0.02, 0.15, and 0.35, respectively.

Effect size complements p-values for a more comprehensive evaluation in PLS-SEM since a path coefficient may be statistically significant but have a poor practical contribution (Hair et al., 2019). Additionally, Sharma et al. (2019) stress that  $f^2$  aids in the identification of significant predictors and constructs whose elimination would significantly lower the explanatory power of the model.

As a result, the  $f^2$  statistic is acknowledged as a crucial benchmark for comprehending the significant influence of specific exogenous variables in PLS-SEM structural models.

- **GPM → PS ( $f^2 = 0.43$ ):** big effect - GPM is significant in influencing project success.
- **EcS → GPM ( $f^2 = 0.283$ ):** medium to large effect economic sustainability has a significant contribution to GPM.
- **SS → GPM ( $f^2 = 0.24$ ):** medium effect - social sustainability carries a significant practical significance.
- **EnS → GPM ( $f^2 = 0.016$ ):** insignificant/low effect and in line with its non-significant path coefficient: environmental sustainability provides little distinct explanatory power to GPM in the presence of EcS and SS.

**Table 16:***Model fit*

<b>Models</b>	<b>Original sample (O)</b>	<b>Sample mean (M)</b>	<b>95%</b>	<b>99%</b>
Saturated model	0.073	0.052	0.063	0.069
Estimated model	0.075	0.055	0.068	0.073

Current methodological improvements suggest presenting model-fit indices combined with reliability and validity measurements to be used, even if PLS-SEM is more of a prediction-based methodology. The most used absolute fit metric is the Standardized Root Mean Square Residual (SRMR), whose values are less than 0.08, indicating a satisfactory model fit (Goran Pavlov, 2021). Additional information about the discrepancy between the empirical and model-implicated covariance matrices is provided by other metrics such as  $d_{ULS}$ ,  $d_G$ , and Normed Fit Index (NFI) (Hair et al., 2022). However, the most widely used and reliable PLS-SEM measure is SRMR. Harpreet Singh Bedi (2023) mention that the indices of model fit assist in identifying misspecification, though model fit is to be interpreted alongside predictions accuracy metrics (e.g.,  $R^2$ ,  $Q^2$ ) because PLS-SEM does not emphasize the outlook to replicate the empirical covariance matrix. Therefore, supportive but not primary diagnostic indices of PLS-SEM include model fit indices like SRMR.

**SRMR = 0.075** → suitable fit. The model's approximate fit to the observed covariance matrix falls below typical PLS-SEM thresholds, which significantly validates the suitability of the model specification. Hu and Bentler (1998) state that an SRMR score of less than 0.08 is deemed suitable for evaluating model fit; if the SRMR is less than 0.08 for both the saturated model and the estimated model, it means that the structural model fits well.

### 3.6.3. Mediation Analysis

**Table 17:**

*Testing Indirect Effects*

<b>Variables Relationship p</b>	<b>Original sample (O)</b>	<b>Sample mean (M)</b>	<b>Standard deviation (STDEV)</b>	<b>T statistics ( O/STDEV )</b>	<b>P values</b>
EcS_ -> PS	0.257	0.267	0.057	4.516	0
EnS_ -> PS	0.065	0.072	0.06	1.075	0.282
SS_ -> PS	0.202	0.205	0.064	3.157	0.002

Indirect effects must be tested to assess mediation in PLS-SEM. The suggested method is non-parametric bootstrapping, which does not require the assumption of a normal data distribution to be significant (Eias Al Humdan, 2024). The bootstrapping of 5,000 resamples is the methodological standard for determining the magnitude, significance, and confidence intervals of indirect pathways (Hair, Jeffrey J. Risher, & Ringle, 2019).

Because t-value 1.96, p-value 0.05, or boot-strap confidence interval do not contain 0, indirect effects have a significant impact (Shu Fai Cheung, 2022).

**Table 18:**

*Hypotheses Acceptation/Rejection Table*

<b>Hypotheses</b>	<b>Decision</b>	<b>Rationale</b>
<b>Hypothesis-1 (H1):</b> Adopting Green Project Management (GPM) techniques is positively impacted by the incorporation of environmental sustainability at several stages of the project life cycle (initiation, planning, execution, monitoring, and closing).	Rejected	Environmental Sustainability (EnS) and GPM have a weak connection ( = 0.118), are not statistically significant ( = 1.137, = 0.256), and have a confidence interval that covers 0 ( = - 0.081 to 0.328). These figures indicate that there is insufficient data to conclude that environmental sustainability has a beneficial effect on the sample's adoption of GPM.

<p><b>Hypothesis-2 (H2):</b> The adoption of GPM practices is positively impacted by the incorporation of social sustainability into project life cycle phases.</p>	<p>Accepted</p>	<p>The statistically significant positive impact on GPM of Social Sustainability (SS) is a positive number (= 0.369, t = 3.281, p = 0.001) with a confidence interval that is entirely positive. This confirms the hypothesis that the more social sustainability is integrated the more GPM practices are adopted.</p>
<p><b>Hypothesis-3 (H3):</b> Adopting GPM techniques is positively impacted by including economic sustainability into project life cycle phases.</p>	<p>Accepted</p>	<p>Economic Sustainability (EcS) has a significant, positive, positive impact on GPM (0.470, t = 5.793, p &lt; .001) and has a 95% CI that is far above zero. This is a positive indication that the hypothesis of the integration of economic sustainability predicts an increase in uptake of GPM.</p>
<p><b>Hypothesis-4 (H4):</b> The application of GPM techniques has a significant positive impact on project success that extends beyond scope, time, and cost to long-term sustainability results.</p>	<p>Accepted</p>	<p>The direction connecting GPM and Project Success (PS) is considerable and considerably important (= 0.548, = 9.806, p = 0.001; 95% CI = [0.464, 0.680]) which means that the adoption of GPM practices is well connected with the enhanced project success results in this model.</p>
<p><b>Hypothesis-5 (H5):</b> GPM techniques serve as a mediator between the environmental, social, and economic aspects of sustainability and project success, demonstrating the practical integration of</p>	<p>Accepted</p>	<p>Accepted in part.</p>

sustainability into construction project management.		
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The measurement and structural models are statistically adequate; all the constructs had a strong reliability, valid measurement properties, and acceptable model fit. When it comes to the dimensions of sustainability, economic sustainability, and social sustainability were the two positive influences on GPM, which were statistically significant. Conversely, GPM that is an indicator of limited practical integration in the project processes could not be predicted by environmental sustainability. GPM has a strong part to play in the translation of sustainable practices into project outputs, which can be attested by its significant and remarkable contribution to project success. The results of the mediation test reveal that GPM is effective in mediating the impact of social and economic sustainability on project success, but not environmental sustainability. The net effect of the model is that project success in the construction industry will be enhanced whereby, under the GPM practices, operationalization and reinforcing of economic and social sustainability practices exist. Sustainability practices in the environment alone are not producing quantifiable impact, which implies that they require further entrenchment in the project management procedures.

### **3.7. Findings and Discussion**

In this part, the author gives the overview of the empirical research of the study and how the results found conform to the theoretical framework, research objectives, and the literature on the sustainable project management within the construction sector in Bangladesh. The findings show how environmental, social, and economic sustainability affects Green Project Management (GPM) procedures and, ultimately, the project's success.

#### **3.7.1. Findings**

##### **1. Environmental Sustainability → GPM (Insignificant)**

- Environmental practices, e.g., waste minimization, energy saving, use of renewable energy, biodiversity shelter, and green procurement did not add up to GPM significantly.

- Whereas the environmental indicators were rated high (the mean value of the indicators was above 4.0), they were not reflected in the engagement of stakeholders and the integration of the technology.
- This implies that in Bangladesh environmental activities are highly procedural or compliance based without systemic incorporation in the project activities.

## **2. GPM → Social Sustainability (Significant)**

- Social sustainability was found to have a significant and strong impact on GPM.
- Such practices as worker safety, fair wages, engagement with the community, a team, and cultural inclusiveness enhance collaboration between stakeholders, communication, and digital technology adoption.
- The positive but indirect influence the project success by implementing GPM is the confirmation that the practices which are socially responsible reinforce the coordination and trust which are critical in management of green projects.

## **3. Economic Sustainability → GPM (Highly Significant)**

- The greatest predictor of GPM was economic sustainability.
- Efficient budget management, life-cycle costing, value engineering, financial risk management, as well as resource optimization helped organizations to implement green technologies and integrated management tools.
- This suggests that, in the context of developing economies like Bangladesh, financial readiness and economic planning are essential components of sustainable practices.

## **4. GPM as a Project Success Mediator**

- GPM had a remarkable impact on the success of the project, and it demonstrated that: clear sustainability goals, green procurement, risk management, monitoring, stakeholder reporting, and efficient resource use together enhance the outcomes of the project.
- The three sustainability dimensions influenced project success indirectly with the assistance of GPM, confirming Hypothesis 5 (mediation effect).
- In the case of the environment, the effect on environmental sustainability was weak, and the mediation paths of social and economic sustainability were stronger.

## 5. The Strength of the Model

- The  $R^2$  of GPM is 0.788, indicating that the link can be described by the three sustainability factors—environmental, social, and economic—and that they account for 78.8 percent of the variation in GPM, a very high degree of explanation.
- The indirect consequences verify that, rather than environmental compliance, the project's performance in Bangladesh depends more on stakeholder participation, integrated technology, financial discipline, and socially acceptable behaviors.

### 3.7.2. Discussion

According to this study, the growth of Green Project Management (GPM) techniques in Bangladesh's construction sector is not equally influenced by the three aspects of sustainability. Even though environmental sustainability implementation is common, its inability to produce a considerable impact on GPM suggests that the idea of environmental activities remains an obligatory compliance measure instead of a managerial choice. This is an indication that there exists a gap between doing environmentally friendly work and its incorporation into the very nature of the operation of project management.

On the other hand, the strong emphasis of the social sustainability means the significance of people-focused approach to the building projects. The effectiveness of project teams in their coordination and responsiveness improves when the safety, wellbeing and equitability of the workers are achieved and the appropriate involvement of communities. This leads to the adoption of GPM practices that are easier. When considered with the case of Bangladesh where the building industry is very labor-intensive and has a social sensitivity, this discovery shows that social well-being is the key to successful integration of sustainability. It has had the most significant influence on economic sustainability, which demonstrates that a person must be financially prepared and manage the available resources effectively to adopt green practices. The organizations that control cost, life cycle cost and planning of finances are at a better position of investing in sustainability tools and technologies, and monitoring systems. This is what is observed in agreement with the practical fact that green building requires economic stability and long-term economic rationale. The results also

confirm that GPM is the instrument that the sustainability efforts contribute to the success of the project. The sustainability will not provide better results unless the process is officially part of the planning and resource allocation, as well as risk management and performance monitoring. This means that the achievements of the projects in Bangladesh are not entirely founded on the ideals of maximum sustainability, but planned process to actualize the ideals.

Overall, the study suggests that the trend towards sustainable project management is yet to arrive, and its effectiveness requires the extent to which social and economic aspects promote the use of green practices. The project management regimes should be more closely integrated with green initiatives to generate measurable outcome. These findings highlight the fact that sustainability will only be realized when organizations align their financial resources, social requirements in addition to management practices in the project life cycle.

### **3.8. Future Research Directions**

The findings of the study can be utilized in several ways, which will be significant in the future. First, the change in sustainability practices and green project management (GPM) can be investigated at the later stages of a project by means of longitudinal research design. This would help in instilling variation in adoption, integration, and outcomes that a cross-sectional study would not capture fully. Second, on top of the environmental, social, and economic measures of sustainability, other measures can be applied in the future studies. To gain a clearer insight into the factors that result in the sustainable management of the project in developing countries, one can consider the problems of technological innovation, institutional support, quality of governance, regulation enforcement, and digital transformation. Third, the qualitative or mixed-method approach may be applied to get to know more about how the sustainability practices are exercised, both organizationally and at the site.

The interviews, case studies and observations would help in unravelling the contextual factors, challenges, and managerial behaviors that cannot be determined through the quantitative data. Fourth, a larger sample would be possible to cover other industries including manufacturing, energy, real estate, and infrastructure. This would provide a possibility of an examination of comparisons and enhance the external validity of the results. Due to the varying sustainability practices of various industries, industry-specific research can provide more information.

Fifth, the research can be expounded in future research on the cultural and behavioral aspects of sustainability adoption such as commitment of leadership, attitude of employees, and organizational learning. This set of internal drivers might be applied to comprehend the presence of stronger impact of certain sustainability dimensions on GPM compared to others.

Lastly, to examine the correlation between the sustainability dimensions, GPM practices and project success, advanced analytical methods, namely, multi group analysis, mediation-moderation models or machine learning-based prediction can be deployed. This would give more empirical findings and enhance the development of theory of sustainable project management.

## CONCLUSIONS AND RECOMMENDATIONS

The thesis discussed the issue of sustainability in relation to project management methods, paying particular attention to the green project management ideas and their role in making project sustainable. The five objectives of the study mentioned in the introduction are well covered in the presented conclusions.

### Conclusions:

The conclusion of the research is provided without any further presentation, and it directly touches upon the objectives of the thesis:

- Applying sustainability concepts throughout the project: In respect of the first objective, the research finds that the notion of sustainability could be successfully used at every step of the project management cycle consisting of planning, execution, monitoring, and closure. Integration is shown to play a vital role especially since the planning and design phase of the project to allow the project to deliver maximum benefits to the environment, society, and the economy in its life cycle.
- Innovative Strategies and Best practices in the management of green projects: To achieve the latter, the research establishes a series of new methods and ideal practices that can be utilized to make green projects a success. They are the sustainability goals by the stakeholders, lifetime assessment, sustainable design using energy and resource efficiency, and the use of organized ways of managing green projects. The approaches improve the performance of the project and minimize adverse social and environmental effects.
- Stakeholder, Resource, and Technology Role: In the context of the third objective, the results show that the secret of successful sustainable project is participation of stakeholders, reasonable resources utilization, and the use of the relevant technology. Stakeholder collaboration, resource allocation and utilization of digital and green technology are significant in terms of enhancing sustainability and project effectiveness.
- Developing a Framework of Sustainability Integration: The study is effective in developing an abstract concept of integrating sustainability in the design, execution, and operation of a project to fulfill the fourth objective. Green Project Management as a process is very important to provide sustainable

performance, which is consistent and measurable since the framework integrates the elements of sustainability and project management processes.

- **Maximization of Sustainability Performance Organization Guidance:** In line with the fifth goal, the paper concludes that the most appropriate way through which organizations can maximize the sustainability performance is by incorporating sustainability in the strategic decision-making process, investing in capacity building, adoption of the set sustainability standards and consistent observation of the sustainability indicators. Organizational commitment and organization leadership support are mentioned as the elements of long-term sustainability success in project management.

### **Recommendations:**

- **First Implication to Sustainability:** Organizations are to infuse the notion of sustainability when creating the project to guarantee that it will have long-term environmental, social, and economic advantages.
- **Green Project Management Tool Implementation:** To institutionalize sustainable practices, project-based organizations are advised to use institutionalized tools of green project management, framework, and certification systems.
- **Stakeholder Engagement and Capacity Building:** The organizations are encouraged to involve the main stakeholders and invest in the training programs to facilitate the sustainability awareness and project management skill.
- **Efficient Resource and Project Performance:** The efficiency of the resources used and performance of the project should be improved using technological advancement, energy-saving system, and sustainable materials.
- **Future study:** To assess the suggested framework in different domains and regions and to ascertain the long-term consequences of sustainability, longitudinal study approaches are required.

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## APPENDIX

### Appendix 1: Survey questionnaire in English language

*Questionnaire: Sustainability in Project Management in Bangladesh's Construction Industry.*

I am Azim Chowdhury, a student at Vilnius University, currently conducting research for my master's thesis titled "**Sustainability in Project Management: A Framework for Green Project Management.**" This questionnaire aims to investigate how sustainability practices—environmental, social, economic, stakeholder, and technological—are implemented in construction projects and how these practices affect overall project success. Your responses will be kept confidential and will be analysed to identify best practices and develop recommendations to improve sustainability in the construction sector. The results will be presented in the final thesis. I would greatly appreciate if you would take the time to complete this questionnaire, as your participation is crucial to the success of this research.

#### 1. Project Sustainability Management Dimensions

##### 1.1. Environmental Sustainability

*(Please rate the extent to which each practice is applied in your project using a scale of 1–5, where 1 = Strongly Disagree and 5 = Strongly Agree.)*

1. The project uses eco-friendly or recyclable construction materials.
2. Water and energy-saving technologies are actively applied on site.
3. Construction waste is systematically sorted, reused, or recycled.
4. There are established guidelines for minimizing on-site pollution (air, noise, soil).
5. Environmental monitoring is conducted at all stages of the project.
6. Renewable energy sources (e.g., solar lighting) are used when possible.
7. Measures are taken to protect surrounding ecosystems and biodiversity.
8. Procurement policies prioritize low-carbon or green-certified materials.
9. Environmental training sessions are provided to project staff.
10. Environmental performance reports are regularly shared with management.

##### 1.2. Social Sustainability

*(Please rate the extent to which each practice is applied in your project using a scale of 1–5, where 1 = Strongly Disagree and 5 = Strongly Agree.)*

1. All workers receive proper safety training before starting work.

2. Adequate safety gear and protective equipment are provided to workers.
3. Fair wages are ensured for all categories of labor.
4. The project provides access to clean drinking water, sanitation, and rest areas.
5. Working hours are reasonable and comply with labor laws.
6. Equal opportunities are available for both male and female employees.
7. The project provides capacity-building and technical training programs.
8. The project management promotes teamwork and collaboration.
9. The project considers the well-being of nearby communities.
10. Workers' feedback and grievances are taken seriously and addressed promptly.
11. Community engagement activities are regularly organized.
12. The project ensures cultural respect and inclusivity in the workplace.

### **1.3. Economic Sustainability**

*(Please rate the extent to which each practice is applied in your project using a scale of 1–5, where 1 = Strongly Disagree and 5 = Strongly Agree.)*

1. The project includes life-cycle cost estimation at the planning stage.
2. Cost-efficiency is pursued without compromising quality.
3. Local suppliers and contractors are preferred to strengthen the local economy.
4. Material procurement decisions consider long-term financial impacts.
5. Sustainable design reduces rework and maintenance costs.
6. Resource allocation is optimized to reduce waste and inefficiency.
7. The project employs value engineering to balance cost and performance.
8. The project contributes to long-term profitability for the organization.
9. Sustainable investment decisions are supported by management.
10. Financial risks related to sustainability issues are identified and mitigated.

### **1.4. Stakeholder and Technology Integration**

*(Please rate the extent to which each practice is applied in your project using a scale of 1–5, where 1 = Strongly Disagree and 5 = Strongly Agree.)*

1. All key stakeholders (clients, contractors, communities) are consulted during planning.
2. Stakeholders are informed of sustainability goals and progress.
3. Digital tools (e.g., BIM, ERP, monitoring apps) are used for project coordination.
4. The organization uses software for tracking environmental and cost performance.

5. Team members receive regular training on new sustainability technologies.
6. Technological innovations are encouraged to reduce resource use and emissions.
7. Project communication among stakeholders is transparent and frequent.
8. Sustainability responsibilities are clearly assigned within the project team.
9. The use of data analytics or IoT devices helps improve project sustainability.
10. Lessons learned from past sustainable projects are stored and reused digitally.

## **2. Project Success Indicators**

*(Please rate the extent to which each practice is applied in your project using a scale of 1–5, where 1 = Strongly Disagree and 5 = Strongly Agree.)*

1. The project meets its completion timeline as scheduled.
2. The project remains within its approved budget.
3. The final product meets expected quality standards.
4. Stakeholders' express satisfaction with project outcomes.
5. The project strengthens the company's image and reputation.
6. The project creates positive environmental impacts.
7. The project improves the social well-being of local communities.
8. Health and safety incidents are minimal throughout the project.
9. The project team demonstrates strong coordination and efficiency.
10. The project's outcomes are sustainable and long-lasting.
11. Knowledge gained from this project supports future sustainability projects.
12. The project contributes to national or regional sustainable development goals.

## **3. Open-Ended Questions**

*(Please provide detailed and specific responses. Use examples where possible.)*

1. Describe a recent construction project where sustainability practices were successfully applied.
2. What were the two most significant challenges faced while implementing sustainability measures, and how did they affect cost, time, or quality?
3. What key successes did your organization achieve through sustainable project management? How were these measured?
4. What new technologies or practices could enhance sustainability in Bangladesh's construction sector?

5. What management or organizational changes (e.g., culture, incentives, training) could better promote sustainability integration?

#### 4. Background Information

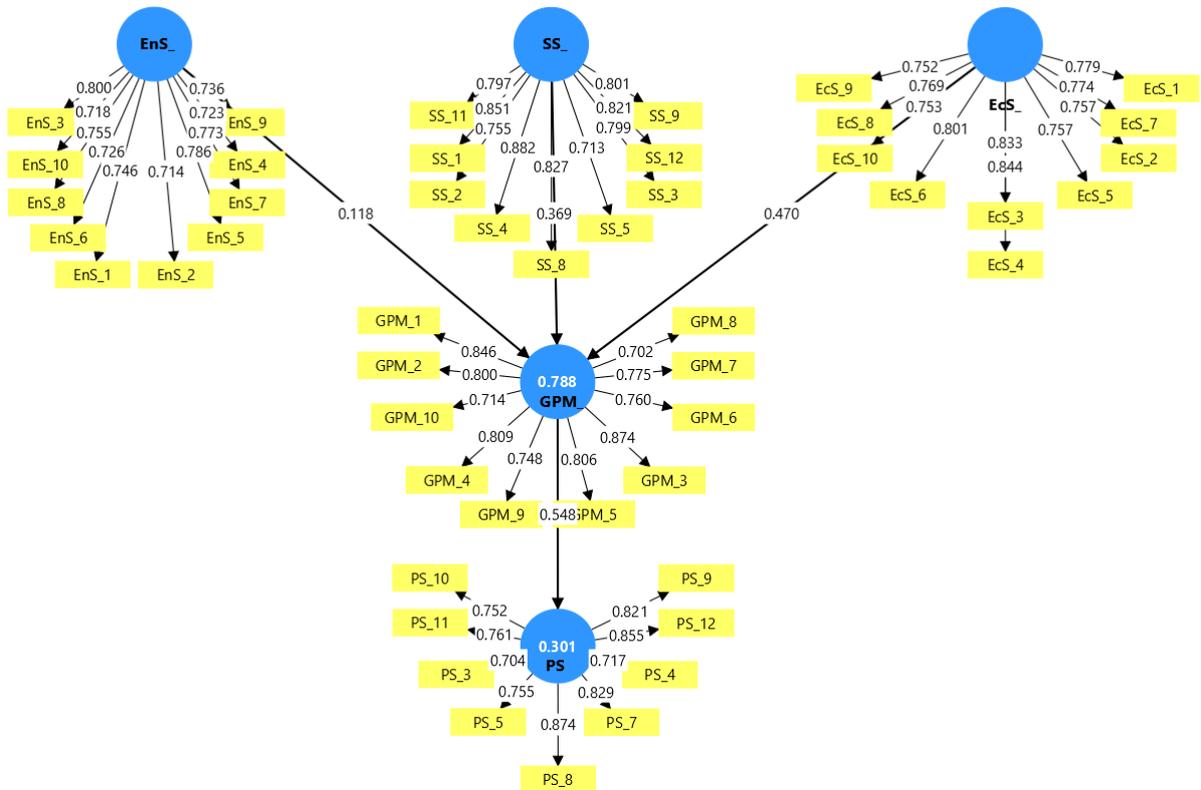
1. District of Operation: \_\_\_\_\_
2. Project Name/Site: \_\_\_\_\_
3. Type of Organization:  Public  Private  Joint Venture  NGO  Others
4. Respondent's Role:  Project Manager  Engineer  Architect  Supervisor  
 Contractor  Consultant  Others
5. Gender:  Male  Female  Prefer not to say
6. Age Group:  20–29  30–39  40–49  50+
7. Highest Education Level:  Diploma  Under-graduate  Graduate  post-graduate  PhD
8. Years of Experience in Construction Industry:  <5  5–10  11–15  >15
9. Organization Size:  Small (<50 employees)  Medium (51–250)  Large (>250)
10. Have you previously worked on sustainability-oriented projects?  Yes  No

Thank you for your time and valuable contributions to this research.

## Appendix 2: PLS-SEM Screenshots

### 1) PLS-SEM Algorithm

Graphic



### 2) Construct Reliability and Validity

Construct reliability and validity - Overview

Copy to

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE) ▲
<b>EnS_</b>	0.912	0.914	0.927	0.560
<b>EcS_</b>	0.929	0.932	0.940	0.612
<b>GPM_</b>	0.930	0.933	0.941	0.616
<b>PS</b>	0.923	0.935	0.936	0.620
<b>SS_</b>	0.932	0.937	0.944	0.651

### 3) Discriminant Validity

Discriminant validity - Heterotrait-monotrait ratio (HTMT) - Matrix					
	EcS_	EnS_	GPM_	PS	SS_
EcS_					
EnS_	0.906				
GPM_	0.902	0.864			
PS	0.501	0.524	0.572		
SS_	0.784	0.832	0.858	0.551	

4) **Collinearity Statistics (VIF)**

### Collinearity statistics (VIF) - Outer model - List

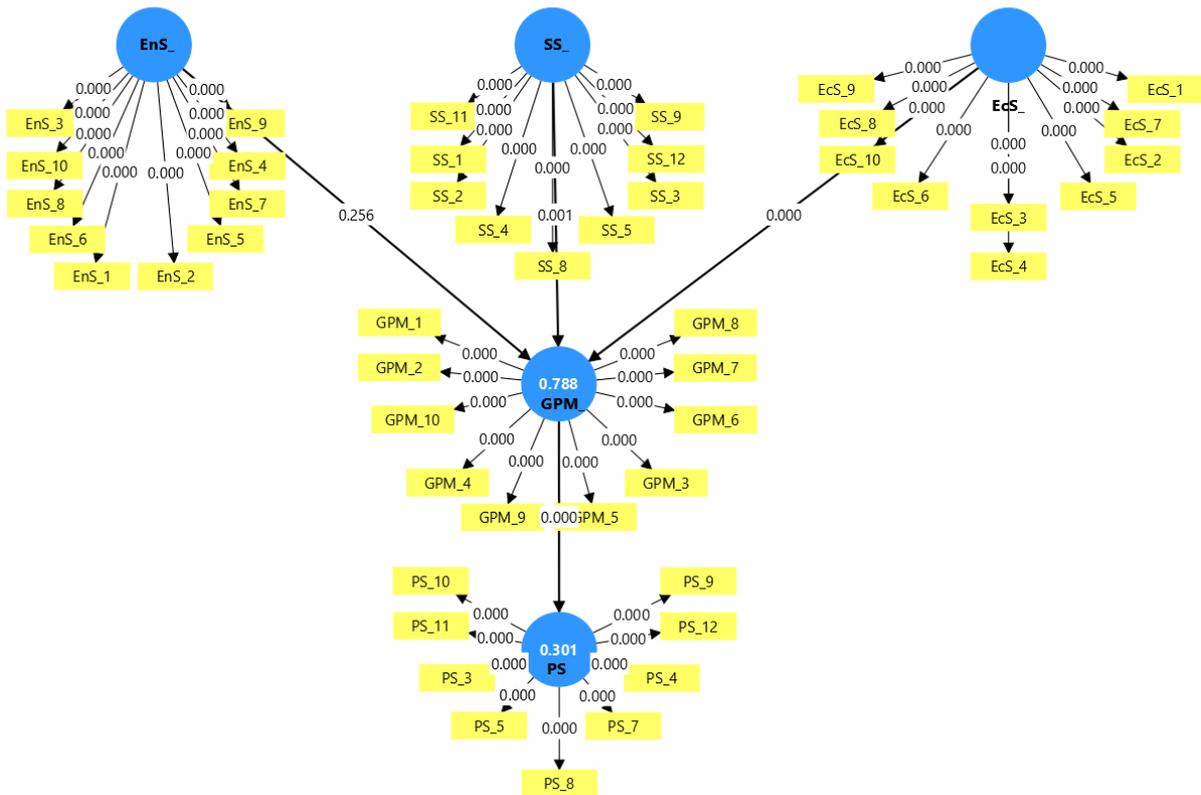
	VIF	
<b>EcS_1</b>	2.442	
<b>EcS_10</b>	2.676	
<b>EcS_2</b>	2.159	
<b>EcS_3</b>	2.786	
<b>EcS_4</b>	3.018	
<b>EcS_5</b>	2.483	
<b>EcS_6</b>	2.998	
<b>EcS_7</b>	2.213	
<b>EcS_8</b>	2.327	
<b>EcS_9</b>	2.486	
<b>EnS_1</b>	2.082	
<b>EnS_10</b>	1.794	
<b>EnS_2</b>	2.024	
<b>EnS_3</b>	2.697	
<b>EnS_4</b>	2.256	
<b>EnS_5</b>	2.657	
<b>EnS_6</b>	2.256	
<b>EnS_7</b>	2.275	
<b>EnS_8</b>	2.258	
<b>EnS_9</b>	2.082	
<b>GPM_1</b>	3.013	

	VIF
<b>GPM_10</b>	1.946
<b>GPM_2</b>	2.577
<b>GPM_3</b>	3.694
<b>GPM_4</b>	2.389
<b>GPM_5</b>	2.564
<b>GPM_6</b>	2.080
<b>GPM_7</b>	2.300
<b>GPM_8</b>	1.878
<b>GPM_9</b>	2.052
<b>PS_10</b>	2.053
<b>PS_11</b>	2.188
<b>PS_12</b>	3.536
<b>PS_3</b>	1.874
<b>PS_4</b>	2.174
<b>PS_5</b>	2.237
<b>PS_7</b>	2.650
<b>PS_8</b>	4.120
<b>PS_9</b>	2.539
<b>SS_1</b>	3.509
<b>SS_11</b>	2.463
<b>SS_12</b>	2.602

<b>SS_2</b>	2.178
<b>SS_3</b>	2.402
<b>SS_4</b>	4.611
<b>SS_5</b>	1.808
<b>SS_8</b>	2.671
<b>SS_9</b>	2.997

## 5) Bootstrapping Algorithm

Graphic



## 6) Path Coefficients & Significance (Bootstrapping 5,000 resamples)

Path coefficients - Mean, STDEV, T values, p values

Copy to Excel/v

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics ( O/STDEV )	P values
EcS → GPM_	0.470	0.469	0.081	5.793	0.000
EnS → GPM_	0.118	0.126	0.104	1.137	0.256
GPM → PS	0.548	0.568	0.056	9.806	0.000
SS → GPM_	0.369	0.362	0.112	3.281	0.001

## 7) Coefficient of Determination ( $R^2$ )

R-square - Overview		
	R-square	R-square adjusted
GPM_	0.788	0.784
PS	0.301	0.296

## 8) *f*<sup>2</sup> Statistics

f-square - Matrix					
	EcS_	EnS_	GPM_	PS	SS_
EcS_			0.283		
EnS_			0.016		
GPM_				0.430	
PS					
SS_			0.240		

## 9) Model fit

Model fit		
	Saturated model	Estimated model
SRMR	0.073	0.075
d_ULS	6.319	6.535
d_G	3.354	3.356
Chi-square	2286.524	2288.631
NFI	0.673	0.672

## 10) Testing Indirect Effects

Total indirect effects - Mean, STDEV, T values, p values						Copy to Ex
	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics ( O/STDEV )	P values	
EcS_ -> PS	0.257	0.267	0.057	4.516	0.000	
EnS_ -> PS	0.065	0.072	0.060	1.075	0.282	
SS_ -> PS	0.202	0.205	0.064	3.157	0.002	