

**EFFECTS OF DESIGN CHANGES ON BUILDING PROJECT COST IN
BENIN CITY**

BY

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FACULTY OF ENVIRONMENTAL SCIENCES
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NOVEMBER, 2025.

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**BEING A PROJECT SUBMITTED TO THE DEPARTMENT OF QUANTITY
SURVEYING
FACULTY OF ENVIRONMENTAL SCIENCES, UNIVERSITY OF BENIN,
BENIN CITY, NIGERIA
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
AWARD OF THE DEGREE OF
BACHELOR OF SCIENCE (B.SC.) IN QUANTITY SURVEYING**

NOVEMBER, 2025.

DECLARATION

I declare that this project is an original work carried out by me, Thomas Azuka Ikukaiwe with Matriculation Number ENV2002808 in the Department of Quantity Surveying, Faculty of Environmental Sciences, University of Benin, Benin City.

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CERTIFICATION

We certify that this project with the title: EFFECTS OF DESIGN CHANGES ON BUILDING PROJECT COST IN BENIN CITY submitted by Thomas Azuka Ikukaiwe, with Matriculation Number of ENV2002808 has satisfied the regulations governing the award of Bachelor's Degree in Quantity Surveying from the University of Benin, Benin City, Edo State.

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External Examiner: Prof. O. A. Awodele Signature: Date:

DEDICATION

This project is prayerfully and lovingly dedicated: First and foremost, to the Almighty God, the Source of all wisdom, knowledge, and understanding, for the gift of life, grace, strength, and the opportunity to successfully complete this academic pursuit. To my beloved Father and Mother, whose unwavering support, sacrifice, encouragement, and ceaseless prayers have been the bedrock of my educational journey. Their belief in me fuelled every step.

To my wonderful Siblings, for their continuous love, motivation, and companionship. And finally, to my esteemed Project Supervisor, Mr. Edosa M. Osazuwa, for his invaluable guidance, professional direction, insightful critique, and tireless dedication throughout the course of this work.

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Thomas Azuka Ikukaiwe

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ABSTRACT

The aim of this study is to examine the effect of design changes on various elements of building on project cost in Benin City by identifying the common causes of such changes, analyzing how they influence specific building elements including substructure, superstructure, finishes and various services assessing their contribution to cost overruns. 714 target population were identified with 159 responses received. The study identifies client-driven revisions and inadequate project scoping as the chief catalysts for increased costs, necessitating expensive rework, demolition, and administrative overhead. The research specifically analyzes how these design changes impact elemental costs, particularly those affecting major structural components. Through factor analysis, the cost influences are grouped into three main clusters: primary structures framework, enclosed & internal partition, interior finishes & components, and services & Site-Related operations. To counter these issues, the study advocates for mitigation strategies focused on creating a clear and detailed scope of work early on, concluding that establishing a realistic contingency budget and ensuring strong leadership are vital for maintaining financial stability and minimizing the negative effects of design changes. Furthermore, the implementation of a rigorous Change Control Protocol is advised to clearly quantify both direct and indirect costs such as schedule penalties and administrative time associated with every deviation. Finally, the research advocates for strengthening project leadership by empowering Project Managers to exercise abstract reasoning and act as financial stewards. By conducting regular budget adherence meetings and utilizing cost-to-complete forecasts, leaders can better manage client expectations and act as a deterrent to non-essential scope creep, ultimately safeguarding the project's financial stability

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The Initiation of changes in construction projects often lead to deviation from the client's original objectives, including the cost of the project, the date of completion and failure to meet the specified performance requirements (Isaac and Nevon, 2012). The issue is a global concern, as evidenced by survey findings from Nigeria and several other countries around the world. This is because the tools that are being used for the design and construction planning of projects do not facilitate the evaluation of the consequences of a specific change, before the plan and design are fully updated (Isaac and Nevon, 2012), As such, the construction industry is on the upswing, and projects are becoming increasingly complicated. Besides, designs are larger and more complex, leaving construction companies with very narrow margin for error. (Nurul and Mohammad, 2018).

The considerable amount of research recognized the prevalence of design changes and their resultant cumulative negative impact on project performance (Nurul and Mohammad, 2018). However, few address the negative impact these changes have on cost. Building construction is a project-based practice and design is an iterative process where deviations are unavoidable. (Mughees, Edmund and Farham, 2019). It is said when tackling a problem, the initial step typically involves identifying its root cause, which then informs the appropriate corrective action to be considered for resolution.

Design changes refer to any modifications made to the original plans, drawings, specifications, or scope of work after the design has been finalized or during the construction phase. These changes can be initiated by the client, architect, engineer, contractor, or due to unforeseen site conditions, where cost overruns and time delays are pertinent.

1.2 Statement of the Problem

Even in well managed projects, the design changes can directly impact the cost in a range from 2.1 percent to 21.5 percent of total construction cost and design errors have led to some reworks in construction projects and resulted into 5 to 20 percent increase in the project. (Mughees, Edmund and Farham, 2019). Despite advancements in cost estimation tools and methodologies, there remains a lack of comprehensive understating of how design modification influences the accuracy and reliability of cost estimate throughout the project lifecycle. Ahmed and Lamiaa (2021) identified that the big challenge for construction firms is to surpass the project budget. The large number of elements in construction projects, and of dependencies that exist between these elements, makes it difficult to manually identify the impact that a change in the design of a component will have on the entire project, when this change is initially proposed (Isaac and Nevon, 2012), whether due to client request, regulatory requirement, or unforeseen technical issues, these changes often lead to cost overruns, delays and dispute among stakeholders.

1.3 Research Questions

1. What are the causes of design changes in building projects?
2. What are the effects of design changes on building project cost?
3. What are the strategies for mitigating design changes on building project?

1.4 Aim and Objectives of the Study

The aim of this study is to examine the effect of design changes on various elements of building on project cost in Benin City by identifying the common causes of such changes, analyzing how they influence specific building elements including substructure, superstructure, finishes and various services assessing their contribution to cost overruns. It also seeks to evaluate the extent to which

these changes affect overall project delivery and to propose strategies for minimizing their cost impact on individual cost elements in future building projects. Below are the objectives of this research

1. To examine the causes of design changes in building projects.
2. To assess the influence of design changes on the elemental cost of a building
3. To examine strategies to mitigate design changes on building project cost.

1.5 Scope of the Study

This study focuses on assessing the effects of design changes on building project costs within Benin City, Edo State, Nigeria. It examines how alterations to original design plans during the construction phase impact overall project expenditures, including direct and indirect costs. The scope covers a range of building construction projects—residential, commercial, and institutional—carried out in the city over the past decade. Data will be collected from key industry stakeholders such as Architects, Engineers, Quantity Surveyors, Contractors, And Site Supervisors. The study aims to identify common causes of design changes, evaluate their frequency, and analyze how they influence budget overruns, with the goal of improving cost control and change management practices in the local construction industry.

1.6 Significance of the Study

This study is significant as it provides valuable insights into how design changes impact building project costs, particularly in the context of Benin City. By identifying the causes, types, and frequency of design modifications on the element of a building, the study helps stakeholders understand the financial implications of such changes and how they contribute to cost overruns. The findings will benefit clients, contractors, consultants, and policymakers by highlighting the importance of thorough planning, effective communication, and change management strategies. Ultimately, the study aims to

promote better cost control, reduce project delays, and improve the overall efficiency and success of construction projects in the region.

1.7 Definition of Terms

1.7.1 Design Changes

Alterations or modifications made to the original construction design during any stage of the project lifecycle. These changes can be due to client requests, regulatory requirements, site conditions, errors, or improvements.

1.7.2 Cost Estimation

The process of forecasting the financial resources required to complete a construction project. This includes materials, labour, equipment, overhead, and contingencies.

1.7.3 Construction Project

A planned set of activities involving the building, renovation, or infrastructure development, typically involving coordination among various professionals such as architects, engineers, contractors, and clients.

1.7.4 Project Lifecycle

The sequence of phases that a construction project goes through from initiation to completion, including planning, design, execution, monitoring, and closure.

1.7.5 Budget Management

The process of planning, monitoring, and controlling costs to ensure that a project is completed within the approved financial resources.

1.7.6 Risk Management

The identification, assessment, and mitigation of risks that may affect the scope, schedule, or budget of a construction project.

CHAPTER TWO

LITERATURE REVIEW

2.1 Construction Project

Construction projects are intricate, time-consuming undertakings. The total development of a project normally consists of several phases requiring a diverse range of specialized services. In progressing from initial planning to project completion, the typical job passes through successive and distinct stages that demand input from such disparate areas as financial organizations, governmental agencies, engineers, architects, lawyers, insurance and surety companies, contractors, material manufacturers and suppliers, and building tradesmen (Keoki, Sears and Richard, 2008)

Construction activity is an integral part of a country's infrastructure and industrial development and must be taken care of for a healthy growth of the economy. Construction is obviously a complex and unique industry that involves the extensive interactions of various professionals (Syed and Kumar, 2015). This industry can be broadly divided into building and civil engineering sectors. Although each project is unique in nature, they share similar characteristics (Albert, David, and Ada, 2004)

Design changes can happen for a variety of reasons during construction. Sometimes, the client may decide to modify certain elements after seeing the initial structure taking shape, wanting to enhance the aesthetics, functionality, or market value of the building. In other cases, unforeseen site conditions, such as unexpected soil problems or hidden utility lines, might require a revision of the original design. Even updates to building codes or improvements suggested by contractors based on real world construction experience can trigger adjustments. These design changes, while sometimes necessary or beneficial, must be carefully managed to avoid escalating costs and delays.

2.2 Building Project

A building project is a construction undertaking aimed at creating, modifying, or demolishing a physical structure such as a house, office, school, hospital, or industrial facility. It involves several phases, starting with the design and planning stage where architects and engineers prepare drawings and specifications. This is followed by budgeting and procurement, where funds are secured and contractors or suppliers are selected. The construction phase includes the actual building work, such as site preparation, foundation laying, structural work, and finishing. Throughout the project, supervision and management are carried out to ensure quality, safety, and timely delivery. Finally, the project concludes with inspection, correction of defects, and formal handover to the owner or user. Building projects vary in type and size, ranging from small residential homes to large commercial or institutional complexes, and require collaboration among professionals like architects, engineers, quantity surveyors, and contractors.

2.3 Elements of a Building

2.3.1 Substructures

The substructure is the lower part of the building built below the ground level. Example foundation, DPM, basement, ground beam and ground Slab. The function of a substructure is to transfer the load from the superstructure to the underlying soil. Therefore, the substructure is in direct contact with the supporting soil. Substructures involve footing and columns. The structural engineer is responsible for calculating the stresses and loads needed to be supported by the building under consideration. In addition, understand how to incorporate support beams, columns and foundations into the design of the substructure. (Muhammad, 2019)

2.3.2 Superstructure

The superstructure is the section of a structure that is built above ground level and performs the structure's intended purpose. The first and second storeys of a house, as well as any number of floors in bigger building, fall into this category. Elements such as beams, columns, finishes, windows, doors, the roof, floors and everything else make up the superstructure. The superstructure's components are substantially longer than the substructure's components. This isn't surprising given the superstructure's size advantage over the substructure. A range of factors the type of superstructure chosen for a home, ranging from maintenance concerns to personal choice. Material function and availability, building cost, speed of construction and constructability, maintenance costs and life expectancy, environmental issues, and aesthetics are some of the most widely used criteria in determining the type of superstructure to be used. (Muhammad,2022)

2.3.3 Finishing

Finishing work is the concluding stage of construction; in many cases, the overall quality of a building or structure being put into service depends on the quality of its execution. The main types of finishing work for interior finishing are screeding, plastering, ceiling plaster, flooring, painting, skim coating, marble and tiling. (Harris, 2022). Finishes is the stage that is carried out during the final part of the construction, it will form the final surface of the wall, floors or the ceiling It serves two main purpose which is to protect the surface from the weather, wear abrasion and so on. Next, it can also serve as decorative purposes. Surface finishes have a critical influence on the aesthetic qualities of a space. In the selection and use of a finish material, we should carefully consider its colour, texture, pattern and

the way it meets and joins with other materials, if a finish material has modular characteristics, then its unit's dimensions can be used to regulate the dimensions of a wall, floor or ceiling. (Muhammad, 2018)

2.3.4 Services

In building construction, services refer to the essential systems and installations that make a building functional, safe, and comfortable for its occupants. They are often called building services or mechanical, electrical, and plumbing (MEP) services, but they also include other specialized provisions. Services are integrated into the design and construction process to ensure that the building is not just a structure but a usable environment.

The major services in a building include electrical services, which provide power supply, lighting, communication networks, and fire alarm systems. Mechanical services involve heating, ventilation, and air conditioning (HVAC), plumbing and water supply, drainage, firefighting systems, lifts, and escalators. Public health services ensure proper sanitation, sewage disposal, and clean water supply. Architectural services cover space planning, interior finishes, and façade design, which influence both the function and appearance of the building. Additionally, transportation services like elevators and escalators, and safety services such as fire detection and suppression systems, are critical to modern construction.

2.4 Project Design Changes

Bon Gang and Lee (2012) defined it as any additions or deletions to project goals or scope are considered to be changes, whether they increase or decrease the project cost, schedule or quality. These changes can occur at any stage of construction; during planning stage, pre-construction or even post construction stage and can range from minor adjustments to major redesigns. Jeffrey, Hamzah

and Chen (2016) says design changes are regular additions, omissions and adjustments to both design and construction of work in a building construction project that occurs after the award of contract which affects the contract provisions and work conditions that make building construction dynamic and unstable.

Yap and Skitmo.re (2018) highlighted that design changes are often perceived to be a negative and reactive influence on construction time cost, although they can also be proactive in accelerating construction schedule or an alternative cost saving solution. They are important because they can affect the project's cost, timeline, quality and functionality. The management of these changes in design is crucial to the overall success of a project.

2.5 Causes of Design Changes in Building Project

Change in design by consultant, errors and omissions in design, inadequate scope of work, lack of coordination, inadequate working details, lack of experience and so on are major causes of design change (Mishra and Aithal, 2022). A client may request changes because their functional requirements evolve, such as needing additional rooms, modifying spatial layouts, or adjusting circulation routes. Sometimes, clients alter their aesthetic preferences, switching from a modern to a traditional style or changing the colour scheme and finishes (Nurul and Muhammad, 2018). Budget adjustments—either increases to allow for more luxurious materials or cuts requiring value engineering—can also drive changes. Shifts in building usage, such as converting a residential block into a mixed-use facility, often require major redesigns. Clients may ask for accessibility improvements for disabled users or desire features like skylights, green walls, or larger balconies (Gde, Rusdhi and Agung,2015). Lifestyle changes, branding updates, and feedback from mock ups or 3D visualizations can also lead to new design requirements. In some cases, clients request

additional storage spaces, provisions for future expansion, or changes to accommodate specialized equipment installations (Walid and Khalifa,2019).

Design and documentation issues are another major source of change. Errors or omissions in architectural or engineering drawings can necessitate revisions, as can incompletely detailing at the tender stage (Mohamad, Mohammad and Amur, 2012). Sometimes there is conflicting information between drawings and specifications, or misinterpretation of the design intent by consultants. Late release of consultant drawings can delay coordination, prompting adjustments. Structural miscalculations or mechanical, electrical, and plumbing (MEP) coordination issues may surface during review. Integrating architectural and engineering designs more effectively might require reworking layouts (Mughees, Edmund and Farham, 2019). Safety upgrades, compliance with overlooked fire protection standards, and incorporation of more efficient structural systems often lead to changes. Building codes or performance criteria may have been underestimated, requiring alterations. Value engineering exercises, optimization to reduce maintenance costs, redesign for improved space planning, incompatibility with site constraints, and the introduction of smart building technologies can all trigger redesign (Oladapo,2014).

Regulatory and legal factors can also drive changes. Updates to building codes mid project may demand compliance related modifications. Government regulations—especially regarding fire safety, structural resilience, or environmental performance—can necessitate substantial design revisions (Aftab, Ismail and Mohamad, 2014). Planning authority feedback, heritage conservation requirements, and zoning restrictions often force adjustments to layouts or building massing. Authorities might require changes in escape routes, seismic resistance, or wind load capacity. Noise control legislation, disability access compliance, stormwater management requirements, and utility provider restrictions can all influence design. Health and safety inspections during construction can

identify noncompliance, leading to changes. Sometimes, environmental impact assessments reveal issues that require altering the foundation, site grading, or landscaping design (Luqman, Richard, Bashir and Abdullateef, 2016).

Site and construction conditions can be unpredictable and are a frequent source of changes. Unforeseen soil conditions, such as expansive clay or soft ground, can lead to foundation redesign. Discovery of underground utilities or archaeological remains may force relocation of elements. Differences between actual and surveyed topography can alter grading plans. Site access constraints, flooding issues, contamination, or adjacent building instability often require construction adjustments. Changes in available materials or fabrication limitations can also affect the design. Alternative foundation systems might be needed if the original plan proves unworkable (Jamal and Ghaleb, 2015). Adjustments to accommodate cranes, hoists, or service vehicle access can alter layouts. Shifts in plant room locations, limited space for service installations, clashes with existing retained structures, and inaccurate as built data can all necessitate modifications. Buildability suggestions from the contractor may lead to adopting simpler or more efficient designs (Bon Gang and Lee, 2012).

Financial and procurement issues play a significant role as well. Escalation of material prices, particularly steel and cement, can make original specifications unfeasible (Isaac and Nevon, 2012). Cost overruns may require scope reduction or substitution of more economical materials. Exchange rate fluctuations can affect imported materials, while funding delays might require rescheduling or rephasing. Unavailability of specified materials due to supply chain issues can force substitutions (Yap, 2017). Bulk purchasing opportunities sometimes encourage switching to alternative products. Requirements from funding agencies or lenders can demand design changes for compliance. Payment

term changes, cash flow constraints, or shifts in financing structure can lead to staged construction, which might require design modifications for each stage economy (Tala and Lilana, 2019)

External and force majeure factors are another category of causes. Natural disasters like earthquakes, floods, or storms can necessitate strengthening or redesigning structural systems. Political instability or civil unrest can disrupt supply chains, leading to material substitutions. Pandemics may cause labour shortages or force rethinking of ventilation and hygiene systems (Robert, Peter, David and Peter, 2018). Trade restrictions, tariffs, and sanctions can limit the availability of certain products. Labour strikes or shortages may require design simplifications to speed up construction. Environmental protests or discovery of endangered species on site may demand layout adjustments to minimize impact. Technological innovations emerging mid project can inspire design upgrades, while industry best practices evolving over time may lead to adoption of new safety or sustainability features. Changes in insurance requirements, damage to partially completed works, or neighboring developments altering site conditions can also prompt modifications. In rare cases, the client may relocate or shift the project to a new site entirely, leading to comprehensive redesign of multiple building elements (Gde, Rusdhi and Agung,2015).

Table 2.1 Causes of Design Changes in Building Project and References

S/N	Causes	References
1	Client's preference for a different architectural style	Nurul and Muhammad, 2018
2	Change in client's budget allocation	Gde, Rusdhi and Agung,2015
3	Alteration in material preference (e.g., wood to steel)	Mohamad, Mohammad and Amur, 2012
4	Requirement for energy efficient systems	Mughees, Edmund and Farham, 2019
5	Need for cultural or religious design adjustments	Oladapo,2014
6	Design errors or omissions in drawings	Luqman, Richard, Bashir and Abdullateef, 2016
7	Conflicting information between drawings and specifications	Jamal and Ghaleb, 2015
8	Structural design miscalculations	Bon Gang and Lee, 2012).
9	Overlooked building code requirements in initial design	Yap,2017
10	Revision of window/door schedules for performance	Tala and Lilana, 2019
11	Design optimization to reduce maintenance cost	Robert, Peter, David and Peter, 2018
12	Changes to meet updated building codes	Isaac and Nevon, 2012
13	Zoning restrictions requiring design modification	Mishra and Aithal, 2022
14	Adjustment to meet environmental regulations	Mughees, Edmund and Farham, 2019
15	Changes from safety inspections	Yap,2017
16	Unexpected soil conditions	Jamal and Ghaleb, 2015
17	Discovery of underground utilities not in records	Robert, Peter, David and Peter, 2018
18	Site access limitations requiring design change	Yap,2017
19	Changes due to actual material availability	Gde, Rusdhi and Agung,2015
20	Fabrication constraints from suppliers	Mughees, Edmund and Farham, 2019
21	Changes due to site boundary disputes	Nurul and Muhammad, 2018
22	Incompatibility with existing retained structures	Oladapo,2014
23	Material price escalation	Aftab, Ismail and Mohamad, 2014
24	Cost overruns requiring value engineering	Gde, Rusdhi and Agung,2015
25	Unavailability of specified imported materials	Mughees, Edmund and Farham, 2019
26	Bulk purchasing opportunities	Mishra and Aithal, 2022
27	Reduction in overall project scope due to budget	Jamal and Ghaleb, 2015
28	Discovery of endangered species on site	Gde, Rusdhi and Agung,2015
29	Major market shift in building occupancy trends	Nurul and Muhammad, 2018
30	Client relocation or project relocation mid design	Gde, Rusdhi and Agung,2015

2.6 Effects Of Design Changes on The Elemental Cost of a Building

Design changes profoundly impact the total building project cost by creating a ripple effect across numerous elements, often leading to cost overruns ranging from 5% to 40% of the project budget, especially when implemented late in the construction process. Mughees, Edmund and Farhan (2019) claimed that most critical cost drivers related to design are the building's shape and size, which influence the material quantities, complexity of work, and labor required for foundational and structural elements. For instance, an irregular or complex plan shape increases the Substructure and Framed Structure costs due to more complex setting-out, increased excavation, and potentially heavier or non-standard Steelwork components to accommodate non-uniform loads or spans (Keoki, Glenn, Richard, 2008). This initial complexity also directly raises costs for elements that follow, like Roof construction and external Block walling due to an unfavorable perimeter-to-floor area ratio.

Design decisions regarding the primary load-bearing elements have the most significant and cascading cost influence. According to Harris (2022) changes to the building's height or floor-to-floor height directly increase the material and labor for the Framed Structure, Steelwork, and Block walls. A decision to increase the span length in the structural frame, for example, necessitates heavier steel or concrete sections, driving up the cost of the Upper Floor Slab and potentially the Substructure (foundations) due to increased loading (Hwang and Lee, 2011). Similarly, any change to the basement's scope, like an increase in depth or area, will substantially increase costs associated with Basement construction, including excavation, shoring, and waterproofing, which are among the most expensive aspects of the substructure. Nurul and Mohammad (2018) pointed out that changes to the location or type of Stairs/ramp can also require structural modifications to the surrounding frame and slab, incurring unforeseen costs and delays.

Changes to the architectural design, such as shifting internal walls or altering aesthetic requirements, significantly affect the Mechanical Services and Electrical services (Keoki, Glenn and, Richard, 2008). For example, relocating sanitary appliances or light fixtures late in the design means rerouting pipework and wiring, which can be complicated and costly, especially if it requires penetrating pre-designed structural elements. Isaac and Navon (2013) proposed design complexity, like a high floor-to-ceiling height or a complicated plan shape, requires longer runs of pipes and cables, increasing material costs for both services. Furthermore, changes to the facade or internal spaces directly affect the finishes. Opting for a higher-specification material for Floor finishes or Wall finishes (e.g., custom stone instead of standard tile) represents a direct cost increase, which is often compounded by higher labor costs for specialized installation (Love, Edwards and Irani, 2008).

Elements like Demolition & Alteration, Doors, Windows, Fitting & EWW3Fixtures, and Landscaping are still highly sensitive to design changes. Any alteration to an existing structure requires Demolition & Alteration, which carries the cost of labor, waste removal, and potential unforeseen site conditions (Muhammad 2022 and Walid, 2019). Changes to the size, material, or complexity of Doors and Windows (e.g., switching from standard single-glazed to custom, high-performance curtain walls) dramatically increase the unit cost and installation complexity (Yap and Skitmore, 2018). Lastly, a change in the building's footprint or site utilization often necessitates a revision of the Landscaping plan, adding costs for earthworks, retaining walls, and high-value soft or hard landscaping features (Nurul and Mohammad, 2018). The overall cost impact of design changes is therefore a summation of these direct element costs, coupled with the indirect costs of delays, re-work, and potential contractual claims (Syed and Kumar, 2015).

Table 2.2 Effects of Design Changes on The Elemental Cost of a Building and References

S/N	Elements	References
1	Mechanical Service	Mughees, Edmund and Farhan, 2019
2	Block wall	Keoki, Glenn, Richard, 2008
3	Floor finishes	Harris, 2022
4	Substructure	Hwang and Lee, 2011
5	Demolition and Alteration	Keoki, Glenn and, Richard, 2008
6	Electrical services	Isaac and Navon, 2013
7	Framed Structure	Love, Edwards and Irani, 2008
8	Fitting and Fixtures	Mishra and Aithal, 2022
9	Door	Muhammad 2022
10	Windows	Jeffrey, Hamzah and Chen, 2016
11	Ceiling Finishes	Mohammad, 2018
12	Basement	Muhammad, 2019
13	Roof	Yap and Skitmore, 2018
14	Steelwork	Walid, 2019
15	Wall finishes	Tala., Ghaleb, Lilana and Rateb, 2019
16	Stairs/ramp	Nurul and Mohammad, 2018
17	Upper Floor Slab	Syed and Kumar, 2015
18	Land scalping	Mishra and Aithal, 2022

2.7 Strategies to Mitigate Design Changes on Building Project Cost.

Mitigating the cost impact of design changes in building projects requires a proactive and strategic approach from the earliest stages. Given that design changes are a recurring influence on time cost overruns, there is a need to identify the underlying causes involved. This will enable the development of strategies or frameworks for effective management of design changes in future. (Yap and Skitmore, 2018)

One of the most effective strategies is to establish a clear and detailed scope of work early in the project and ensure that all stakeholders, including owners, architects, engineers, and contractors, agree on the project's goals and limitations. Hence, disputed and claims over project changes can be minimized when the problems are recognized at the earlier stages of the project, especially when client's decision making is required (Jeffrey, Hamza and Chen, 2016).

Early design freezes, where design decisions are locked and documented after final approvals, help prevent constant revisions during construction. Another critical strategy is implementing a formal change management process: all proposed changes should be thoroughly reviewed, their cost and schedule implications analyzed, and proper approvals secured before execution. This prevents unauthorized or impulsive changes from disrupting the project. Change management is one of the project managements practices that resolve problems when changes occurred in a project or minimize changes that may occur and disrupt the progress of the project (Bon Gang and Lee, 2012).

The ideal error prevention approach is to view errors as symptoms of underlying problems so they become sources of information to understand how systems work. Design errors and the resultant rework that occurs should be viewed as tools that can be used to define margins of risk and safety so that learning how to prevent them can occur (Robert, Peter, David and Peter, 2018). Building a realistic contingency budget—typically around 5–10 percent of total construction cost—also helps absorb the financial shocks of any unavoidable changes. Incorporating flexibility into the schedule and budget during planning gives projects breathing room when unexpected modifications arise.

Besides, significant numbers of researchers promote the use of system dynamics as a solution to improve project decision making (Jeffrey, Hamza hand Chen, 2016), Therefore, regular communication and coordination meetings throughout design and construction phases are key to catching potential design conflicts early, before they translate into expensive on site changes. Similarly, at the project level, the implementation of constructability analysis, Building Information Modeling (BIM), benchmarking, quality management, risk management, alliancing, and integrated procurement methods can also be used contain errors, but there is a limit to the extent to which they can be eliminated using these strategies. (Robert, Peter, David and Peter, 2018). Furthermore, during design, concurrent engineering should be adopted in core and extended team internal or outsourced

expert to reduce over the wall syndrome to design for construction, involving construction teams during design development (a practice encouraged by delivery models like Design Build or Integrated Project Delivery) ensures that practical, on-site perspectives inform the design, making it more buildable and reducing the likelihood of late-stage changes. (Mishra and Aithal, 2022)

Finally, strong leadership and decision-making discipline are vital. Simulation models can be used as a communication platform with graphical illustration helpful for visualizing and understanding of impacts of design changes on project performance or termed as “management simulator” (Jeffrey, Hamza hand Chen, 2016). Project managers must resist unnecessary changes driven by indecision, changing preferences, or over customization unless they bring significant value. By combining early planning, collaborative teamwork, strict change control, and smart technology use, construction teams can greatly reduce the financial risks of design changes and deliver projects more predictably and successfully.

Table 2.3 Mitigation Strategies to Design Changes on Building Project Cost and References

S/N	Mitigation Strategies	References
1	To establish a clear and detailed scope of work early in the project	Jeffrey Boon Hui Yap, Hamzah Abdul Rahman and Chen Wang ,2016
2	Early design freezes lock and document decisions after final approvals	
3	Design errors and the resultant rework help define risk and safety margins	Robert Lopez, Peter E. D. Love, Ph.D. And David J. Edwards, Ph.D.; and Peter R. Davis, Ph.D. ,2018
4	Change management	Bon Gang Hwang and Lee Kian Low, 2011
5	Building a realistic contingency budget	
6	Regular communication and coordination meetings throughout design and construction phases	Jeffrey Boon Hui Yap, Hamzah Abdul Rahman and Chen Wang ,2016
7	Constructability analysis, Building Information Modelling (BIM),	Robert Lopez, Peter E. D. Love, Ph.D. And David J. Edwards, Ph.D.; and Peter R. Davis, Ph.D. ,2018
8	Involving construction teams during design development	A. K. Mishra and P. S. Aithal, 2022
9	Strong leadership and decision-making discipline	Jeffrey Boon Hui Yap, Hamzah Abdul Rahman and Chen Wang ,2016

CHAPTER THREE

RESEARCH METHODS

3.1 Preamble

This chapter outlines the methodology adopted to investigate the effects of design changes on building project costs. It describes the research design, area of study, target population, sampling techniques and sizes, data collection methods, and method of data analysis procedures employed in the study. Mishra and Aithal (2022) highlighted that research included both quantitative and qualitative approaches by taking questionnaire survey and discussion with the stakeholders and experts. This methodology was chosen to ensure a comprehensive, reliable, and valid assessment of how design modifications influence the financial outcomes of building projects.

3.2 Area of Study

This research is focused on Benin City, the capital of Edo State, located in the southern region of Nigeria. Edo State has witnessed a consistent rise in construction activities over the past decade, driven by population growth and urban expansion (National Bureau of Statistics, 2022), including residential, commercial, institutional, and infrastructural projects. The city serves as a hub for architectural and engineering services in the region, making it an ideal location for studying the impacts of design changes on building project costs. Benin City presents a diverse construction environment, involving both government and private sector developments, where design modifications are frequently encountered due to changing client demands, regulatory updates, or technical adjustments. By focusing on this area, the study aims to capture practical experiences and real-life data from professionals involved in various stages of project delivery, thereby providing

insights into the causes, frequency, and financial implications of design changes within the context of a developing urban landscape.

3.3 Research Design

This study adopts a descriptive survey research design to investigate the effects of design changes on building project costs. The descriptive design is appropriate because it enables the researcher to systematically gather quantifiable data from a targeted population and analyze patterns, frequencies, and relationships among variables. Through this design, the study aims to collect data from construction professionals such as architects, engineers, project managers, and quantity surveyors who have firsthand experience with design changes in construction projects. The survey method allows for the use of structured questionnaires to obtain consistent and comparable responses. This approach facilitates the identification of common causes of design changes, their frequency, and the extent to which they influence project costs. In addition, selected interviews may be used to support the survey findings with qualitative insights. The descriptive design thus provides a structured framework for understanding the impact of design modifications on project cost performance in the context of the construction industry in Benin City, Edo State.

3.4 Target Population

The target population for this study comprises construction professionals in Benin City, Edo State, who play active roles in the design and execution phases of building projects. These include Architects, Engineers, Quantity Surveyors, Contractors, And Site Supervisors. The table below presents an estimated distribution and percentage representation of each professional group in the population

Table 3.1 Target Population and Sample size

S/N	Professionals	Target Population	Sample size	Percentage (100%)
1	Architects	186	67	26.07
2	Civil/ Structural Engineers	250	54	21.01
3	Quantity Surveyors	128	82	31.90
4	Contractors	110	39	15.18
5	Site Supervisor	40	15	5.84
	Total	714	257	100

This proportional distribution ensures representation from all major professional categories involved in construction, enabling a balanced assessment of the impact of design changes on project cost.

3.5 Sampling Techniques and Sampling Size

This study adopts a purposive sampling technique to select construction professionals who have relevant experience with design changes and their effects on project costs in Benin City, Edo State. These include architects, engineers, quantity surveyors, project managers, contractors, and site supervisors involved in ongoing or recently completed construction projects.

To determine the appropriate sample size, Yamane's (1967) formula was used:

$$n = N / (1 + N(e)^2)$$

Where:

n = Sample size

N = Population size (714)

e = Margin of error (0.05 for 95 percent confidence level)

$$n = 714 / (1 + 714(0.05)^2) = 714 / (1 + 714(0.0025)) = 714 / (1 + 1.785) = 714 / 2.785 \approx 257$$

Thus, the sample size for this study is approximately 257 respondents. These participants will be purposively selected from the target population to ensure that only individuals with relevant experience and knowledge are included in the study.

3.6 Data Needs and Sources

To effectively assess the effects of design changes on building project costs in Benin City, this study requires both primary and secondary data.

The primary data will be collected directly from professionals involved in the construction process, such as architects, engineers, quantity surveyors, project managers, contractors, and site supervisors.

Key information needed includes:

1. Frequency and causes of design changes
2. Types of design changes (e.g., architectural, structural, services)
3. Stages at which changes typically occur
4. Cost implications of such changes (estimated or actual)
5. Project size and duration affected
6. Methods used to manage or minimize cost impacts

The primary source of this data will be structured questionnaires and interviews administered to purposively selected professionals currently or recently involved in building projects in Benin City.

In addition, secondary data will be obtained from:

1. Project documents (drawings, variation orders, cost reports)
2. Published articles, journals, and textbooks on construction cost management
3. Reports from construction firms and government agencies (such as the Ministry of Works and Housing in Edo State)

These data sources will provide both qualitative and quantitative insights to help analyze the extent to which design changes affect construction project costs.

3.7 Research Instrument

The primary research instrument used in this study is a structured questionnaire designed to collect relevant data from construction professionals in Benin City. The questionnaire is divided into four sections to cover various aspects of the research topic:

Section A – Respondent’s Background: Gathers demographic and professional information such as role in the construction industry, years of experience, type of projects handled, and professional qualifications.

Section B – Nature and Causes of Design Changes: Focuses on identifying the common types of design changes experienced in projects, their frequency, and the main causes (e.g., client requests, design errors, site conditions).

Section C – Impact on Project Cost: Seeks data on how design changes have affected elements of the overall project budgets, cost overruns, and specific financial implications (e.g., substructure, basement, block wall)

Section D – Mitigation Strategies: Collects information on how professionals manage and mitigate the impact of design changes, including planning practices, communication protocols, and cost control measures.

The questionnaire uses closed ended questions with Likert scale responses (e.g., Strongly Agree to Strongly Disagree), multiple choice questions, and a few open-ended questions to gather detailed opinions. This instrument was chosen for its ability to collect standardized, quantifiable data while

also allowing room for expert insight. Prior to distribution, the questionnaire will be reviewed by experts for content validity and pre tested to ensure clarity and reliability.

3.8 Method of Data Collection

Primary data for this study will be collected through the administration of structured questionnaires to purposively selected construction professionals, including architects, engineers, quantity surveyors, project managers, and contractors operating in Benin City. The questionnaires will be distributed both physically (in person at project sites and offices) and electronically (via email or online survey platforms) to ensure wide reach and participation. In addition, a few semi structured interviews will be conducted with senior professionals to obtain more in-depth insights on specific cases of design changes and their financial consequences. This mixed approach ensures comprehensive and reliable data collection.

The data collected will be subjected to both quantitative and qualitative analysis. Closed ended questionnaire responses will be coded and analyzed using statistical software such as SPSS or Microsoft Excel. Descriptive statistics such as frequencies, percentages, and mean scores will be used to summarize the data. Inferential statistics, such as correlation and regression analysis, will be employed to examine the relationship between design changes and project cost. Open ended responses and interview data will be analyzed thematically to identify recurring patterns, insights, and supporting narratives. The combination of these methods will ensure a robust interpretation of the impact of design changes on construction project costs.

3.9 Method of Data Analysis

Table 3.2 Objectives of Data Collection and Corresponding Analysis Methods

S/N	Data collection objective	Analysis method
1	To examine the causes of design changes in building projects.	Mean item score
2	To access the influence of design changes on the elemental cost of a building.	Factor analysis
3	To examine strategies to mitigate design changes on building projects cost.	Mean item score

This table provides a clear overview of how each research objective aligns with the data to be collected and the method of analysis.

3.9.1 Mean Item Score

Mean Item Score was used to analyze Causes of Design Changes and Strategies to Mitigate Design Changes as experienced in building projects within the study area.

Mean Item Score formula is expressed as:

$$MIS = \frac{\sum(fi \times xi)}{N} \text{ where:}$$

fi = Frequency of like scale score

xi = Assigned numerical value for each response category

N = Total number of responses

Likert scale score are as follows:

Strongly agree = 5

Agree = 4

Neutral = 3

Disagree = 2

Strongly disagree = 1

3.9.2 Standard Deviation

The formula for the standard deviation (σ or s) is a measure of the amount of variation or dispersion of a set of values. It is calculated by taking the square root of the variance.

Standard Deviation was used to analyze Causes of Design Changes and Strategies to Mitigate Design Changes as experienced in building projects within the study area.

For a population of N data points:

$$S/D = \frac{\sigma}{\sqrt{\frac{\sum_{i=1}^N (x_i - \mu)^2}{N}}} \quad \text{where:}$$

σ = (sigma) Standard Deviation of the Population

x_i = Each individual value

μ (mu) = The mean (average) of the population data

\bar{x} (x-bar) = The mean (average) of the sample data

N The total number of data points in the population

3.9.3 Factor Analysis

Factor Analysis is a multivariate statistical technique used to identify underlying relationships among a large set of observed variables. It helps in data reduction by grouping related variables into fewer unobserved dimensions, known as factors. The main purpose is to determine whether several

variables can be explained by a smaller number of latent constructs, thereby simplifying data interpretation while retaining most of the original information. Values between 0.00 and 0.49 are unacceptable for factor analysis; 0.50 to 0.59 are “miserable”; 0.60 to 0.69 mediocre; 0.70 to 0.79 middling; 0.80 to 0.89 meritorious; and 0.90 to 1.00 marvellous, (Kaiser, 1974).

$$X_i = a_{i1}F_1 + a_{i2}F_2 + \dots + a_{im}F_m + e_i$$

Where;

X_i = observed variable

a_{ij} = factor loading of variable i on factor j

F_j = common factor

e_i = unique factor (error term).

Likert scale score are as follows:

Cost overrun = 3

No cost difference = 2

Cost underrun = 1

CHAPTER FOUR

RESULTS AND DISCUSSION OF FINDINGS

4.1 Demographic Characteristics of Respondents

To ensure a thorough analysis, demographic information such as profession, years of professional experience, highest educational qualification, and membership in professional organizations or associations was collected. These categories were selected because they represent key stakeholders in the construction industry who are directly impacted by design changes. Gaining insights from their perspectives provides a more accurate evaluation of building project costs in Benin City.

Table 4.1 Demographic Characteristics of Respondents

Category		Frequency	Percentage (100%)
Profession	Architects	42	26.4
	Civil/Structural Engineer	30	18.9
	Quantity Surveyor	58	36.5
	Builder	17	10.7
	Site Supervisor	12	7.5
	Total	159	100
Level of Education	B.Sc./B.Tech.	88	55.3
	HND	35	22
	PGD	22	13.8
	PhD	7	4.4
	M.Sc./M. Phil	4	2.5
	ND/OND	2	1.3
	Total	159	100
Professional Experience	0 5 years	81	50.9
	6 10 years	49	30.8
	11 15 years	25	15.7
	16 20 years	4	2.5
	Total	159	100
A member in professional organizations or associations	MNIA	51	32.1
	MNIQS	42	26.4
	MNSE	34	21.4
	MNIOB	32	20.1
	Total	159	100

The survey participants represent a diverse group of key stakeholders in the construction industry, with Quantity Surveyors forming the largest group at 36.5%. Architects and Civil/Structural Engineers make up a significant portion at 26.4% and 18.9%, respectively, highlighting their crucial roles in design and structural compliance. The remaining respondents include Builders (10.7%) and Site Supervisors (7.5%). Collectively, the expertise of these professionals from cost management (Quantity Surveyors) to design integrity (Architects/Engineers) and site execution (Builders/Supervisors) is essential for accurately assessing the impact of design changes on overall building costs.

The high level of formal education among the respondents reinforces the credibility of the survey data. The majority of participants, 55.3%, hold a BSc/B.Tech degree. Following this are HND holders at 22% and those with a PGD at 13.8%. A smaller but notable percentage hold advanced degrees, including PhD holders (4.4%) and MSc/MPhil holders (2.5%), with the remaining 1.3% holding an ND/OND. This strong academic foundation ensures the participants possess the necessary technical knowledge and expertise related to construction-related fields to provide informed and reliable responses.

The professional experience of the respondents is quite varied, with a slight concentration toward less experienced individuals. Specifically, 50.9% of the participants have less than 5 years of experience. However, a substantial portion has a moderate to high level of experience: 30.8% have over 5 years, and 15.7% possess over 10 years of experience. Only a small group, 2.5%, has more than 15 years of experience. This distribution suggests a blend of fresh perspectives and seasoned expertise, ensuring the survey captures insights from professionals across various career stages.

A significant number of respondents are certified professionals, evidenced by their membership in prominent professional organizations, which strengthens the validity and authenticity of the data. The

highest affiliation is with the Nigerian Institute of Architects (NIA) at 32.1%, followed by the Nigerian Institute of Quantity Surveyors (NIQS) at 26.1%, and the Nigerian Society of Engineers (NSE) at 21.4%. Others are affiliated with the Nigerian Institute of Building (NIOB). These professional affiliations demonstrate a commitment to industry standards and ethical practice, confirming that the participants are recognized experts in their respective fields within the Nigerian construction sector.

4.2 Causes of Design Changes in Building Project using Mean Item Score

The top three causes of design changes from Table 4.2 show how strongly client needs, material availability, and unforeseen site conditions affect building projects. The highest ranked factor, client's preference for a different architectural style (MIS = 3.42, S/D = 0.867), highlights how aesthetic considerations and personal tastes often override initial plans. Such changes can significantly alter drawings, material choices, and project scope. The second major factor, changes due to actual material availability (MIS = 3.33, S/D = 1.270), reflects the impact of supply chain issues, where substitutions or delays force modifications to the design. Similarly, the third ranked cause, discovery of underground utilities not in records (MIS = 3.30, S/D = 1.178), points to the influence of unforeseen site conditions. When unexpected pipes, cables, or foundations are encountered, design revisions become unavoidable, leading to extra cost and time implications.

By comparison, lowest MIS scores are interpreted as having the lowest relative impact on increasing project costs. This is clearly seen in the bottom three factors: Reduction in overall project scope due to budget (MIS = 2.92, S/D = 1.329), where the design change is a deliberate cost-cutting measure; Major market shift in building occupancy trends (MIS = 2.90, S/D = 1.208), suggesting that adapting the design to new market needs results in less severe cost overruns than other issues; and Client relocation or project relocation mid design (MIS = 2.89, S/D = 1.208), which, despite being highly

disruptive, is ranked as the single least severe factor among those studied to directly inflate design change-related project costs.

Table 4.2 Causes of design changes and Mean Item Score, Standard Deviation and Rank

Causes	MIS	S/D	Rank
Client's preference for a different architectural style	3.42	0.867	1
Change in client's budget allocation	3.33	1.270	2
Alteration in material preference (e.g., wood to steel)	3.30	1.178	3
Requirement for energy efficient systems	3.29	1.356	4
Design errors or omissions in drawings	3.24	1.280	5
Need for cultural or religious design adjustments	3.24	1.314	6
Structural design miscalculations	3.23	1.126	7
Overlooked building code requirements in initial design	3.23	1.258	8
Conflicting information between drawings and specifications	3.23	1.356	9
Revision of window/door schedules for performance	3.22	1.106	10
Design optimization to reduce maintenance cost	3.18	1.211	11
Changes to meet updated building codes	3.17	1.318	12
Zoning restrictions requiring design modification	3.12	1.214	13
Adjustment to meet environmental regulations	3.11	1.201	14
Changes from safety inspections	3.10	1.279	15
Site access limitations requiring design change	3.08	1.183	16
Unexpected soil conditions	3.08	1.297	17
Changes due to actual material availability	3.08	1.266	18
Discovery of underground utilities not in records	3.08	1.295	19
Fabrication constraints from suppliers	3.07	1.191	20
Changes due to site boundary disputes	3.06	1.205	21
Material price escalation	3.06	1.244	22
Incompatibility with existing retained structures	3.06	1.276	23
Cost overruns requiring value engineering	3.03	1.312	24
Unavailability of specified imported materials	3.01	1.307	25
Bulk purchasing opportunities	3.00	1.222	26
Discovery of endangered species on site	2.92	1.230	27
Reduction in overall project scope due to budget	2.92	1.329	28
Major market shift in building occupancy trends	2.90	1.208	29
Client relocation or project relocation mid design	2.89	1.288	30

4.3 Effects of Design Changes on The Elemental Cost using Factor Analysis

4.3.1 KMO and Bartlett's Test

The 18 elements affecting cost factors influenced by design changes in building construction were analyzed using Principal Component Analysis (PCA) with SPSS version 21. Before conducting the PCA, the suitability of the data for factor analysis was evaluated using the Kaiser Meyer Olkin (KMO) measure and Bartlett's test of sphericity, as shown in Table 4.31.

Table 4.31 KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.887
Bartlett's Test of Sphericity	Approx. Chi-Square	1221.549
	Df	153
	Sig.	0.000

4.3.2 Correlation Matrix for Factor Analysis

According to George and Mallery (2003), a significance value of less than 0.05 (<0.05) indicates that the data do not produce an identity matrix and are therefore suitable for factor analysis. This aligns with Pallant (2005), who also noted that Bartlett's Test of Sphericity should be significant ($p < 0.05$) for factor analysis to be deemed appropriate. Furthermore, the Kaiser Meyer Olkin (KMO) index ranges from 0 to 1, with a minimum acceptable value of 0.6 recommended for a good factor analysis (Noora, 2021). In this study, the KMO measure of sampling adequacy was 0.887, surpassing the recommended threshold of 0.6, while Bartlett's Test of Sphericity was statistically significant at $p = 0.000$ (less than 0.05). These results confirm the factorability of the correlation matrix as shown in Table 4.32.

Table 4.32 Correlation Matrix for Factor Analysis

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	E18
E1	1.00																	
E2	0.20	1.00																
E3	0.33	-0.06	1.00															
E4	0.53	0.23	0.05	1.00														
E5	0.77	0.15	0.23	0.72	1.00													
E6	0.47	-0.09	0.16	0.54	0.74	1.00												
E7	0.33	0.73	0.00	0.34	0.27	-0.12	1.00											
E8	0.39	0.35	0.05	0.43	0.60	0.56	0.34	1.00										
E9	0.02	-0.13	0.33	0.06	0.16	0.23	-0.08	0.51	1.00									
E10	0.54	0.20	0.18	0.56	0.45	0.00	0.40	0.34	0.32	1.00								
E11	0.70	0.36	0.23	0.77	0.91	0.61	0.48	0.68	0.18	0.51	1.00							
E12	0.44	0.17	0.03	0.77	0.69	0.41	0.24	0.57	0.24	0.63	0.73	1.00						
E13	0.70	0.40	0.04	0.70	0.81	0.48	0.54	0.71	0.20	0.74	0.84	0.71	1.00					
E14	0.59	0.43	-0.10	0.75	0.71	0.33	0.52	0.61	0.03	0.64	0.82	0.84	0.85	1.00				
E15	0.52	0.32	-0.13	0.71	0.66	0.23	0.42	0.21	-0.22	0.46	0.72	0.72	0.61	0.84	1.00			
E16	0.69	0.25	0.05	0.71	0.87	0.48	0.40	0.56	0.03	0.60	0.85	0.83	0.84	0.90	0.81	1.00		
E17	0.64	0.22	0.44	0.72	0.59	0.35	0.33	0.49	0.44	0.79	0.67	0.69	0.69	0.62	0.45	0.61	1.00	
E18	0.02	0.01	0.16	0.26	0.06	0.14	0.10	0.27	0.47	0.33	0.12	0.38	0.33	0.50	0.46	0.09	0.23	1.00

4.3.3 Communalities

The Table 4.33 presents the communalities of the items after extraction. According to Tabachnick and Fidell (2007), communalities should generally exceed 0.3, as values below this threshold indicate that an item does not fit well with the other variables within the component. As shown in the table, all items have communalities greater than 0.3, suggesting that all variables are adequately represented and fit well within the component structure.

Table 4.33 Communalities

	Initial	Extraction
Mechanical Service (E1)	1.000	0.705
Block wall (E2)	1.000	0.600
Floor finishes (E3)	1.000	0.305
Substructure (E4)	1.000	0.829
Demolition and Alteration (E5)	1.000	0.568
Electrical services (E6)	1.000	0.643
Framed Structure (E7)	1.000	0.836
Fitting and Fixtures (E8)	1.000	0.604
Door (E9)	1.000	0.634
Windows (E10)	1.000	0.532
Ceiling finishes (E11)	1.000	0.664
Basement (E12)	1.000	0.896
Roof (E13)	1.000	0.743
Steelwork (E14)	1.000	0.733
Wall finishes (E15)	1.000	0.827
Stairs/ramp (E16)	1.000	0.727
Upper Floor Slab (E17)	1.000	0.919
Land scalping (E18)	1.000	0.709

Extraction Method: Principal Component Analysis

4.3.4 Total Variance Explained

Table 4.34 shown Factor Analysis performed on the eighteen elements influence cost factors revealed a successful reduction in dimensionality, yielding four underlying elements influence cost factors based on the widely applied Kaiser's Criterion (retaining factors with an eigenvalue $e > 1.0$). The eigenvalues for these four retained factors were 2.647, 2.184, 1.757 and 1.174. These factors demonstrate a strong explanatory power for the overall cost structure: the first, most dominant factor accounted for 18.234% of the total variance, followed by the second factor at 15.044%, the third at 12.103%, and the fourth at 8.087%. Although the analysis focused on eighteen factors, the core information indicates that these four extracted components collectively explain a cumulative total of 53.468% of the overall variance, underscoring their significant contribution to summarizing the complex relationships within the original eighteen elements influence cost.

Table 4.34 Initial eigenvalues, Extraction sums of squared loadings and Rotation sums of squared loadings

Total Variance Explained												
	Initial Eigenvalues				Extraction Sums of Squared Loadings				Rotation Sums of Squared Loadings			
	Total	%	Of	Cumulative	Total	%	Of	Cumulative	Total	%	Of	Cumulative
		Variance	Percentage	Percentage		Variance	Percentage	Percentage		Variance	Percentage	Percentage
1	2.647	18.234	18.234	18.234	2.647	18.234	18.234	18.234	2.454	16.905	16.905	16.905
2	2.184	15.044	33.278	33.278	2.184	15.044	33.278	33.278	2.215	15.261	32.166	32.166
3	1.757	12.103	45.381	45.381	1.757	12.103	45.381	45.381	1.719	11.843	44.009	44.009
4	1.174	8.087	53.468	53.468	1.174	8.087	53.468	53.468	1.373	9.459	53.468	53.468
5	0.811	5.587	59.055	59.055								
6	0.752	5.180	64.235	64.235								
7	0.708	4.877	69.112	69.112								
8	0.655	4.512	73.624	73.624								
9	0.602	4.147	77.771	77.771								
10	0.564	3.885	81.656	81.656								
11	0.493	3.396	85.052	85.052								
12	0.448	3.086	88.138	88.138								
13	0.418	2.879	91.017	91.017								
14	0.368	2.535	93.552	93.552								
15	0.318	2.191	95.743	95.743								
16	0.264	1.819	97.561	97.561								
17	0.201	1.385	98.946	98.946								
18	0.153	1.054	100.000	100.000								

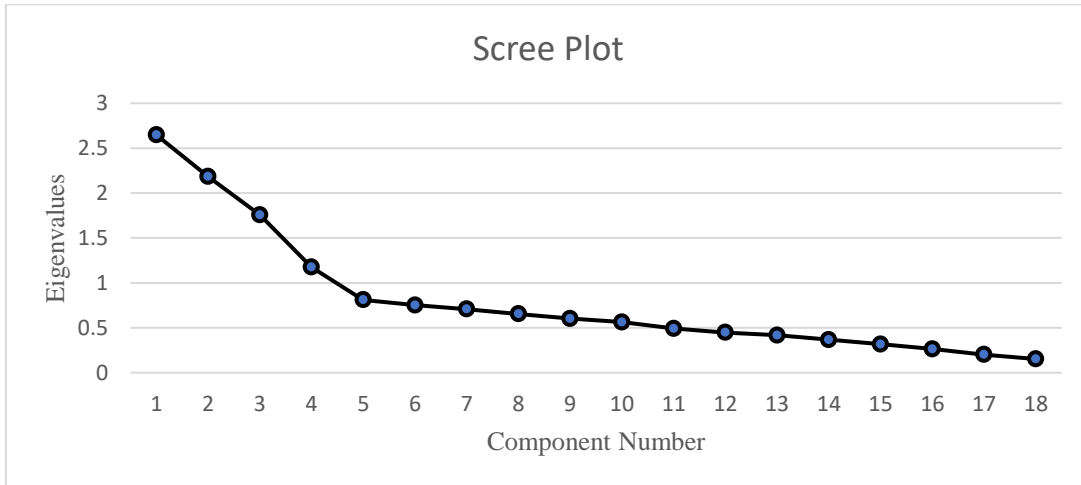
a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

Extraction Method: Principal Component Analysis

4.3.5 Scree Plot

The scree plot from Figure 4.1 determines the optimal number of components to retain in a model.

The component number (1-18) is plotted against its corresponding eigenvalue, the Kaiser's Criterion suggests retaining components with an eigenvalue greater than 1, which in this case would mean retaining 4 components (2.647, 2.184, 1.757, 1.174); and the "Elbow Rule," which recommends retaining the components before the point where the slope of the line connecting the eigenvalues sharply bends and flattens out. In this data, the steep decline seems to level off around Component 5 or 6, suggesting 5 or 6 components might be retained based on the "elbow."

Figure 4.1 Scree Plot

4.3.6 Component Matrix

The factor analysis identified four significant cluster importance factors influencing elemental cost.

Table 4.35 presents a summary of these clustered importance factors, illustrating how design changes impact the elemental cost

Table 4.35 Component Matrix

	Factors			
	1	2	3	4
E1				0.760
E2		0.747		
E3			0.723	
E4	0.746			
E5				0.702
E6				0.697
E7	0.684			
E8			0.652	
E9		0.630		
E10		0.741		
E11			0.737	
E12	0.614			
E13		0.547		
E14	0.516			
E15			0.741	
E16	0.740			
E17	0.755			
E18				0.525

Extraction Method: Principal Component Analysis.

a. 4 components extracted.

FACTORS 1 Primary Structural Framework

- i Substructure
- ii Framed Structure
- iii Basement
- iv Steelwork
- v Stairs/Ramp
- vi Upper Floor Slab

FACTORS 2 Enclosure and Internal Partitions

- i Block Wall
- ii Door
- iii Windows
- iv Roof

FACTORS 3 – Interior Finishes and Components

- i Floor Finishes
- ii Fittings and Fixtures
- iii Ceiling Finishes
- iv Wall Finishes

FACTORS 4 – Services and Site-Related Operations

- i Mechanical Services
- ii Demolition and Alteration
- iii Electrical Services
- iv Land Scalping

4.4 Strategies to Mitigate Design Changes on Building Project Cost using Mean Item Score

The top three strategies seen in Table 4.4, which exhibit the highest mean importance scores (MIS) in Table 4.4, center on establishing project clarity and financial foresight. Specifically, "To establish a clear and detailed scope of work early in the project" (MIS = 3.54, S/D = 0.817) is perceived as the most crucial, underscoring the necessity of freezing the design intent early to prevent costly downstream variations, a finding well-supported in literature emphasizing detailed planning for cost reduction). This is closely followed by "Building a realistic contingency budget" (MIS = 3.36, S/D = 1.058), which acts as a financial buffer for inevitable minor changes, aligning with project management principles that allocate contingency for known and unknown-unforeseen risks within the scope. Finally, "Strong leadership" (MIS = 3.29, S/D = 1.176) suggests that decisive, authoritative project governance is key to controlling scope creep and managing stakeholder expectations, reflecting the need for project directors to sign off and own the project's financial plan.

Conversely, the strategies ranked at the bottom of the list indicate a lower perceived immediate impact on cost mitigation. For instance, processes like formal "Change management" (MIS = 2.94 S/D = 1.194), while important for documentation, are considered less effective for preventing cost increases than initial scoping. These echoes research that success lies not in managing the change process itself, but in minimizing the need for major changes through initial rigor. Similarly, while beneficial for buildability, "Involving construction teams during design development" (MIS = 3.06, S/D = 1.196) and "Adaptability" (MIS = 3.06, S/D = 1.168) are seen more as facilitating design execution than fundamentally preventing design-change-driven costs, though early collaboration is widely cited as an essential component of cost control and value engineering. The data suggests that success lies not in managing the change process itself, but in minimizing the need for major changes through initial rigor and strong project control.

Table 4.4 Strategies to mitigate of design changes and Mean Item Score, Standard Deviation and Rank

Strategies	MIS	S/D	Rank
To establish a clear and detailed scope of work early in the project	3.54	0.817	1
Building a realistic contingency budget	3.36	1.058	2
Strong leadership	3.29	1.176	3
Early design freezes lock and document decisions after final approvals	3.28	1.136	4
Abstract reasoning	3.25	1.162	5
Constructability analysis	3.20	1.195	6
Decision making discipline	3.18	1.250	7
Building Information Modelling (BIM),	3.15	1.298	8
Design errors and the resultant rework help define risk and safety margins	3.14	1.340	9
Self motivation	3.08	1.167	10
Regular communication and coordination meetings throughout design and construction phases	3.08	1.215	11
Adaptability	3.06	1.168	12
Involving construction teams during design development	3.00	1.196	13
Change management	2.94	1.194	14

4.5 Discussion of Findings

4.5.1 To Identify and Analyze the Key Causes of Design Changes on Building Project in Benin City

The analysis of the causes of design changes reveals a clear hierarchy of factors, with client-driven aesthetic preferences, material constraints, and unexpected site discoveries emerging as the most significant drivers. This finding is consistent with Nurul and Muhammad (2018). The highest-ranked factor, the client's preference for a different architectural style, demonstrates the potent influence of aesthetic considerations and personal tastes during a building project. Such a shift in architectural style is not merely cosmetic; it often necessitates fundamental changes to the design documents, impacts the selection of materials, and invariably alters the overall project scope. This finding underscores the challenge for design teams in managing evolving client expectations that can drastically reshape initial, agreed-upon plans.

Complementing the client-centric drivers are two other major factors rooted in the practical realities of construction and the site itself. Gde, Rusdhi and Agung (2015) highlighted those changes due to actual material availability highlight the pervasive influence of supply chain volatility on the design process. When specified materials are unavailable, design modifications are required to accommodate substitutes, which can introduce delays and variations from the original concept. Similarly, the third-ranked cause, discovery of underground utilities not in records, emphasizes the disruptive nature of unforeseen site conditions. Encountering unmapped infrastructure like pipes or cables mandates unavoidable design revisions to navigate the obstructions, often leading to unforeseen increases in both cost and project timeline noted by Mohamad, Mohammad and Amur (2012).

In contrast to these high-impact factors, the causes ranked at the bottom of the list are interpreted as having the lowest relative impact on inflating project costs directly attributable to the design change

itself. The lowest score belongs to client relocation or project relocation mid-design, suggesting that while highly disruptive, the financial consequences linked specifically to the resulting design alterations are less severe than other issues studied, a view shared by Jamal and Ghaleb (2015). Similarly, major market shift in building occupancy trends is ranked low, indicating that design adaptations to evolving market needs, while necessary, do not trigger the most significant cost overruns.

The second lowest-ranked factor, a reduction in overall project scope due to budget, provides an interesting counterpoint, as the design change here is a deliberate, mitigating action taken to control costs, rather than an external or internal pressure causing a cost escalation, an assessment also reached by Nurul and Muhammad (2018). This grouping of lowest-ranked factors suggests that design changes resulting from proactive financial decisions or broad market shifts, or even logistical disruptions like relocation, are financially less damaging than those stemming from sudden, high-level client aesthetic shifts, unexpected material shortages, or unknown site constraints. The data, therefore, as Gde, Rusdhi and Agung (2015) confirms clearly distinguishes between issues that intrinsically force costly, reactive design changes and those that are either deliberate cost-cutting measures or lower-impact disruptions.

4.5.2 To Identify and analyze the key Influence of Design Changes on The Elemental Cost in Benin City

Design changes significantly influence the cost of the Primary Structural Framework due to the fundamental nature and scale of these components. For the Substructure and Basement, altering the foundation type, depth, or size to accommodate a new structural load or building footprint will have a high-cost impact, as these changes involve significant excavation, material volume, and labor. Similarly, modifications to the Framed Structure, Steelwork, and Upper Floor Slab—such as

changing column spacing, beam sizes, or material from concrete to steel—directly affect the quantity of high-cost materials and the complexity of erection, leading to substantial cost increases or savings. Even seemingly minor changes to Stairs/Ramps can impact structural connections and adjacent components, cascading costs across the entire framework.

The Enclosure and Internal Partitions factor shows a moderate to high-cost sensitivity to design changes, depending on the component's complexity and extent. Changes in the type, thickness, or placement of the Block Wall directly affect material and labor costs, while altering the quantity, size, or specification of Doors and Windows can significantly influence both procurement costs and installation time, especially if high-performance or custom units are specified. The Roof is a key cost driver; a design change from a simple flat roof to a complex pitched or green roof involves a complete overhaul of the structural support, waterproofing, drainage, and material palette, resulting in a considerable change in total project cost.

For Interior Finishes and Components, design changes are generally characterized by a high number of individual components but a lower overall cost impact compared to the structural or enclosure factors, though the impact on perceived quality is high. Switching Floor, Ceiling, and Wall Finishes from standard materials to premium, custom, or highly durable options (e.g., from vinyl tile to marble, or from standard paint to custom millwork) directly escalates material purchase price, while modifications to Fittings and Fixtures—such as opting for high-efficiency plumbing or specialized lighting—can lead to localized cost spikes. These costs are often driven by aesthetic choices and specialized trade labor, making the cost influence of design changes highly dependent on the level of luxury or customization desired.

Finally, the Services and Site-Related Operations factor exhibits a highly variable cost influence based on the scope of the design change. Modifications to Mechanical and Electrical Services can be

extremely costly; for instance, changing the HVAC system from a basic package unit to a complex Variable Refrigerant Flow (VRF) system or implementing advanced automation requires extensive redesign, equipment replacement, and coordination with other trades. Demolition and Alteration costs are directly proportional to the scope of the pre-existing structure being removed or modified, while Landscaping (Land Scalping) costs are highly sensitive to changes in grading, drainage requirements, and the complexity of hardscaping elements. Changes in this factor often affect long-term operational expenses as well as initial construction costs.

4.5.3 To identify and analyze the key strategies of design changes on building project cost in Benin city

The analysis of strategy importance clearly indicates a strong professional consensus favoring proactive planning and financial certainty as the primary drivers for successful cost mitigation in projects. The top-ranked strategy, "To establish a clear and detailed scope of work early in the project", stands out as the most critical intervention a view shared by Jeffrey, Hamzah and Chen (2016). This reflects a deep-seated understanding that ambiguities in the initial design are the root cause of subsequent expensive changes. By "freezing the design intent early," project teams effectively immunize the budget from the cost escalation that accompanies mid-project variations, validating established literature that advocates for detailed, upfront planning as the most effective form of cost management.

The strategies outlined are also highlighted by Jeffrey, Hamzah and Chen (2016), Complementing this focus on scope clarity is the second highly valued strategy, "Building a realistic contingency budget". While not a preventative measure, its high ranking signals the practical recognition that projects are inherently susceptible to unforeseen issues or minor scope adjustments. Professionals view this contingency as an essential financial buffer, a necessary component of responsible project

management that allows for the controlled absorption of inevitable minor risks without jeopardizing the overall budget. This financial foresight, when coupled with the third key strategy, "Strong leadership", forms a robust control mechanism. Strong leadership is seen as vital for the decisive project governance required to enforce the initial scope, manage demanding stakeholder expectations, and ultimately own the project's financial plan, preventing the costly drift known as scope creep Jeffrey, Hamzah and Chen (2016) concurs.

In contrast to these preventatives and controlling strategies, the strategies perceived as less impactful primarily involve reactive management or facilitative processes. Bon and Lee (2011) highlighted that the low ranking of formal "Change management" is particularly insightful. While necessary for documentation and process, its low Mean Importance Score suggests that industry professionals consider it a process for managing the consequences of change rather than a strategy for preventing cost increases in the first place. The data thus argues that efficiency lies not in perfecting the change management ritual, but in the initial rigor and project control that minimizes the necessity for major change events, reinforcing the value placed on the top-tier strategies.

The middling scores for strategies such as "Involving construction teams during design development" and "Adaptability" further support this emphasis on initial rigor over later-stage collaboration or flexibility, Mishra and Aithal (2022) lends credence to this finding. While early construction input is widely accepted as critical for buildability and value engineering, the data suggests that these activities are seen more as supporting the execution of the design rather than fundamentally preventing the initial design-change-driven costs. Ultimately, the collective findings present a clear hierarchy of importance where project success is overwhelmingly perceived to be rooted in front-end control, financial prudence, and authoritative governance, making these the critical focus areas for any cost mitigation effort as detailed by Robert, Peter. And David and Peter (2018).

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

Design changes on a building project stemming significantly by client-driven aesthetic preferences, particularly a shift in architectural style, which often necessitates fundamental redesigns and alterations to the project scope and material selection. This highlights the difficulty design teams face in managing evolving client expectations. Complementing this are two major practical factors: material constraints due to supply chain volatility, which force modifications to accommodate substitute materials, and unexpected site discoveries, such as unmapped underground utilities, which mandate unavoidable design revisions to navigate obstructions, often leading to unforeseen costs and delays.

design changes significantly impact construction costs across all factors, with the Primary Structural Framework exhibiting the highest cost sensitivity due to changes in fundamental elements like the Substructure, Basement, and Steelwork, which involve substantial material and labor investment. Modifications to the Enclosure and Internal Partitions, particularly the Roof and Block Walls, also drive considerable cost variations depending on the complexity and specification changes. While the Interior Finishes and Components factor has a high frequency of changes, its overall cost influence is typically lower but heavily dependent on the chosen level of customization and luxury for items like Floor Finishes and Fixtures. Finally, Services and Site-Related Operations present highly variable and potentially expensive changes, especially in areas like complex Mechanical and Electrical Services, underscoring that design revisions must be managed early to mitigate escalating costs, which often cascade through dependent factors.

Effective mitigation strategies against design change cost escalation is establishing a clear and detailed scope of work early, which validates the literature by showing that freezing the design intent prevents expensive mid-project variations rooted in initial ambiguity. Complementing this is the highly valued strategy of building a realistic contingency budget, acknowledging the inevitability of minor unforeseen issues and providing an essential financial buffer for controlled risk absorption. This dual approach of detailed upfront planning and financial foresight is reinforced by the third key strategy, strong leadership, which is deemed vital for decisive governance to enforce the initial scope, manage stakeholder expectations, and prevent costly scope creep.

5.2 Conclusions

Design changes in construction are an unavoidable reality, stemming from client aesthetic demands, material supply volatility, and unexpected site issues like unmapped utilities. These revisions critically impact costs, with modifications to the Primary Structural Framework (substructure, steelwork) proving the most financially sensitive due to the fundamental nature of the elements. While changes to finishes are frequent, complex services and structural changes drive maximum expense. To mitigate this cost escalation, projects must prioritize three key strategies: first, freezing the design early by establishing a detailed scope of work; second, building a realistic contingency budget for risk absorption; and third, implementing strong leadership for decisive governance to enforce the initial scope and prevent costly scope creep. This combined approach of detailed upfront planning and strict oversight is essential for managing the cascading financial effects of design revisions.

5.3 Recommendations

Prioritize Robust Initial Scoping: Project teams must invest heavily in developing an exhaustive, frozen initial scope of work and detailed design before any on site work begins. This document should feature high resolution visualizations and a locked bill of materials, mandating formal, written authorization and a full cost/time impact assessment for any subsequent client requested deviation.

Implement a Change Control Protocol: Establish a rigorous, non-negotiable Change Order Management System (COMS). This system must clearly quantify not just direct costs but also indirect costs like rework, administrative time, and schedule penalties for every requested change. This transparency manages client expectations and acts as a financial deterrent to non-essential scope creep.

Strengthen Project Leadership and Communication: Elevate the role of the Project Manager to be a primary financial steward, empowered to exercise abstract reasoning to foresee downstream cost impacts. They should conduct regular, formal client meetings focused solely on budget adherence, utilizing cost to complete forecasts to reinforce the financial consequences of design and material changes.

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APPENDIX

RESEARCH QUESTIONNAIRE



Department of Quantity Surveying,
Faculty of Environmental Sciences,
University of Benin,
P.M.B 1154, Ugbowo,
Benin City, Edo State.

Dear Respondent,

Request for Response to Questionnaire

I am a student of the University of Benin, currently undertaking a B.Sc. programme in Quantity Surveying. I am carrying out a research project titled, **“EFFECTS OF DESIGN CHANGES ON BUILDING PROJECT COST IN BENIN CITY”**.

The goal is to analyse how design changes impact the elemental costs and overall budget of building projects in Benin City.

Kindly assist me by completing the attached questionnaire with respect to the last completed building project handled by the professional which will be used solely for research purposes.

Your responses will be kept confidential.

Thank you.

Yours sincerely,

Thomas Azuka Ikukaiwe

+2347061449788

QUESTIONNAIRE

SECTION ONE

GENERAL INFORMATION

PLEASE KINDLY TICK THE OPTION THAT APPLIES TO YOU

1. What is your profession?

- (A) Architect [] (B) Builder [] (C) Engineer [] (D) Quantity Surveyor [] (E) Site Supervisor []

2. How many years of professional experience do you have?

- (A) 0 5 years [] (B) 6 to 10 years [] (C) 11 to 15 years [] (D) 16 to 20 years [] (E) above 20 years []

3. Please indicate your highest level of educational attainment

- (A) ND/OND []
 (B) HND []
 (C) B.sc/B.Tech []
 (D) PGD []
 (E) PhD []
 (F) M.Sc./ M.Phil. []

4. Please specify if you are a member of any professional organizations or associations.

- (A) MNIA [] Reg.Arc []
 (B) MNIOB [] Reg.Bldr []
 (C) MNSE [] Reg.Egrn. []
 (D) MNIQS [] Reg.QS []

5. Telephone number (Optional) _____

SECTION TWO

1. CAUSES OF DESIGN CHANGES IN BUILDING PROJECT

Please indicate your agreement with the following causes of Design Changes on Building Project using the following scale: 1 = Strongly disagree, 2 Disagree, 3 = Neither agree nor disagree 4 = Agree, 5 = Strongly Agree

S/N	CAUSES	1	2	3	4	5
1	Client's preference for a different architectural style					
2	Change in client's budget allocation					
3	Alteration in material preference (e.g., wood to steel)					
4	Requirement for energy efficient systems					
5	Need for cultural or religious design adjustments					
6	Design errors or omissions in drawings					
7	Conflicting information between drawings and specifications					
8	Structural design miscalculations					
9	Overlooked building code requirements in initial design					
10	Revision of window/door schedules for performance					
11	Design optimization to reduce maintenance cost					
12	Changes to meet updated building codes					
13	Zoning restrictions requiring design modification					
14	Adjustment to meet environmental regulations					
15	Changes from safety inspections					
16	Unexpected soil conditions					
17	Discovery of underground utilities not in records					
18	Site access limitations requiring design change					
19	Changes due to actual material availability					
20	Fabrication constraints from suppliers					
21	Changes due to site boundary disputes					
22	Incompatibility with existing retained structures					
23	Material price escalation					
24	Cost overruns requiring value engineering					
25	Unavailability of specified imported materials					

26	Bulk purchasing opportunities					
27	Reduction in overall project scope due to budget					
28	Discovery of endangered species on site					
29	Major market shift in building occupancy trends					
30	Client relocation or project relocation mid design					

SECTION THREE

2. EFFECTS OF DESIGN CHANGES TO THE ELEMENTS OF BUILDING ON PROJECT COST

Please indicate your how Design Changes influence these elements of building on Project cost shown below using the following scale:

1 = Cost overrun, 2 = No cost difference, 3 = Cost underrun

S/N	Elements	1	2	3
1	Mechanical Service			
2	Block wall			
3	Floor finishes			
4	Substructure			
5	Demolition and Alteration			
6	Electrical services			
7	Framed Structure			
8	Fitting and Fixtures			
9	Door			
10	Windows			
11	Ceiling Finishes			
12	Basement			
13	Roof			
14	Steelwork			
15	Wall finishes			
16	Stairs/ramp			
17	Upper Floor Slab			
18	Land scalping			

SECTION FOUR

3. STRATEGIES TO MITIGATE DESIGN CHANGES ON BUILDING PROJECT COST.

Using the scale below, kindly indicate your agreement with the following Strategies to Mitigate Design Changes on Construction Project Cost with . 1 = Strongly disagree, 2 Disagree, 3 = Neither agree nor disagree 4 = Agree, 5 = Strongly Agree

S/N	Causes	1	2	3	4	5
1	To establish a clear and detailed scope of work early in the project					
2	Early design freezes lock and document decisions after final approvals					
3	Design errors and the resultant rework help define risk and safety margins					
4	Change management					
5	Building a realistic contingency budget					
6	Regular communication and coordination meetings throughout design and construction phases					
7	Constructability analysis					
8	Building Information Modeling (BIM),					
9	Involving construction teams during design development					
10	Strong leadership					
11	Decision making discipline					
12	Adaptability					
13	Self motivation					
14	Abstract reasoning					