DEVELOPMENT OF MULTI - OBJECTIVE OPTIMIZATION MODEL FOR PROJECT PORTFOLIO SELECTION USING A HYBRID METHOD

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By

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ABSTRACT

Selecting inappropriate projects and project portfolios can result in irreversible wasted economic opportunities, reduced manpower value, and missed prospects and other resources for the organization. As a result, to achieve the best possible outcome, all criteria to enable the best possible choices to be made should be considered. Choosing projects wisely and managing the project portfolio can assist organizations in gaining a better understanding of their projects and their risks and advantages. When faced with budget and other constraints, the ability to select an optimal mix of projects is a significant advantage in the project selection process. The selection of projects by means of employing an effective method is uncommon because many methods are deemed ineffective due to limitations on the number of projects that can be chosen, along with the failure to select economical projects. Project selection is a complex, multi-criteria decision-making procedure involving numerous and frequently competing goals. The complexities of project selection problems stem primarily from the large number of projects that are required to be selected for an appropriate collection of investment projects. The study identified some research gaps such as limited studies on social sustainability benefits, criteria for public project selection not being considered or mentioned, and the decision-making committee or expert generating weight to the deviational variables instead of using weighting techniques.

The aim of this study is to employ an integrated approach to establish a multi-objective optimization approach for public project portfolio selection. The specific research objectives are to develop an integrated method of Analytic Hierarchy Process, Goal Programming and Genetic Algorithm (AHP-GP-GA), establish a relationship for the developed models to correct the bias of each model and apply the integrated method in a selected community with a set of projects. Data was collected by compiling a well-structured questionnaire for decision-makers analysed by applying the AHP and GP methods.

The composition of the integrated approach includes decision support tool with exact and includes meta-heuristic modelling known as Analytic Hierarchy Process, Goal Programming and Genetic Algorithms (AHP-GP-GA) for solving public project portfolio selection problems. The Analytic Hierarchy Process model was used to develop project selection criteria, assign relative priority weights of decision makers, and determine the overall weight of project alternatives. The GP constructed the mathematical model to handle large numbers of objectives and constraints. The GA is the solution algorithm for the effective and flexible optimization model to produce optimal solutions. The AHP and GA employed Spice Logic and MATLAB software packages to analyse, validate and enhance the research. The AHP model highlighted some sub-criteria and project criteria attributes that are significant to project selection criteria. These criteria are economic development, job creation, community acceptance, structure aligned with company goals, employment record of project manager, locality of the project, finish period of the project selected, project threats and political impact.

Meanwhile, empirical research on public agencies was undertaken with the AHP-GP-GA, AHP-GP and GP separately to address the problem. The GP and AHP-GP used the LINGO 18.0 software package, while the developed integrated method AHP-GP-GA was solved using MATLAB software package to exhibit the competence of the model and the research. The high point of the empirical research showed that the AHP-GP-GA model can solve large-scale, or complex problems with a large number of decision variables. It selected more projects compared to the AHP-GP and GP standalone model and provided more optimal solutions, which made the approach robust and flexible for solving decision-making problems.

The theoretical and practical contributions of the study are the research, which will improve the knowledge and understanding of researchers or academia in PPSP and add to the literature to enhance the existing methods of integrated approaches. The stakeholders in project management practitioners like organization management, top executives, senior and junior supervisors, and personnel connected to the projects will also benefit from the research in selecting optimal projects from the various solution options, saving costs, and learning how to handle and select more complex projects in large-scale real-life situations. This study recommends further research on the integration of stochastic models, evolutionary algorithms, or computation with AHP and GP for the Public Project Portfolio Selection Problem.

DECLARATION

I, Mogbojuri, Akinlo Olorunju, hereby declare that this thesis is my original work, that all citations and texts are properly referenced, and that this thesis has not been submitted to any other university for any other degree. This thesis is being submitted to the Department of Industrial Engineering for the degree of Doctor of Engineering (DEng).

Submitted by

____28/10/2023________________

Mogbojuri, Akinlo Olorunju Date

Approved for submission by

____

Prof O. A. Olanrewaju Date

DEDICATION

This doctoral thesis is dedicated to the God Almighty, Who was, Who is and Who is to come, for His presence, protection, provision (wisdom, knowledge and understanding) and preservation of my life.

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LIST OF ACRONYMS

The notations are presented as follows:

S_y = School projects awarded in period (y)

HC_y = Health centre projects awarded in period (y)

H_y = Housing projects awarded in period (y)

SPW_y = Solar power water scheme projects awarded in period (y)

RI_y= Road infrastructure projects awarded in period (y)

WJ_y = Water jetty projects awarded in period (y)

CC_y = Civil centre projects awarded in period (y)

E_y = Electrification projects awarded in period (y)

P = Priority level of decision making

W = Weights of the project alternatives

y = Number of period or year projects awarded

a_{ij} = the coefficient of the jth decision variables in the ith goal

x_{ij} = Decision variables of the jth set

x_{ij} = 1, if project i or j is selected

x_{ij} = 0, if project i or j is not selected

C_{ij}= Cost of projects $i\ or\ j_{th}$ awarded

N = Total number of projects awarded

$i\ or\ j$ = Number of projects

D_{iy} = Duration of project i in period (y)

E_{iy} = Number of jobs created when project i is executed in period (y)

ACOS = Ant Colony Optimization System

ACOS = Ant-Colony Outranking System

AHP = Analytical Hierarchy Process

AHP-GP-GA = Analytic Hierarchy Process - Goal Programming - Genetic Algorithm

AHP-TOPSIS-2N = Analytic Hierarchy Process - Technique for Order of Preference by Similarity to Ideal Solution

AI = Artificial Intelligence

ANFIS = Adaptive Neuro-Fuzzy Inference System

ANN = Artificial Neural Network

ANP = Analytic Network Process

BG = Belief Degrees

BIG = Beam-Search Informed Genetic Algorithm

BOT = Build-Operate-Transfer

BRKGA = Biased Random-Key Genetic Algorithm

BSC = Balanced Scorecard

CBR = Case-Based Reasoning

CFDC = Community Futures Development Corporations

CO = Capability Options

DEMATEL= Decision making trial and evaluation laboratory

DE = Differential Evolution

DEA = Data Envelopment Analysis

DM = Decision Maker

DRLC = Desired Risk Level of the Company

DRSA = Dominance-based Rough Set Approach

DSM = Design Structure Matrix

DSS = Decision Support Systems

EA = Evolutionary Algorithms

EM = Electro-Magnetic

ESPRI = Evolutionary Algorithm for Solving the Public Portfolio Problem from Ranking Information

EVIKOR = Extend VlseKriterijumska Optimizacija I Kompromisno Resenje

FAHP = Fuzzy Analytic Hierarchy Process

FAHP-ANN = Fuzzy Analytical Hierarchy Process - Artificial Neural Network

FANP = Fuzzy Analytical Network Process

FDFD = Future Defence Force Design

FRB = Fuzzy Rule-Based

FGP = Fuzzy Goal Programming

FIGP = Fuzzy Interval Goal Programming

FIS = Fuzzy Inference System

GA = Genetic Algorithm

GAMS = Generalized Algebraic Modelling System

GBML = Genetic Based Machine Learning

GIS = Geographic Information System

GP = Goal Programming

GPGA = Goal Programming Genetic Algorithm

HD = Human Development

H-MCSGA = Hybrid Multi-Criteria Sorting Genetic Algorithm

HPC = High-Performance Computing

ICA = Imperialist Competitive Algorithm

IMO-DRSA = Interactive Multi-Objective Optimization-Dominance Based Rough Set Approach

ILP = Integer Linear Programming

INLP = Integer Non-Linear Programming

IT = Information Technology

ITA = Iterative Trichotomic Approach

IS = Information System

IT/BD = Information Technology/Business Development

IT2FSs = Interval Type-2 Fuzzy Sets

LSR-PV = Large-Scale Rooftop Photovoltaic

LGP = Linear Goal-Programming

MABAC = Multi-Attribute Border Approximation Area Comparison

MADA = Multi-Attribute Decision-Making

MCDM = Multi-Criteria Decision Making

MDM = Modified Delphi Method

MSVP = Mean-Semi Variance Project

MGPS-fuzzy = Methodology for Governmental Project Selection Using Fuzzy Logic

MILP = Mixed-Integer Linear Programming

MINLP = Mixed-Integer Non-Linear Programming

MIQP = Mixed-Integer Quadratic Programming

MAPPSSP = Multi-Attribute Project Portfolio Selection and Scheduling Problem

mPOEMS = Multi-Objective Optimization Strategy Called Optimization Technique Optimization with Evolved Improvements Steps

MATLAB = Matrix Laboratory

MOCS = Multi-Objective Binary Cuckoo Search

MODM = Multi-Objective Decision Making

MOEA/D = Multi-Objective Evolutionary Algorithm based on Decomposition

MOGA = Multi-Objective Genetic Algorithm

MCGP-UF = Multi-Choice Goal Programming with Utility Function

MOPSO = Multi-Objective Particle Swarm Optimization

NDCS = Non-Dominated Cuckoo Search

NLP = Non-Linear Programming

NOSGA-II = Non-Outranked Sorting Genetic Algorithm II

NMBP = Non-linear Multi-Objective Binary Program

NSGA-II = Non-dominated Sorting Genetic Algorithm II

NPV = Net Present Value

OPA-R = Robust Ordinal Priority Approach

OWA = Ordered Weighted Aggregation

PF = Proposed Framework

PM = Project Management

PP = Project Portfolio

PS = Project Selection

PPP = Public Private Partnership

PPSP = Project Portfolio Selection Problem

PPSSP = Project Portfolio Selection and Scheduling Problem

PPM = Project Portfolio Management

PPS = Project Portfolio Selection

PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses

PROMETHEE II = Preference Ranking Organization Methods for Enrichment Evaluations

PROSEL = PROject Analysis and SELection

PSO = Particle Swarm Organization

QFD = Quality Function Development

R&D = Research and Development

REP = Renewable Energy Project

ROI = Region of Interest

ROI = Return on Investment

(rNPV) = Risk-Adjusted Net Present Value

kRGH = k – random risk greedy heuristics

RPP = Robust Possibilistic Programming

SA = Simulated Annealing

SAW = Simple Additive Weighting

SD = Stochastic Dominance

SEM = Structural Equation Model

SGLR = Strategic Goal Loss Rate

SMAA = Stochastic Multi-Attribute Acceptability Analysis

SPEA2 = Strength Pareto Evolutionary Algorithm 2

TIFNs = Triangular intuitionistic fuzzy numbers

TLBO = Teaching-Learning-Based Optimization

TOPSIS = Technique for Order Preference by Similarity to Ideal Solution

TS = Tabu Search

VIKOR = VlseKriterijumska Optimizacija I Kompromisno Resenje

WAFGP = Weighted Additive Fuzzy Goal Programming

WCBD = Weighted Cumulative Belief Degree

ZODP = Zero–Desirability Programming

ZOGP = Zero-One Goal Programming

TS = Total cost of School

THC =Total cost of Health Centre

TH = Total cost of Housing

TPSW = Total cost of Solar Power Water Scheme

TRI = Total cost of Road Infrastructure

TWJ = Total cost of Water Jetty

TCC = Total cost of Civic Centre

TE = Total cost of Electrification

TES = Total Employment School

TEHC = Total Employment Health Centre

TEHC = Total Employment Housing

TESPW = Total Employment Solar Power Water Scheme

TERI = Total Employment Road Infrastructure

TEWJ = Total Employment Water Jetty

TECC = Total Employment Civic Centre

TEE = Total Employment Electrification

TDS = Total Duration School

TDHC = Total Duration Health Centre

TDH = Total Duration Housing

TDSPW = Total Duration Solar Power Water Scheme

TDRI = Total Duration Road Infrastructure

TDWJ = Total Duration Water Jetty

TDCC = Total Duration Civic Centre

TDE = Total Duration Electrification

RESEARCH OUTPUTS

1.) **A. O. Mogbojuri** and O. A. Olanrewaju (2023). Using the deterministic approach model for project portfolio selection problem (PPSP) solutions. Heliyon 9 e19129. https://doi.org/10.1016/j.heliyon.2023.e19129

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4.) **A.O. Mogbojuri,** R. Taiwo; O. A. Olanrewaju; A. Darko; A. P. C. Chan; I. A. Awodele (2023). Project portfolio selection using integrated methods: A scientometric-systematic review. Computer and Industrial Engineering, Manuscript No: **CAIE-D-23-03484** (**Under Review)**

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6.) **Mogbojuri, A.O.,** Olanrewaju, O. A. and Oloyede, O. J. (2023) Goal Programming Approach for Waterway Transportation System, IEOM International Conference on Smart Mobility & Vehicle Electrification, Lawrence Technological University, Michigan, USA, 10^{th} – 12^{th} October, 2023.

Article Outside Research

1.) **Mogbojuri, A.O**., Olanrewaju, O. A. and Adeyeye, A. D. (2023). Linear Programming Model for Scheduling Bus Rapid Transit in Lagos State, Nigeria. Nigerian Journal of Technology (NIJOTECH) Vol. 42, No. 2, pp.236 – 243 https://doi.org/10.4314/njt.v42i2.11

CHAPTER ONE: INTRODUCTION

1.1 Introduction

A project consists of interconnected tasks carried out by numerous companies and has a well-defined objective, schedule and budget. In the conventional method, each project must meet three criteria: budget, schedule and quality. The budget is the project's specified or authorized cost and the target cost of the work to be completed. The schedule specifies the time and date of completion of works, in addition to the desired completion date. Quality refers to the standards and criteria that define what the stakeholder expects from the project's outcomes, as well as satisfying other criteria for performance (Archer & Ghasemzadeh, 1999; Nicholas, 2000).

Project selection is critical in industrial management, industrial engineering, and governmental, non-profit, and commercial organizations. The following is a breakdown of the project selection process: it begins with the continual gathering, analysis, and evaluation of available information about a project, which leads to project selection while considering the elements that influence the selection process. A project portfolio selection process is a multi-criteria decision problem that considers both quantitative and qualitative aspects (Razi, 2014). According to Perez & Gomez, (2016), there are three main areas in the project portfolio selection process: (1) Selection happens over a set period, which is typically separated into months, quarters and years, during which periods the availability of funds differs. In contrast, several projects may have a different priority order, which must be considered when solving the problem. (2) Concurrent project implementation may involve mutually beneficial relationships (shared resources). These interactions can result in projects that would not be chosen on their own but would be chosen if implemented alongside other projects. (3) Organizations strive for the best results in terms of various criteria (maximizing profits, minimizing risk, utilizing a minimum of resources, and contributing significantly to regional social development).

A social project is a collection of tasks or activities that consume cash and are carried out over a while in one or more regions, with an impact on the goals defined by an organization, institution, or agency and aimed at solving societal problems or requirements (Litvinchev et al., 2014). When goals are achieved in social projects, they benefit society. These goals are often intangible, such as social and scientific influence and human resource training, and they are measured based only on prospective economic advantage. It's also worth noting that most of these initiatives are assigned to a single area, state, or region. The region is primarily concerned with the geographic area that will benefit, which could be a state, county, district, or town, and the following are considered.

1. No single area/state/region may be allocated the maximum share of the budget, leaving the remaining areas/states/regions with insufficient resources.

2. A minimum budget is allocated to all areas/states/regions, assuring their long-term viability and growth (Rivera et al., 2012).

Prioritizing projects and building project portfolios according to rational principles helps achieve normative requirements, such as those underlying prevalent public policies or political ideology (e.g., maximizing social benefits). Public projects are characterized as the following:

(1) While the projects are profitable, their effects are indirect, possibly only noticeable in the long term, and difficult to quantify.

(2) To establish an integrated social vision, some intangible advantages should be evaluated in addition to their potential economic contributions to social welfare.

(3) Equity should be considered regarding impacts and the social conditions of those benefiting (Fernandez et al., 2013). In social or public domains, the goal is usually to maximize the portfolio's quality in terms of the social impact of the projects chosen. The Social Project Portfolio Selection Problem, which is described as a multi-criteria problem, presents a challenge for multi-objective optimization algorithms (Rivera et al., 2012). Meanwhile, there has been relatively less attention on the social impact or benefits of project portfolio selection problems than on economic and environmental benefits. Therefore, this research considers the social sustainability PPSP for the quality of life and significant influences on society or community. The significance of the study is that the hybrid method will update knowledge and enable managers (practitioners) in PPSP to select projects for social impact in both developed and developing communities.

The reminder of this chapter consists of the research background, statement of the research problem, research aim and objectives of the study, methodology, significance of the study, thesis structure and conclusion.

1.2 Research Background

PPS studies have grown in popularity since the early 2000s, according to research. Still, the studies of Archer and Ghasemzadeh (1998 and 1999) paved the way and established an innovative way for scholars to conduct PPS research. However, in the last few years (the 2010s), the number of PPS studies has increased significantly (Mohagheghi et al., 2019).

A group of researchers approached the PPS problem as a multi-objective problem, with the goal of selecting the best candidate projects while optimizing conflicting objectives such as maximizing the organization's profit or minimizing risk within a set of constraints (El-Kholany & Abdelsalam, 2017). A portfolio includes projects, programs, and other activities such as maintenance and continuous operations. All the components have been integrated to make the portfolio and achieving the company's objectives easier (Mohagheghi et al., 2019). The proposed project components are identified, reviewed, selected, and approved in a portfolio format. Only a few portfolio variables can be measured, categorised, prioritized, chosen, and scheduled (Ghannadpour et al., 2021).

According to (Arratia-Martinez et al., 2021), a project portfolio is a cluster of project proposals chosen by a decision-maker based on one or more criteria (individual or group). After receiving project proposals in response to a demand, a funding organization must select which ones to support based on constraints (such as a limited budget) and criteria (goals, priorities, and preferences). The portfolio of projects gets funding over time, either simultaneously or sequentially (Arratia et al., 2016). Multiple project proposals are generated to benefit organizations and business reputations (Koohathongsumrit & Luangpaiboon, 2022). Due to limited cost, time, resources, and other factors, organizations must choose a suitable project portfolio (PP) from such candidate projects (Bai et al., 2023). These factors influence the final decision, which has a significant impact on the organization's strategy's success or failure (El-Kholany and Abdelsalam, 2017). Project portfolio selection is a strategic approach that entails prioritizing projects for implementation inside an organization based on their alignment with their strategy and considering the company's limited resources. It is a process through which organizations choose the most relevant projects to match project implementation with strategy completion and boost their competitiveness (Verdecho et al., 2020).

Portfolio selection and optimization seek the optimal project mix that maximizes resource utilization while lowering project portfolio risk. Furthermore, as the knowledge base grows, techniques such as interactive methods, scoring, portfolio optimization, decision analysis, mathematical programming, economic models, and decision support systems (DSS)/artificial intelligence (AI) are employed (Hansen & Svejvig, 2022). Optimization problems are a type of problem that is frequently encountered in engineering applications and scientific research. These problems entail determining the best solution or solutions to a specific problem. Single-objective optimization problems have a single objective function, whereas multi-objective optimization problems (MOP) have multiple objective functions and attempt to satisfy all objective functions at the same time. A multi-objective optimization solution is frequently composed of a number of equilibrium solutions, which are a collection of optimal solutions arranged into many sets of Pareto optimal solutions, with each component known as a Pareto optimal solution (Wang et al., 2023).

Optimization is the process of determining an optimal set from a set of all potential solutions to a given problem. To find such a solution, an optimization algorithm is typically developed. Regardless of the structure, such algorithms must compare two solutions at some point to determine which one is superior. An objective function (which is commonly implied to as fitness, expenditures) is employed to estimate the worth of every result (Mirjalili & Dong, 2020). In the study of (Mogbojuri & Olanrewaju, 2022), there exist two key elements to multi-objective optimization issues such as: (a) establishing the Pareto excellent outcomes (optimization) and (b) determining the best preferred result. The optimization procedure can uncover the most suitable solution, or the optimum level. Optimization problems can have a maximum or a minimum value, as well as a single or multiple objectives. Multi-objective optimization (MOO) refers to problems with numerous objectives rather than a single objective.

The rationale for using the MOO is that it does not involve complicated equations in optimization, which simplifies the problem. Making decisions using MOO requires a compromise (trade-off) on some contradictory issues. The exhaustive method, which checks the entire solution, can be used in the MOO to find the optimal value. For a large-scale situation, determining the optimal value can be employed through specific algorithms to aid in the means of finding the optimal solution. The algorithm can be a metaheuristic algorithm, i.e., a more advanced approach or heuristic designed to discover, create, or select heuristics that might offer an adequately good solution to an optimization problem, such as GA that relies on genetic and natural selection mechanisms, with three basic operators as follows: selection, crossover, and mutation; particle swarm optimization (PSO) as a stochastic optimization technique that mimics the ’swarming’ behaviour of animals like birds and insects. It creates a population of particles that move in the search space by cooperating or interacting with one another; and also, ant colony optimization (ACO) that is based on the natural behaviour of ants, which can navigate using pheromone routes, and so on (Gavrilas, 2016; Gunantara, 2018). Optimization models have several benefits, including the ability to select projects without bias or subjectivity. Optimization models take into consideration the correlation between projects and other elements that other approaches do not contemplate (Caballero et al., 2012). Using optimization methods is one of the most common approaches in PPS. However, given the wide range of PPS applications and features, it is impossible to say which optimization approach is the best, and each problem necessitates a different approach (Mohagheghi et al., 2019).

According to (Wei et al., 2020), study authors are more interested in project portfolio optimization than in project interaction. Meanwhile, much research has confused multi-objective optimization with multi-criterion decision-making because the weighting operation directly transforms multiple objectives into a single objective. In fact, multiple ideas and algorithms have been developed mainly for multi-objective optimizations (Wei et al., 2020). PPS optimization problems are developed as knapsack problems, in which a subset of projects must be chosen from a list of tasks, each with its benefit and expenditure profile, to maximize the overall benefit of the selection while not exceeding the total allowed spending limit (Sampath et al., 2021). As a result, project selection has become critical at every step of a company's strategy and objective (Koohathongsumrit and Luangpaiboon, 2022). However, professionals face two difficulties when deciding on the best project portfolio. First, the broad interactions between projects have an impact on the true value and risk of a project portfolio. Second, because project portfolio optimization continues to have multiple objectives that are efficient in obtaining non-dominated solutions, they propose the issue of how to select the optimal project portfolio from these potential solutions (Wei et al., 2020).

PPS is among the best critical decision-making concerns for many organisations in PM and engineering management (Nowak & Trzaskalik, 2021). PS and portfolio management are accomplished by means of a multi-stage process that involves pre-screening, analysis, and screening of new-project proposals, followed by ranking, selecting, and ongoing review of current projects. Portfolio management is the procedure of selecting and managing projects that best accomplish company goals while adhering to resource constraints (Nicholas & Steyn, 2012)

Project portfolio management is divided into two process groups: project evaluation and selection, and project implementation. Prioritizing and selecting projects submitted with the best chance of success is a critical aspect of project portfolio management (Ebnerasoul et al., 2022).

Project portfolio management (PPM) is managing a group of programs and projects as an integrated system and appropriately allocating financial, technological, and human resources. For organizations, project portfolio management is critical for prioritizing and ranking projects by organizational strategies. PPM entails finding, analysing, choosing, and prioritizing projects, as well as balancing the project portfolio to ensure that projects are aligned with the organization's objectives, vision, mission, and values (Golghamat Raad et al., 2020). Project portfolio management is gaining momentum as a tool for prioritizing and managing various projects at the enterprise level (Muriuki & Gitonga, 2018).

Project portfolio management has become an effective technique for organizations to manage their projects effectively and efficiently by selecting and organising initiatives. Project portfolio management is a managerial activity related to the initial screening, selection, and prioritization of project proposals, the concurrent re-prioritization of projects in the portfolio, and the allocation and reallocation of resources to projects based on priority. As a result, project selection is a method of evaluating individual projects or groups of projects before deciding which ones to pursue to achieve the organization's objectives. Prioritization and the selection of projects in portfolio management for projects are accomplished through management approaches or optimization algorithms that employ specific project selection criteria. There are two approaches to project portfolio selection: one is based on a traditional methodology widely used in practice, and the other is a quantitative analysis using new advanced methods and techniques (Mohammed, 2021). Project portfolio selection is a common research topic in project management. It's also an intricate managerial problem that's gaining prominence in practice and as a field of academic study. It usually includes multiple, varying, and inadequate criteria (Kandakoglu et al., 2020).

1.3 Research Problem

Project selection is a critical decision in virtually every organization, most especially in project-based organizations, and has a vital role in the achievement of an organization (Namazian et al., 2019). Managers of project-based organizations are constantly faced with a project portfolio selection problem due to limited budgetary resources. A variety of experimental and analytical mechanisms are developed and presented. Many tools prioritise projects based on expert assessments of their worth, relevance, and resources. The standard techniques and methods of project selection in many industries consist of two steps: First, all the projects are evaluated, and the best set of projects is chosen using a greedy algorithm. A group of specified criteria is used to select and prioritize these projects. Second, until all resources are exhausted, projects are chosen based on their priority (Namazian & Yakhchali, 2016). However, any organization's resources are limited, which affects the number and type of projects that can be included in a given portfolio. As a result, project portfolio managers must manage them through a dynamic decision process in which (i) new projects are assessed, chosen, and prioritized; (ii) existing projects may be intensified, eliminated or deprioritized; (iii) a business's record of helpful projects is continually reviewed and revised; and (iv) resources are distributed and redirected to the ongoing projects (Saiz et al., 2022). Previously, company decision-makers did not use a specific technique to select projects. They usually made this decision based on their intuition or experience. However, because this process is tedious and time-consuming, researchers were motivated to establish more formal selection systems (with quantitative tools) to help decision-making. More mathematical programming models enabled decision-makers to incorporate a variety of issues and factors, such as economic, technical, social, political, and environmental considerations (Carazo et al., 2012). Typically, project portfolio selection is formulated as a combinatorial problem with such a large set of alternatives that exact methods are ineffective (Nowak, 2013). Carazo et al., (2010) also agreed with the above points that finding solutions with exact algorithms is computationally expensive or even impossible in some cases; there is thus growing interest in the use of metaheuristic procedures. Aminbakhsh (2018) explained further that exact methods are inefficient in finding optimal solutions to large-scale problems. They are crucial in evaluating the efficacy of alternative optimization methods such as heuristics and meta-heuristics. However, the quality of the results achieved using other methods cannot be calculated without the existence of an exact solution. Because of the prior resource constraints, optimization methodologies are required to assist executives or companies in managing project portfolios, that is, deciding which projects should be completely financed, partially financed, or not financed entirely. However, some professionals argue that the existing PM approaches utilized in their organizations (that depend on the net present value and strategic scoring criteria) are inappropriate given their structures for one-off decisions, lack of reliable information, exclusion of resource constraints, and inexperience of the dependencies among various projects. Meaning that, new optimization methods are required to account for all relevant factors while supporting dynamic decision making, and the addition of realistic constraints to some portfolio optimization problems has caused them to become NP-hard. Thus, metaheuristics are becoming more popular to address project portfolio problems (Saiz et al, 2022). Metaheuristics primarily uses stochastic operators to examine the search space and find near-optimal solutions effectively. In contrast to deterministic algorithms, stochastic methods furnish multiple results with each iteration Mirjalili and Dong, (2020). Organizations have to establish or adjust a systematic approach to project portfolio selection in order to ensure beneficial results from effective and efficient project portfolio selection. This systematic approach incorporates the integration of methods, or models and frameworks, or processes (Afshari et al., 2018)

Iamratanakul et al., (2008) stated in their review of existing methods on project portfolio selection that one method is not suitable for all PPS because individual approach exhibits a unique identity set of benefits and drawbacks. They suggested conducting research on the integration of different methods in order to establish more accurate computation or use to an entirely novel application. Mohagheghi et al. (2019) examined project portfolio selection problems models, uncertainty approaches, solution techniques, and case studies. They presented several reviews of project portfolio selection problems in many categories, and selection and evaluation criteria (financial, risk, strategic, green and environmental, social, sustainability, and others). They opined that some researchers used uncertainty theories such as stochastic, fuzzy set theory and grey theory and modelling approaches like frameworks and decision support systems (DSS), optimization methods, scoring methods, and solution approaches to find the best project portfolio under exact heuristics, and meta-heuristics. The study trends consider the social and environmental aspects of project portfolio selection and using meta-heuristics to find the solution to mathematical models. They also opined that using hybrid methods in addressing uncertainty would improve the existing methods (Mohagheghi et al., 2019). There are some studies on decision support tool, exact and meta-heuristic methods on PPSP. Eldrandaly (2007) employed analytical hierarchy process (AHP) to select suitable GIS software package and in a related study Mohamad, (2015) used AHP to identify the project selection criteria to meet a group of companies' requirements. Kim and Emery (2000) developed goal programming model to determine which project to purse to maximize profits, also in another study, Liao (2009) presented a zero-one goal programming (ZOGP) to select a set of marketing activity project. Martinez-Vegas et al (2019) used another exact approach called integer linear programming to select sub-set projects and scheduled them with a period. Ma et al, (2020) employed Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) to consider some criteria for PPS. Kumar and Pushkar, (2015) developed GA to elucidate multi-criteria PSP, while Zhao and Huang, (2017) applied GA to solve PSP with complicated limited resources. Gomez et al (2018) employed ACOS to involves decision makers preferences of PS in allocating a general budget. Lee and Kim, (2000) integrated analytic network process (ANP) and ZOGP for IS project selection problems. Mohammed, (2021) developed AHP-TOPSIS for project alternatives, evaluation, and selection for oil projects. Wu et al (2018) also applied integrated approaches called Triangular intuitionistic fuzzy numbers, analytical hierarchy process, Preference Ranking Organization Methods for Enrichment Evaluations and Non-dominated Sorting Genetic Algorithm II (TIFNs), (AHP), (PROMETHEE II) and (NSGA-II) for optimal pareto set. Namazian et al (2019) developed

Goal Programming Genetic Algorithm (GPGA) for both small and medium size PPSP. Chen et al (2021) also developed NSGA-II-TOPSIS to optimize investment portfolio for multi-objective PSP. The above points of view showed there were limited studies on social sustainability project benefits, fewer criteria for public project selection, and exact algorithms were ineffective for large-scale projects.

Therefore, a hybrid method that includes a metaheuristic algorithm is proposed for practitioners and non-practitioners with a multiple objective's optimization model in the public PPSP for a Pareto optimal solution in a developing or developed community.

1.4 Research Questions

The following questions has been raised based on the research gaps identified in the problem statement.

1. What are the best suitable and pertinent project selection criteria and sub-criteria required for the study?
2. Can the designed questionnaire provide the necessary information or data needed?
3. Can the proposed integrated approach select the appropriate project from large-size projects for optimal solutions?
4. If the integrated approach fails to handle multi-objective optimization project portfolio selection problem, what will happen?

1.5 Research Aim and Objectives

The research aims to develop a multi-objective optimization model for public project portfolio selection using a hybrid method.

The objectives are to:

1. Develop an integrated Analytic Hierarchy Process, Goal Programming and Genetic Algorithm (AHP-GP-GA).
2. Establish a relationship for the developed models and remove the bias of each model.
3. Apply the model developed in a selected location/community with a set of large-size projects for optimal solutions.

1.6 Methodology

This study adopted an integrated exact and metaheuristics modelling approach known as the Analytic Hierarchy Process, Goal Programming and Genetic Algorithms for project portfolio selection problems.

PPS is a complex problem with a large number of alternatives that must be assessed against multiple criteria by multiple DMs. As a result, MCDM and Metaheuristic methods are appropriate methods for dealing with the PPS problem.

The Analytic Hierarchy Process (AHP) method is a Multi-Criteria Decision Making (MCDM) approach that examines the problem at several levels of hierarchy. The analytic hierarchy process is a well-known tool for dealing with decisions under consideration, in which subjective judgement is quantified logically and then used to make a decision. It is intended for situations in which ideas, feelings, and emotions influencing decision-making are quantified in order to provide a numerical scale for prioritizing alternatives. AHP involves the simultaneous study of numerous criteria, such as economic, environmental, social, and technological considerations, to select a project and make the decision sustainable (Solangi et al., 2021; Taha, 2007).

Goal programming is a mathematical programming design that provides a methodology for solving an optimization problem with multiple objectives. Goal-programming is more useful for problems with conflicting objective functions. It aims to minimize deviations from established goals to a minimum (Chandra, 2008; Mogbojuri & Olanrewaju, 2022).

The genetic algorithm (GA) is an optimization technique that utilizes natural selection. It is based on a population search approach that operates on the survival of the fittest principle. It is a widely recognised algorithm based on biological evolution. GA is controlled by chromosome representation, fitness function, selection, crossover, and mutation (Mogbojuri and Olanrewaju, 2022).

The AHP method will be employed to establish the relative importance of weights and priorities, preference of decision choices/criteria, and project alternatives. Both the relative weights and priorities determined by the AHP will be applied to the mathematical formulation of both the Pre-emptive and Weighted goal programming model for the multi-objective project portfolio selection problem. The genetic algorithm (GA) will solve the integrated model formulated to obtain the optimal Pareto set or solution. The developed model established relationship is shown in figure 1.1.

The goal is to find solutions to complicated large-scale optimization PPSP for social benefits.

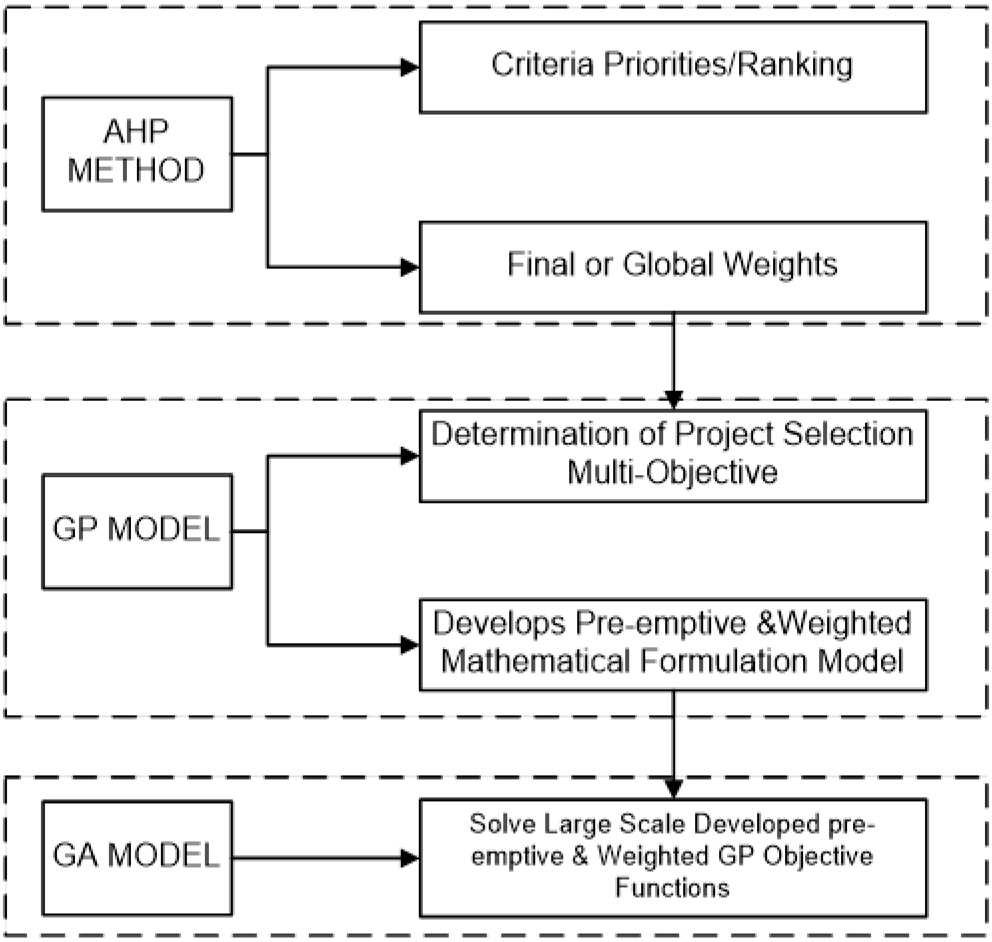

Figure 1.1: The model established relationship.

1.7 Significance of the Study

The study will go a long way in both developed and developing nations and also contributes to the existing body of knowledge. The hybrid method updates knowledge and enables managers (practitioners) in PPSP to select a project for social impacts, focus the attention of the professionals and non-professionals to use the proposed hybrid method on infrastructural developments for the society, remove the bias of selecting optimal projects from government agencies in some developing nations, and also quantify the social impacts of the selected projects of the community. The novel practical and theoretical contributions involve employing the goal programming method to an extensive set of 100 projects (Mogbojuri & Olanrewaju, 2023) and the integrated method to more than 200 large projects. Similarly, the hybrid method was added to the literature to enhance the existing methods since the AHP-GP-GA is novel to PPSP.

In the same way, the stakeholders that will benefit from the study are project management practitioners like organization management, top executives, senior and junior supervisors, and personnel connected to the projects. It will assist them in selecting optimal projects from various options of solutions by the hybrid method and improve the lives of the citizens of the host community and infrastructural developments.

1.8 Thesis Structure

The overall research flow of the study that will enhance the public project portfolio selection problem is shown in Figure 1.2.

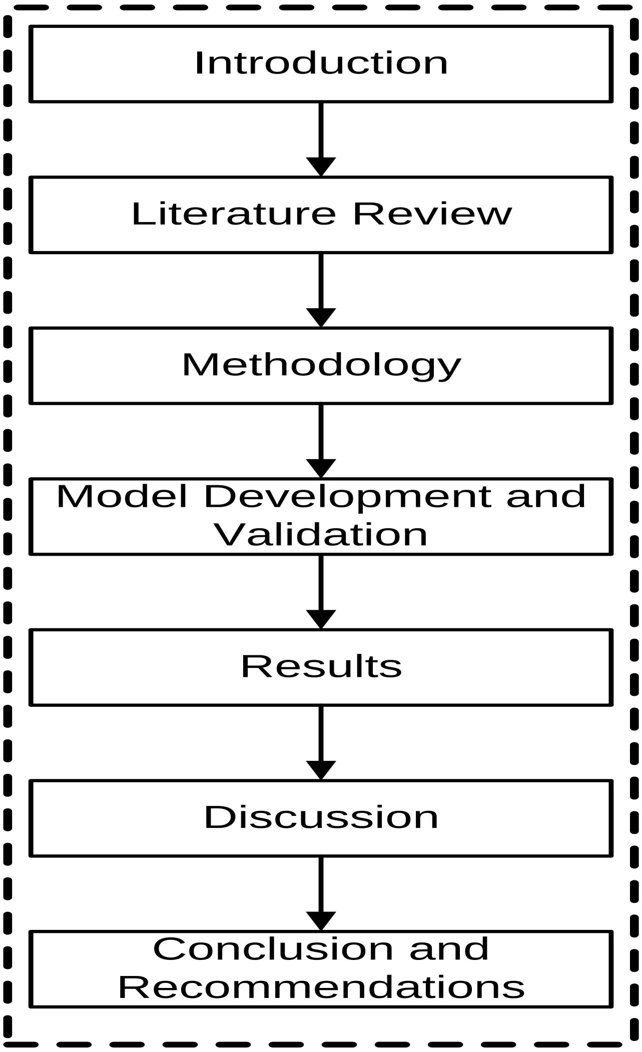

Figure 1.2: The overall research flow of the study

The first chapter introduces the study, and includes the study's background, research problem, research aim and objectives, methodology, study significance, and the thesis structure. The second chapter discusses the literature review of decision support tools, exact optimization methods, that includes the comprehensive AHP and GP models for PPS, and the metaheuristics methods of PPS, including the detailed GA model for PPS and the hybrid model.

Chapter three enumerates the developed AHP-GP-GA method. Chapter four presents the model's development and validation. Chapter five presents the results and discussion. The last chapter, which is Chapter six, provides the conclusion and recommendations.

1.9 Chapter Summary

This chapter consists of the introduction to the study of project portfolio selection, the research background, research problem, research aim and objectives, methods to carry out the study (methodology), significance of the study, or contribution to knowledge, and also the thesis structure.

In the introduction to this chapter, the significance of the project, project selection, project portfolio selection process, and a brief discussion of the public or social project portfolio selection problem was given. The background to the study mentioned the history of project portfolio selection, studies on proposed project portfolio selection, discussions on portfolio selection and optimization, optimization problems and processes, multi-objective optimization (MOO) and project portfolio management. The research problem discussed the organization's limited resources and models to solve PPSP where exact methods have inefficiency, and the integration approach of MCDM techniques and meta-heuristics model was proposed. The aim and objectives of the study were stated to justify the study.

The proposed method adopted integrated models of both exact and metaheuristics approaches known as AHP-GP-GA, and each model was briefly explained. The significance of the study was mentioned for both developed and developing nations, and PPS practitioners and the thesis structure were listed.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

The literature review presents various approaches to the project portfolio selection problem. These approaches include exact optimization, meta-heuristics, and hybrid methods. This chapter will look at these various approaches and identify their gaps and the appropriate way to approach the problem statement of this study. The structure of this chapter can be seen in Figure 2.1.

An exact optimization method is preferred if it can solve an optimization problem with an initiative that expands polynomially with problem size (Rothlauf, 2011). Meta-heuristics are high-degree techniques that help a fundamental and more problem-specific heuristic perform better (Zobolas et al., 2008). According to (Etgar & Cohen, 2022), it is impractical to apply any exact algorithm successfully to large-scale problems while the meta-heuristic approach provides near-optimal solutions. The meta-heuristic approach is able to solve complex optimization problems using a set of several general heuristics (Gavrilas, 2016). It also reviews the proposed methods for the study, i.e., the Analytic Hierarchy Process model for project portfolio selection, the Goal Programming model for project portfolio selection, and the Genetic Algorithm for project portfolio selection. In conclusion, the study presented some reviews of the hybrid method under exact and meta-heuristic approaches for project portfolio selection problems. The gaps in the existing knowledge are that there are limited studies on social sustainability benefits, some developed models of exact algorithms were not applied to a large number of projects, and an integer Linear programming mathematical model solved a single objective. At the same time, GP can solve multi-objectives, and also some methods used by decision-making committees to generate or get objective function weights instead of weighting techniques.

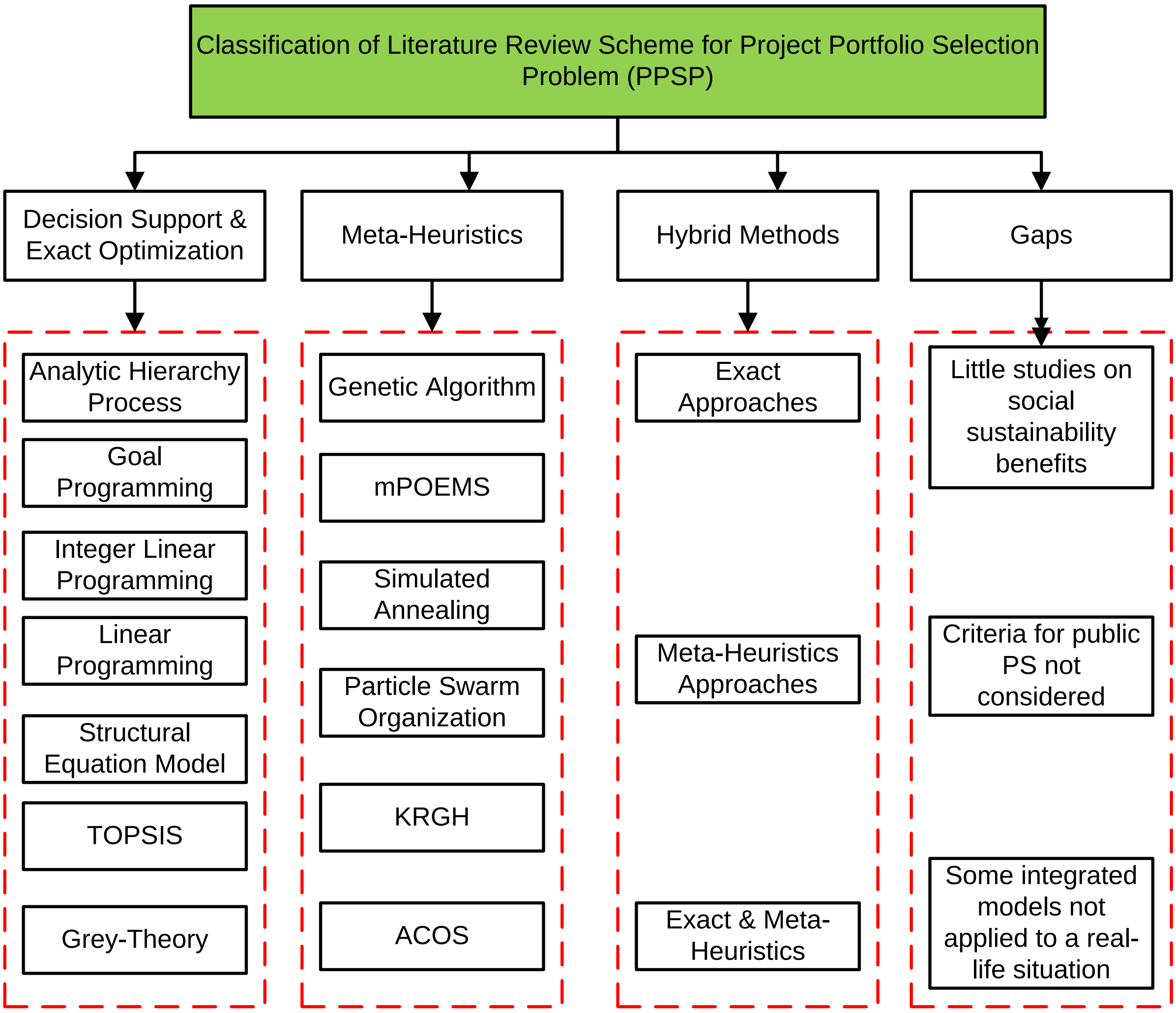

Figure 2.1. The Classification of the Literature Review Scheme for Project Portfolio Selection Problem

2.2 Previous Studies on Decision Support Tool and Exact Optimization Methods

The frequently used decision support tool and exact optimization techniques in project selection include: Analytical Hierarchy Process (Eldrandaly 2007; Chavez, 2008; Mohamad, 2015; Chatterjee et al., 2018; Verdecho et al., 2020 and Ramalho et al., 2021); Goal Programming (Kim and Emery 2000; Rabanni et al., 2006; Liang, 2010; Li, 2020); Integer Linear Programming (Brown, 2008; Caballero, 2014; Liu and Liu, 2017 and Arratia-Martinez et al., 2021); Linear Programming (Namazian and Yakhchali, 2016); Structural Equation Model (Khalili-Damgbani and Tavana, 2014); TOPSIS (Haddadha et al., 2017 and Ma et al., 2020); and Grey theory (Bhattacharya, 2015). Because project portfolio selection models are widely used in real-world scenarios, much research has been conducted in this area.

Meanwhile, this research is based on the multi-objective optimization of project selection that implies numerous criteria, and the multi-criteria decision-making (MCDM) tool AHP has been adopted. According to Rane et al., (2023), the Analytic Hierarchy Process (AHP) is a decision-making technique that aids in the grouping of complex issues into a hierarchy of criteria and alternatives and then evaluates them using pairwise numerical scores. When there are multiple criteria for consideration, and the decision maker wants to include subjective judgements in the decision-making process, AHP is useful. The AHP method operates with a variety of criteria, including those defined both verbally and numerically, with no further adjustments (Siekelova et al., 2021).

2.2.1 Analytic Hierarchy Process Model for Project Portfolio Selection

Some of the studies that have used AHP are reviewed below:

The difficulty of choosing the best GIS software package for a certain GIS project is a MCDM challenge. Eldrandaly, (2007) formulated an Analytic Hierarchy Process (AHP) model to aids the system developers to choose the most suitable three (3) GIS software. It demonstrated that AHP is an effective MCDM approach for GIS software selection because it is able to manage both qualitative and quantitative criteria. It also reduced the amount of energy and time required for decision-making. However, the AHP could have shown the scoring weights of selected criteria and priorities before showing the final weights for alternatives.

In the study of Chávez, (2008) on IT, PPS employing an AHP deployed on the design that considered Stakeholder points of view would cover all possible environments, the design offered a DSS that was adaptable, expandable, and interactive for selecting IT projects for portfolio management. They applied AHP as a decision support tool to combine all the variables tangled in the decision process. The AHP framework process of evaluation could be adequately explained to apply the results for the best approach.

In another development, Huang et al., (2008) developed a fuzzy analytic hierarchy process (FAHP) for R&D projects sponsored by the government. The process included the level of optimism to revitalize expert verdicts on various decision threats. The contribution that the study made to addressing the problem was extended to the public sector. In this study, the AHP assisted decision-makers in solving decision problems in a hierarchical structure, formulating uncertainty judgement and resolving disparity among the experts. Their findings revealed that scientific and technological excellence, as well as potential benefits, project execution, and risk, are four (4) important evaluation criteria for technical committees. The evaluation criteria were considered independently.

Mohamad, (2015) identified the project selection criteria that could best meet the requirements of a well-diversified group of companies (Private College Perspective) using the AHP technique to support project selection in a multi-criteria environment. The AHP technique successfully helped the group's decision-makers to single out the most appropriate projects from the 4 projects that best suited the organization's operational needs and prioritized these projects accordingly. The selection criteria should be based on both a literature review and stakeholders.

Sharma & Batra, (2016) reviewed selecting contractors using the Analytical Hierarchy Process (AHP) as a potential decision-making method for project management. The application of AHP prioritised prequalification criteria, and a sequential order roll of contractors was made to select the best contractor to undertake the project. The study could have shown an illustration example on choosing the best contractor.

According to (Chatterjee et al., 2018), project portfolio prioritization is a process for determining optimum expenditure and selecting the most suitable project proposal using a multi-criteria mode that employs linguistic preferences in uncertain circumstances. Their purpose was to apply a fuzzy AHP for project prioritization in portfolio management by captivating into contemplation some basic actions. They developed the Fuzzy analytic hierarchy process to explore the ranking of the project selection problem, and to determine the weighting of the criteria and the five (5) project preference ordering in portfolio management. Their choice process helped professionals prioritize project portfolios by eliminating inefficient ones with unpredictable resources and outcomes and predicting success probability using pre-determined criteria. The AHP method could be used to solve stochastic problems for large data sets.

Kaiser et al., (2019) presented a managerial tool for prioritizing and selection of ten (10) projects in a medium-sized software development company using the AHP methodology to balance the project portfolio. With the participation of representatives from other fields, the effort helped simplify, standardize, and improve the quality of the decision-making process in software development. There were also additional opportunities to apply the management application to minimize power play, and promote collaboration, exchange of knowledge, studying, decision-maker dedication, and systematically planned project selection. The study found that organisations with similar situations or conditions as described above would increase the validity of the AHP and adjust it based on the new considerations.

The primary criteria employed by a company in selecting contractors to identify the weighted criteria using the AHP method in a recent study in Malaysia were developed by (Razi et al., 2020). The method used as a decision support model is necessary to eliminate the risks of project failure due to poor contractor performance. The Analytical Hierarchy Process (AHP) could have been used to determine the priority scales instead of the experts' opinions or judgements on accuracy.

Alyamani & Long, (2020) developed a multi-criteria decision-making (MCDM) approach for a sustainable project selection tool using a fuzzy analytic hierarchy process (FAHP) that quantified and ranked five (5) critical sustainable project criteria. The proposed method showed the criteria deemed essential to consider in sustainable project selection in the sequence order of project cost, novelty, uncertainty, skill and experience and technology information transfer respectively. A larger sample size could have been considered in the study; project researchers and practitioners could have used relevant literature to act as the voice of experts.

In the study of Verdecho et al. (2020), an Analytic Hierarchy Process (AHP) model was developed for seven (7) list of project alternatives for project selection and integrated the Balanced Scorecard (BSC) with the environmental and social sustainability of a supply chain. In this study, the supply chain has some merits in presenting the BSC as a strategic tool to implement the supply chain's environmental and social sustainability management. They developed a feedback mechanism to analyse the advancement of the supply chain in relation to sustainable goals. They set up a decision model that prioritizes the portfolio selection that alienates the sustainability of strategic objectives of the supply chain. The developed model benefits enterprises in the supply chain that prioritize the projects for sustainability strategy but could have been tested with more projects.

Due to its reliability and accuracy characteristics, AHP has become the "most extensively used method" to prioritize projects. Ramalho et al., (2021) developed a multimethod to prioritize projects evaluated in different formats. The method offers flexibility in replacing project prioritization, taking advantage of evaluations in diverse preference formats. Such flexibility allows enterprises to keep the prioritization method compatible with their strategy. The results of the study are universal and replace any process of prioritization. The study could have been tested for a larger sample and developed a hierarchy of criteria.

The analytic hierarchy process (AHP) is a powerful tool for decision-making because it can handle multi-criteria decision-making (MCDM). However, it has limitations by not being able to find ideal solutions based on company objectives and constraints conditions for multi-objective optimization to handle multiple, usually conflicting, objectives measures in which GP succumbed to the limitations (Wu & Chen, 2021).

2.2.2 Goal Programming Model for Project Portfolio Selection

Studies that have used GP include a study by Kim & Emery, (2000) who presented a paper to deal with a project for the Aircraft Controls Group. However, the employment of goal programming as a support in project selection was purposed and applies to all companies with multiple projects to select with limited resources. They developed a goal programming (GP) model to determine which programs to pursue to maximize profit over four years and evaluated machine acquisition schemes and estimated personnel needs. The approach determined the circumstances in the short term for a limited number of programs but showed great potential for extension to deal with 12-15 programs in the long-term. However, due to constraints in the number of decision variables that GP software can operate, the supervisory team agreed to extend the scheduled timeframe to four years.

According to Badri et al., (2001), the supervisory team of healthcare organizations is continually faced with the challenge of distributing funds between alternative projects. A GP was developed to include multi-objective problem into one decision model and constructed to deal with the problem of assigning a hybrid system to select a list of 28 projects set consistent with the organisation's objectives. Meanwhile, a qualitative method of analysis might be employed to estimate decision-makers' and people's preference scores.

A comprehensive 0-1 LGP model was presented to reflects the 10 projects for R and D project portfolio selection and scheduling problem by (Rabbani et al., 2006). The proposed model focused on the significant issues that must be considered in project portfolio selection. It provided the decision-makers with a tool to understand the nature of compromise between the different elements that influence the R and D project portfolio. For both project practitioners and non-practitioners, the R&D project problems could focus either on the selection or the scheduling.

Ahern & Anandarajah, (2007) developed a weighted integer goal-programming model for prioritising four (4) railway projects for investment. The study recommended investment options at different capital investment levels when the decision is made based on economic benefits, revenue or qualitative goal scores. The users assigned the weighting scores for the model, and a multi-criteria decision analysis (MCDA) tool could be developed or proposed to assign the weighting scores.

Tripathy & Biswal, (2007) presented a goal programming (GP) model which supported the new product development project selection and employment in a controlled resources situation. In this study, the GP method considered the multiple, conflicting goals and provided some degree of adaptability of decision-making as regards resource allocation. The proposed model supports a combined scheme to select a set of six (6) projects conforming to organization goals and eases the decision-making planning process and supervisory policy in resource planning. Large-scale cases could be applied to the model to test its efficiency.

A ZOGP problem was presented by Liao, (2009) to select a set of eight (8) projects (e.g., marketing activity projects) that were consistent with the goals of the company. The approach better understands the nature of the trade-off between the various components that affect the choice of projects for decision-makers (DMs). The proposed model could be used in a larger set of projects for optimal solutions.

Liang, (2010) devised a two-phase FGP model for solving project management (PM) decision challenges with multiple goals in uncertain territories. The findings presented a systematic decision-making framework which enables policymakers to collaborate with the set of variables until the preferred efficient result is identified.

When confronted with the complexity reliance and relationship of project activities, decision-makers require the identification of all competing objectives in a single model. To be more applicable to real-world project selection problem data, the proposed approach must be updated.

Using a goal programming method, Sahebi et al., (2015) developed a multi-criteria mathematical model to choose of eight (8) best partners for an ideal joint venture (JV) in oilfield projects. Their strategy included varied objectives and priority levels based on the venture party's strategic goals and prospects. As a result, a collection of solutions was generated by changing the priority level rankings for the decision-maker as opposed to a single result. In the meantime, an integrated multi-criteria decision-making method, such as the ANP or AHP, could be used to demonstrate the criteria and criteria priority levels of goals.

Li, (2020) evaluated the criteria of government guarantee project selection in Build-Operate-Transfer (BOT) or Public Private Partnership (PPP) project finance. However, the study applied the multi-objective programming method to assist the government select assurance projects in infrastructure project funding. The evaluation showed that the selection of government for the BOT/PPP infrastructure guarantee project is a multi-objective decision-making problem, and they developed a goal programming model for the government to decide on the choice of guaranteed project. The suggested approach could have been validated in a real-world setting.

Akbari et al., (2021) developed an interval coefficient goal programming model to address the impreciseness and uncertainty associated with the goals and coefficients of the method used for 43 possible projects of marine renewable energy project selection in tactical decision-making. Their results showed that incorporating the mid-point to the interval method adds more certainty and modelling control to the goal programming (GP) solution and yields more varied outcomes. Meanwhile, the researcher or modeller obtained weight assignments, not expert judgements, which could lead to some limitations or bias.

The studies show that the goal programming (GP) model cannot handle large numbers of decision variables; in spite of that, it can solve relatively large-scale multi-criteria decision-making problems' analytical structure that a decision maker can use to provide optimal solutions to multiple and conflicting objectives. However, with a complex problem with a large scale of decision variables, which involve non-smooth and multimodal search spaces or uncertainty conditions, GP is limited and cannot produce Pareto efficient solutions, but GA has proved to be effective in multi-modal search spaces and is also capable of producing Pareto efficient solutions (Jin et al., 2013; Kawale & Jagtap, 2016; Lee et al., 2021; Velasco-maranan & Curbano, 2022; Zhao & Huang, 2017).

2.2.3 Integer Linear Programming Model for Project Portfolio Selection

Studies that used ILP include a study by Brown, (2008) who presented a project portfolio selection problem using decision support optimization tools in the areas of budget and time constraints. The study developed a zero-one integer linear programming model to select a list of 26 projects for optimal project portfolio. The model and decision support system contributed an accelerated and easy project selection method to the organization. The project selection decision support model assumed that the listed projects had the same priority, and the procedure for selecting the weighting factor or score was not stated.

Caballero, (2014) studied project portfolio evaluation and selection using mathematical programming and optimization methods. He applied two mathematical programming approaches for project selection: 0-1 integer linear programming for issues with a single target, and weighted goal programming for problems with many objectives. The study looked at a business case of eight (8) projects from 2006 and 2014 in which a company was dealing with two project selection problems. The study found that the optimization model used in 2014 produced better solutions than the weighted scoring models in the project selection problem in 2006. The project portfolio also found that using a global optimization approach gave better results than using a local optimization approach in 2014. The formulation model includes all the constraints in linear form and doesn't admit non-linear constraints. Also, the model uses weighted goal programming with multiple objectives, which requires the user to include the weights without considering project priorities.

Sefair et al., (2017) studied the Mean-Semi Variance Project (MSVP) portfolio selection problem, where the objective is to obtain the optimal risk-reward portfolio of non-divisible projects when the risk is measured by the semi-variance of the portfolio's NPV. They suggested two alternative linear solution approaches that effectively solved the problem while avoiding the use of Mixed-Integer Quadratic Programming (MIQP) solutions and requiring only the use of Mixed-Integer Linear Programming (MILP) techniques. The Mixed-Integer Linear Programming (MILP) technique outperformed the default CPLEX 12.5 Mixed-Integer Quadratic Programming (MIQP) solution for general large-scale instances of the Mean-SemiVariance Project (MSVP) problem in the computational testing. The proposed method should be used for more than one objective.

Liu & Liu, (2017) developed a robust and credible optimization method for the project portfolio selection problem. They modelled interval-valued fuzzy variables with variable parametric possibility distributions. Their proposed optimization model took into account interactions between projects, such as synergy and cannibalization, and used an optimistic value criterion to convert the original optimization model to non-linear mixed-integer programming equivalents. The model considered the total of 16 candidate projects portfolio returns as a single objective function; a multi-objective optimization model may have been helpful in practical project portfolio selection problems, and a stochastic optimization model could have been developed for portfolio selection synergy and cannibalization.

Martinez-Vega et al., (2019) studied project portfolio selection problems with scheduling time dependencies. A mixed integer linear programming model was developed to maximise the problem's total benefits while minimizing project execution time. The proposed model selected a subset of the projects and scheduled them with a time horizon as a constraint. The model was compared to the Non-dominated Sorting Genetic Algorithm (NSGA-II) and CPLEX, two state-of-the-art models. On the other hand, the linearization increased the number of variables and restrictions, making the proposal more effective and efficient. However, the proposed method could not solve problems with several projects or in a shorter time.

Arratia-Martinez et al. (2021) integrated the PPSSP and developed a unique mixed-integer linear programming (MILP) model that takes into account renewable and non-renewable resources distribution, partly and fully funded guidelines, project divisibility, and interdependences. However, the study should have also considered the number of projects selected and the time needed to choose the projects accordingly.

2.2.4 Linear Programming Model for Project Portfolio Selection

Studies that have used LP include the study of Namazian and Yakhchali (2016), who developed a fuzzy linear programming model that considered project portfolio selection based on project scheduling and contractor selection options for each of the current activities. They examined a project portfolio selection problem based on project schedules, aiming to achieve the least expected profit in the shortest time possible for the two (2) portfolio's projects to be completed. Their modelling and proposed solution were investigated and analysed to help the organization's top management in the project portfolio selection process by considering the project's true impact and related procedures on the selected contractor. The proposed model needs to be tested with several projects to ascertain the validity of the work. Also, the project selection problem should be separated from the project schedule.

2.2.5 Structural Equation Model for Project Portfolio Selection

Studies that used SEM include the study by Khalili-Damghani & Tavana, (2014), who proposed an approach for strategic and sustainable project portfolio selection with two interrelated modules. They selected a set of prospective projects using strategic planning and sustainability ideas in the first module. They then utilized a project portfolio selection technique in the second module to select between the 34 favourable projects recognized in the first module. They developed an SEM to explore and describe the links between the many variables in their proposed framework. The structural equation model only established the impacts of factor performance on total performance in investment banking and integrated various pillars of an organization in management and engineering applications, including long-term macro- and short-term micro-level assessments.

2.2.6 Technique for Order Preference by Similarity to Ideal Solution for Project Portfolio Selection

Studies that used TOPSIS include the study of Haddadha et al., (2017) which focused on developing a model based on Shannon's Entropy and multi-criteria decision-making (MCDM) techniques (Fuzzy TOPSIS) for solving the project portfolio selection problem. They established the appropriate criteria for the project selection problem and used Shannon's Entropy to determine the criterion weights and Fuzzy TOPSIS to rank the three (3) projects for the right selection choice. In determining the weights of the criteria in the study, experts' opinions on the criteria were used but didn't specify the mode or method used by the experts.

Ma et al., (2020) studied project selection from the sustainability perspective in an uncertain decision-making environment. They adopted a three-pillar concept to examine and quantify sustainability: economic, environmental, and social sustainability. To incorporate sustainability with uncertainty and find the most sustainable solution, they built a fuzzy logic model based on the Technique for Order of Preference by Similarity to the Ideal Solution (TOPSIS) approach. The method used measurable indicators to evaluate the long-term viability of potential projects, providing decision-makers with numerical recommendations for selection. The process considered twelve (12) list of projects with six criteria for PPS, including profitability and environmental effect, and a set of social sustainability factors such as accidents, working time, job creation, and job training, all of which are prevalent attributes in decision-making. Other criteria in social sustainability, like the location of the project, project priority or needs, and economic sustainability, like project benefits, durations and cost, should have been considered in the study.

2.2.7 Grey Theory for Project Portfolio Selection

Studies that have used the Grey theory include the study by Bhattacharyya, (2015), which considered the research and development in the project portfolio selection problem as a multiple attribute decision-making (MADM) problem. The Grey theory-based method dealt with the decision makers' preferences on project alternatives or qualities. He argued that the ratings and weights of the attributes are treated as exact numeric values in a traditional (MADM) problem. Grey’s numbers and linguistic phrases represent the ratings and weights. He also said that the grey theory has an advantage over the fuzzy set theory because it can deal with ambiguous situations more flexibly. Although the experimental five (5) candidate projects results showed that the proposed approach is consistent and sensible, it needs to be tested with several projects.

2.2.8 Other General Exact Methods for Project Portfolio Selection

The other reviews of Exact Optimization Methods include studies by Radulescu & Radulescu, (2001), who presented a zero-one mathematical programming model for project selection problems under risk and limited resources. They developed PROSEL (PROject analysis and SELection system), a software solution to assist managers in making high-quality project portfolio selections. PROSEL was developed as an interactive system that helped decision-makers make better decisions, understand the decision-making process, and improve their performance. Meanwhile, PROSEL is a "prescriptive" software instrument, not a descriptive or normative one, according to the "Decision Analysis" terminology. They believe it may be expanded to add interdependencies with other projects. The CPU time was observed to increase, depending on the number of resources, and high scores given by experts' opinions did not determine the increase/decrease of project risk. Meanwhile, opinion experts' scores should be uniform to decide project risk.

In the study of Le & Nguyen, (2007), they stated that organisations need to develop or adopt a systemic approach to ensure effective and efficient selection of project portfolios. In their study, the systemic approach integrated selection committees, models and processes or frameworks as a factor. Their study revealed that complex processes or frameworks of project portfolio selection recommended by academics and practitioners are superior and best able to help mature organizations. Meanwhile, frequent changes in committee members may lead to the failure to balance or optimise the project portfolio. Also, the selection criteria were based on the personal perception of the chairman or board of management, not rational thinking.

Reza Zeynalzadeh, (2011) presented a framework for portfolio selection with a risk reduction approach. The framework proposed was based on the concepts of project strategy and the Diamond method. They examined four elements contributing to project portfolio efficiency: 1) tactics fit, 2) sole project positive result, 3) portfolio equity, and 4) project interconnection. Three factors determined the project's interdependence: 1) resources, 2) technology, and 3) marketing. The Diamond approach evaluates projects on four dimensions: novelty, technology, complexity, and pace. They noted that projects could be refused or accepted depending on the above conditions. The framework aids the organization's review and selection processes for projects. Observation from the study relates to the need for a project market in profit-oriented organizations. Still, in non-profit (business) oriented organizations, project marketing is not necessary except for projects that have more significant social benefits to society.

Wang & Shou, (2011) presented a real choices theory for management flexibility in complicated environmental changes and a decision thread to deal with uncertainty to overcome the limits of the traditional NPV method. They discovered that the Real Options theory outperforms the traditional NPV technique in project portfolio selection evaluation for greater applicability and practicality in project portfolio management. They believed that applying the fundamental option theory to project portfolio selection and using maximum option value as the objective function in project portfolio evaluation was both feasible and advantageous. The addition of real options between option values has some constraints because it is through the process of additive option collection that the evaluation of project portfolio selection can be achieved.

Zaras et al., (2012) proposed the Dominance-based Rough Set Approach (DRSA) to assist the Board of Directors of Community Futures Development Corporations (CFDC) in the municipal sector in three steps: 1) with the use of a multi-criteria process and the active participation of experts and managers, data from the CFDC dashboard is classified into five categories (economic, social, demographic, health, and well-being), 2) a classification of municipalities is based on the values of indicators, and 3) managers use quantifiable information to choose projects for sustainable development priorities. They stated that funding for these priority projects would improve the municipality's performance measures and allow them to track and monitor their strategic goals. By removing some redundant indicators and finding the critical values of selected indicators, their suggested Rough Set Theory gave program managers an advantage in deciding which projects to prioritize or select for sustainable development. The proposed Rough Set Theory should be able to activate the redundant indicators since the funding priority projects will improve the performance indicators of the municipality.

Nowak (2013) researched Project Portfolio Selection using an Interactive Approach. He argued that when constructing a project portfolio, scholars and practitioners agree that some varieties of quantitative and qualitative criteria should be considered. He presented three methods for deciding on projects, i.e., collecting preference information before the procedure for identifying the final solution begins, analysing after the primary calculation method has been completed, and only decision-making problems with certainty are determined. Meanwhile, the project's goal was to develop a framework or concept within which such a technique may be developed rather than to propose a new universal method for project portfolio selection. Identifying the portfolio closest to the ideal solution is the issue to be noticed because the conditions defined by the decision maker must be considered in the new proposal. The risk and uncertainty also must be considered.

Nassif et al., (2013) analysed various erroneous project selection issues, including 1) an excessive number of projects, 2) inappropriate projects, 3) projects unrelated to strategic objectives, and 4) an unbalanced portfolio. They developed a Methodology for Governmental Project Selection using Fuzzy Logic (MGPS-fuzzy) to avoid these challenges and help make proposals to decision-makers. The developed MGPS-fuzzy consists of the following methods: Identification, Strategic planning association, Categorization, Definition of linguistic variables and fuzzy functions, Definition of inference procedures, Function calculation, Portfolio balancing and prioritization. The model aided in the decision-making process when there was a lot of uncertainty. The approach considered only a qualitative method in the governmental sphere and didn't consider a quantitative approach.

Arratia-Martinez et al., (2016) stated that the problem of project portfolio selection consists of allocating resources (e.g., money) to a set of proposals and optimizing specific impact measures. They considered the following characteristics: project tasks, resource allocation policies, and interdependence between tasks and projects. They proposed a mathematical methodology for selecting a research and development project portfolio under uncertainty based on fuzzy programming. They could minimize overestimation in portfolio impact measures due to their efforts. The proposed model constraints could be more explicit for both practitioners and non-practitioners.

Li et al., (2016) developed an enhanced method for the PPSP spanning a period for setting up with several intervals by simultaneously considering project divisibility and interdependence. Their model integrated reinvestment, setup costs, cardinality limitations, and the precedence relationship in the scheduling. The model was used for projects executed in time for selection rather than selecting a set of projects and other criteria could also be used.

Mohagheghi et al., (2016) proposed an approach based on multi-objective decision-making (MODM) to select the optimum sustainable project portfolio using interval-valued fuzzy sets (IVFSs) for uncertainty. They divided the decision-making criteria into two categories: financial (investment return and risk of return) and non-financial (social effect, environmental effect, project risk, non-financial benefits, strategic alliance and organizational readiness). Their findings demonstrated the proposed approach's strong capabilities in solving long-term challenges in a real-world context and group decision-making with multi-dimensional perspectives. But in complex situations, with the model proposed in today's highly competitive business environment, using classical fuzzy sets and expressing the degree of membership in a crisp value cannot fully express the current uncertainty.

Mohagheghi et al., (2017) proposed a new approach to R&D project evaluation and project portfolio selection using interval type-2 fuzzy sets (IT2FSs), considered project investment capital risk and return simultaneously, and used lower semi-variance as a downside risk measure to evaluate project risk. First, they initiated a unique methodology for assessing R&D projects that incorporated a new risk-return index. The model was expanded to include a new approach for selecting R&D project portfolios with uncertainty. The proposed model is more suited for very uncertain areas like R&D projects only.

Li et al., (2017) developed a new method for decision-makers to handle some essential but uncertain variables, such as return on investment, and set-up cost in project portfolio selection problems, which considers the divisibility of projects. They proposed a mean-variance model that allows decision-makers to control the portfolio's return and risk by selecting an optimal portfolio and schedule. They also proposed a second mean-variance model without taking project divisibility into account. They concluded that it could hurt the NPV if projects were forced to be interrupted due to divisibility constraints. Also, high-risk levels do not bring a high profit to the company, so decision-makers should choose risk levels carefully. The decision-makers could control the portfolio's return and risk by selecting an optimal portfolio excluding the schedule.

Baqeri et al., (2019) proposed a multi-objective mathematical model for selecting the project portfolio that maximizes efficiency and quality by minimizing the risk involved in project execution to reflect the organization's position, goals, and priorities. In the actual world, their proposed model recommended how to choose some projects from among competing projects based on return, quality, risk, resource availability, and other technical constraints. The proposed model failed to state the project's priorities or arrange the projects based on priority level.

In the study of Kandakoglu et al., (2020), they opined that the use of multi-criteria decision analysis (MCDA) methods for addressing the project portfolio selection (PPS) problem had received increased attention in recent years both from researchers and practitioners in dealing with multiple, conflicting and varying criteria. They surveyed the literature on MCDA methods in support of the PPS process and differentiated the individual project and portfolio evaluation problems in single- and two-phase procedures. Their review presented valuable information on existing literature for researchers, professionals and decision-makers dealing with real decision-making situations in a project portfolio selection process. But, if the number of projects grows or the number of portfolios increases exponentially, the two-phased procedure makes it difficult to solve the problem reasonably because the system was applied to only a small number of projects.

Şahin Zorluoğlu & Kabak, (2020) structured the information technology/business development project portfolio selection problem (IT/BD PPS) as a hierarchical group decision-making (HGDM) problem. They devised the Weighted Cumulative Belief Degree (WCBD) method for assessing project decision-makers and experts, as well as the importance weights of the criterion. The proposed method allowed for faster evaluations from a broad business and provided a variety of findings depending on different levels of satisfaction. The suggested method merely provides a rating and ranking of the alternative projects; it does not take into account any relationships between the projects, such as dependencies or interactions.

Li et al., (2020) studied the project portfolio selection problem (PPSP), considering project interdependency and cardinality constraints. They developed a new linearization technique to provide alternative linear reformulations with fewer continuous variables and more linear equality requirements. They also offered an approach to determine alternative solutions that combine the proposed method with a broad binary cut scheme, allowing decision-makers to explore more choices. The developed linearization technique produced significantly fewer continuous variables and slightly more linear equality constraints, but discrete variables and non-linear equality constraints are not considered.

According to Bai et al., (2021), choosing an appropriate project portfolio is essential for a company to reach its long-term objectives. However, choosing one is difficult because of the interconnected nature of a project portfolio. As a result, they proposed a method based on complex network theory to assist decision-makers in selecting a robust project portfolio (PP) under strategic goals. Their research provides practitioners with theoretical guidance as well as having practical application value. In addition, an evaluation technique or approach could be used to evaluate the projects instead of experts.

According to Sadeghiyan et al., (2022), most practitioners in the field of project selection examine the risks associated with the projects and select the project using ranking tools or expert opinion. They emphasised the risk of choosing or being responsible for determining a project under uncertainty in their study. Their proposed model is a generalisation of the project selection model with limited resources under uncertainty, which significantly increases the efficiency of the entire project subset compared to the other models and minimizes the effect of uncertainty threat on the project selection process. However, the proposed model should be given a name for identification purposes.

Marques et al., (2022) presented a novel proposal for selecting project portfolios using the flexible and interactive method known as FITradeoff. The proposed approach was developed into a Decision Support System (DSS), which used the notion of c-optimal portfolios and feasibility and efficiency classifying tactics during the portfolio generation process. The proposed approach is promising for issues requiring verification of all possible combinations of a set of projects to form portfolios.

According to Zorluoğlu & Kabak, (2022), companies must divide their resources across several projects, and they believe that project selection and timing significantly affect the success of their project management. A new multi-objective programming model for a collective procedure to combine selection and scheduling processes in project management was proposed. The ratings for the project are shown as belief degrees (BG), which are distributed to linguistic phrase levels derived from employing the weighted cumulative belief degree method. It takes longer times to solve the model for all satisfaction levels, and the model selected is equal to the proposed projects.

According to Karimi et al., (2022), good portfolio management focuses on doing the right projects at the right time by selecting and managing projects as an investment portfolio. An optimization model known as a robust possibilistic approach was proposed to help managers make decisions for a project portfolio selection problem with uncertainty of schemes such as revenue, cost of each project, and contributed capital. The optimistic approach resulted in lower liquidity levels (cash) at the end of each period, reflecting different macroeconomic conditions, which can have a significant impact on the combination of project portfolios. A technique or method could have been used to determine the estimated value instead of an expert to avoid deviation.

According to Bai et al. (2023), the inability of one project to succeed may cause its accompanying projects to fail, culminating in cascading failure, and the failure of incomplete projects will result in the strategic goal being incompletely realized. They proposed an optimal PPS model for selecting a high-performing project portfolio (PP) while taking into account cascading failures among projects, and they estimated the strategic goal loss rate (SGLR). Their research has a guiding inference for project portfolio management decision-makers, assisting them to recognize PPSP from a current point of view in order to make more rational choices. The optimization framework or model could be developed for both PPS benefit and risk.

The best three decision support tools and exact methods are AHP, GP and TOPSIS. From the review of the above studies, it can be seen that there were some limitations such as the experts' opinions, selection of project criteria based only on the perception of the chairman of the board of management, no proper procedure for selecting the weighted factor, some models considered only qualitative factors in the government sphere or were only tested with a small number of projects, while some PPSPs were for R & D projects only; also, the evaluation technique was not used to evaluate projects.

2.3 Meta-heuristic Computational Methods for Project Portfolio Selection Problem

Another stream of research considered meta-heuristic computational methods in PPSP as follows:

Meta-Heuristics – some of the frequently used Meta-Heuristics techniques in PPSP include GA (Bastiani et al., 2013; Kumari and Pushkar, 2015; Xu et al., 2017; Guo et al., 2018 and Sampath et al., 2021), mPoems (Kremmel et al. 2011), SA (Nikkahanasab and Najafi, 2013; Naderi, 2013), PSO (Tofighian et al., 2018), KRGH (Mira et al., 2012), ACOS (Rivera et al., 2013 and Gomez et al., 2018).

2.3.1 Genetic Algorithm Model for Project Portfolio Selection Problem

Several researchers have established GA models for PPSP in the past decade as follows:

Based on the Non-Dominated Sorting Genetic Algorithm-II (NSGA-II), Bastiani et al., (2013) presented an Evolutionary Algorithm for Solving 100 list of Public Project Portfolio Problem from Ranking Information (ESPRI), which appears to be capable of producing solutions near the Pareto frontier. Their proposition helped the decision-makers strike a reasonable balance between the number of projects accepted and the portfolio's overall quality. The Pareto-front diversity was not sustained by NSGA-II.

The Non-outranked sorting genetic algorithm II (NOSGA-II), developed by Fernandez et al., (2013) employs numerous criteria to address the challenge of allocating government funds to engaging initiatives as well as projects, and guidelines that take a personal viewpoint to the notion of foremost portfolio social exchange. The proposed method was devised for searching for the best (14) group portfolio in the feasible portfolio space. It was also helpful in increasing social participation in decision-making on the allocation of public resources, a tool of participatory democracy. The proposed method seeks the best group portfolio in the feasible portfolio space instead of selecting the best group of projects.

Huang & Zhao, (2014) discussed an R & D project selection and scheduling problem in which there is no historical data about the project parameter values. Expert evaluations provide the problem's investment cost and net income as unknown variables. They developed a Genetic Algorithm (GA) to solve the problem with many choice variables efficiently. They concluded that the proposed algorithm effectively dealt with the investment cost and net income issues, proving that it is robust against the specified parameters. Their numerical experiments form 10 list of projects showed that the developed GA is a good solution algorithm. The model has only been tried out on a limited sample of projects therefore larger experiments may alter the given empirical result. However, enumeration efficiency will drop dramatically when the number of candidate projects and the duration of the overall deadline for the project both increase to considerable levels. Problems with project selection and scheduling need to be dealt with independently.

Kumar & Pushkar, (2015) studied an approach based on a Genetic Algorithm to solve the problem of multi-criteria project selection to improve the performance of analogy-based software cost estimation. Based on decision-makers' criteria, they devised a multi-criteria project selection issue with and without interacting effects amongst the (21) projects. Both the efficiency of the GA-based optimization technique and the CPLEX barrier optimizer were evaluated. The authors indicated the number of projects to be selected rather than letting the model choose the best projects.

The use of a genetic algorithm to choose subcontractors for all work packages in a building project while taking into account their time, cost, and quality performance has been examined (Polat et al., 2015). The proposed model helped the general contractor choose the best subcontractor team for each individual work package by taking into account the interdependencies among twenty (20) contractors and their effects on project success. The optimum compromise solution was determined by analysing the project's performance metrics across time (days), budget, and quality (percentages) and then applying the results from the Non-dominated Sorting Genetic Algorithm (NSGA-II) to the problem. A rise in quality % results in a corresponding increase in project expense, as demonstrated by the study.

According to the study of Xu et al., (2017), it was determined that the use of genetic algorithms (GA) might greatly increase the profit of a project portfolio by focusing on two key aspects: the selection of projects and the assignment of resources. In order to maximize profits, businesses will often assign tasks or resources to managers with relevant experience. If the proposed staffing model is implemented, different project managers may be assigned to execute different seven (7) projects in order to maximize revenues without taking into account a situation where the project manager was to be removed from his role or suddenly resigned.

Zhao & Huang, (2017) proposed a better genetic algorithm (GA) to solve project selection problems with complicated limited resources. The projects chosen from the list of 20 projects by the improved genetic algorithm yielded significantly more benefit than those that did not thoroughly analyze the resource attributes and limits. The improved genetic algorithm might be tried out on non-resources project selection problems.

For project portfolio selection (PPS) in unpredictable environments and with a focus on striking a balance between strategic contributions and financial returns, Guo et al., (2018) developed a fuzzy multi-objective model known as a multi-objective genetic algorithm (MOGA) for 30 candidate projects. Their model assisted in facilitating project portfolio decision-making and improving selection efficiency. After crossover and mutation with MOGA, the modifications designed for the next generation could only fulfill the technological limitation and left risk and resource constraints not entirely fulfilled.

Dewi & Sawaluddin, (2018) discussed the issue of project selection with the existence of two objective functions that maximize profit and minimize cost, and the presence of scarce resources like manpower, machines and basic material resources. In order to assist in the project selection process, a multi-objective combinatorial optimization technique based on a genetic algorithm was implemented with 6 projects. The Genetic Algorithm method steps were not explicitly explained for both readers and project selection practitioners in the study.

The optimal investment–consumption problem for project portfolio selection with a flexible time horizon was investigated by (Liu & Zhang, 2019). They presented two flexible time horizons project portfolio optimization models, such as bankruptcy control, project start time constraints, and a reinvestment strategy, among other realistic decision factors. A genetic algorithm was developed to solve the 6 investment projects presented models, which assisted rational investors in determining the best investment strategy for project portfolio selection in challenging investment conditions. The models could be tested in a large-scale real-life system.

Sampath et al., (2021) developed an evolutionary algorithm framework called the Beam-Search Informed Genetic Algorithm (BIG) to generate an efficient frontier of 36000 portfolios within an acceptable amount of time for project portfolio selection. The framework addressed a resizable framework incorporating an increasing model complexity. Other problem instances may not discard infeasible solutions but correct them for more efficiency.

GA is a suitable optimization tool for solving complex problems with a large number of decision variables, which involve non-smooth and multimodal search spaces. GA is a meta-heuristic and optimization algorithm used in large-scale project selection problems. It mimics the process of natural evolution in such a way that it utilizes the concepts of natural selection and genetic dynamics to solve search and optimization problems. However, portfolio selection from many potential projects can't be handled effectively and efficiently by GA (Khalilzadeh & Salehi, 2017; Maghawry et al., 2021). However, to make up for the limitations of GA, Razi, (2014) mentioned that the selection of a portfolio from a large number of potential projects can be modelled as a hybrid model, including metaheuristic algorithms and multicriteria decision-making techniques. Also, Chaparro et al., (2019) opined that integrated methods enable managers to employ different techniques, and input data are more convenient to adopt in project portfolio selection problems for both incremental and radical innovations since no single method has all the features required to respond adequately under uncertain circumstances.

2.3.2 Multi-Objective Optimization Strategy called Optimization Technique Optimization with Evolved iMprovements Steps (mPoems) for Project Portfolio Selection

Studies that have used (mPoems) include the study of Kremmel et al., (2011) which presented a practical approach to model the complex project portfolio selection environment in a formal model, focusing on the adaptability to multi-objective optimization algorithms. They proposed a multi-objective optimization strategy called Optimization Technique Optimization with Evolved iMprovements Steps (mPOEMS), which they compared to two other state-of-the-art multi-objective optimization evolutionary algorithms, Non-dominated Sorting Genetic Algorithm II (NSGA-II) and Strength Pareto Evolutionary Algorithm 2 (SPEA2). Their proposed mPOEMS outperformed SPEA2 and NSGA-II in generating well-fit solutions for quality measures. The mPOEMS proved to be the best optimization strategy for considering project selection problems, and the evaluated optimization algorithms proved capable of dealing with complex goals and constraints. The mPOEMS approach exhibits better capabilities for finding high-quality solution clusters than the state-of-the-art algorithms (SPEA2 and NSGA-II). The test set with which the method was tested was 50 projects. It should be investigated how the performance of the optimization algorithms under consideration changes for test sets with a more significant number of projects. The presented approach could not deal with incomplete data sets, and uncertainty was only considered in the risk metric.

2.3.3 Simulated Annealing Approach for Project Portfolio Selection

Among the research studies that maximised the net present value of a project portfolio, a study by Nikkhahnasab & Najafi, (2013) employed SA to accomplish project selection problem. Simulated annealing (SA) and genetic algorithm (GA) were the two meta-heuristic algorithms that were proposed. The study proved that the genetic algorithm (GA) outperformed the simulated annealing (SA) technique, according to the computational experiment results. The research would have addressed two objective functions: maximizing the NPV and minimizing the project portfolio's completion time and cost.

Naderi, (2013) studied the resource-constrained project selection and scheduling problem. Each project has a collection of activities, which necessitates the expenditure of specific resources to be completed. There is a time limit, and the decision maker must select and schedule a subset of possible projects to maximize total profit. The problem was first theoretically formulated using a mixed integer linear programming model. In addition, Naderi devised three meta-heuristics based on the imperialist competitive algorithm (ICA), SA, GA to tackle large-scale problems efficiently. According to the results, the imperialist competitive algorithm (ICA) was the most effective. The resource-constrained project problem should be studied separately from selection and scheduling because they are both essential in project management but too much for decision-makers to perform simultaneously.

2.3.4 Particle Swarm Organization for Project Portfolio Selection

Studies that used PSO include the study of Tofighian et al., (2018) which studied the multi-period project portfolio selection problem. They established a novel mathematical model that takes into account project expenses, threats, stochastic income, and the prospect of investing in financial services like banks. Against the Orthogonal array L9 algorithm, they proposed new meta-heuristic algorithms of GA, PSO and Electromagnetic like (EM-like). Orthogonal array L9, the suggested technique, exhibits supremacy in terms of all indicators and outperforms other algorithms in all sizes. The study was on multi-period project portfolio selection problems (PPSP), which could be multi-objective PPSP and be tested in many projects.

2.3.5 k – random risk greedy heuristics for Project Portfolio Selection

Among the studies that used kRGH, the study by Mira et al., (2012) presented a model for the Project Portfolio Selection Problem based on a real-world situation of selection and scheduling of projects in the power generation industry. They proposed a heuristic based on the GRASP meta-heuristic, the k-random risk greedy heuristics (kRGH), to solve the problem and evaluate its quality and performance using computational tests. They also demonstrated a decision support system (DSS) prototype that included the heuristic, data visualization, data management, and total risk/cost charts, among other things. The kRGH is distinguished from the basic GRASP heuristic by constructing a single solution instead of repeatedly searching for several locally optimal solutions and not updating the element benefits.

2.3.6 Ant-Colony Outranking System for Project Portfolio Selection

Among the studies that used ACOS, the study of Rivera et al., (2013), presented two evaluation alternatives for handling synergy in the Ant-Colony Outranking System (ACOS) for solving social project portfolio problems. The proposed approach for managing synergy as a multi-objective function adaptation performed better in the used case assigned in terms of solution quality and execution duration. On the other hand, adding artificial projects and redundancy rules made the algorithm more flexible. The evaluation alternatives for solving the social project portfolio problem integrated artificial projects and redundancy rules, which were more flexible but increased the number of unfeasible combinations, which affected the performance of their proposed algorithm.

Esfahani et al., (2016) stated that because there were so many projects to fund, and organizations only had so much money to invest in projects, they had to choose from a restricted number of options. Despite this, they went to a lot of trouble selecting projects that would help them achieve their objectives. For the problem of project portfolio selection, they devised a conventional harmony search method for a list of 31 projects. Organizations can identify which project is more profitable or has lower risk using the presented algorithm, which solves the problem to near optimality, and is very quick and robust. However, the researchers should have mentioned the difficulties involved in selecting appropriate projects.

Gomez et al., (2018) elaborated on the study by Rivera et al. (2013). They developed a strategy based on the ant colony optimization system (ACOS) that incorporates the decision-maker's preferences in forming a portfolio of public projects targeting project selection in allocating a general budget under synergy, cannibalization, redundancy, and reciprocations among 100 projects with 9 objectives. Their algorithm, compared to other methods of selecting projects (called ranking), ACOS, has the merit of presenting to the decision maker (DM) not only a solution but also a set of non-dominated portfolios. ACOS finds solutions that exceed the

Pareto dominance or preference terms to the ranking solution. The model was developed for forming a portfolio of public projects but does not provide a unique solution or the stated number of projects or portfolios selected.

2.3.7 Other General Meta-Heuristics Methods for Project Portfolio Selection

Some other Meta-Heuristics Methods are reviewed below:

According to El bok & Berrado, (2022), categorising projects allows for better alignment of a portfolio with the organisational strategy and goals, which aids in understanding the portfolio's structure and enables proper project portfolio selection (PPS). Clustering analysis was presented as the core computing technology in their study that allows for empirically based categorization. The proposed approach improves the portfolio's structure's visibility, including its components' comparability, and provides for the execution of many projects. It also identifies the key attributes, or factors that influence project grouping, such as strategic and intrinsic features. Meanwhile, it may be preferable for the proposed approach to focus on project categorization, while allowing other techniques to facilitate project evaluation and prioritisation.

Etgar & Cohen, (2022) did research to address the project selection problem under resource constraints and technical precedence. Using metaheuristic search techniques known as clustering methods, the researchers designed a benchmark database of portfolios varying in size, precedence complexity, and resources. The proposed method was able to generate feasible, meaningful, and highly satisfactory solutions to long-term problem planning.

Li et al., (2022) proposed overcoming the unreliable public R&D PPSP with sectoral estimation and project failure. They developed a stochastic programming model to help corporate sponsors make portfolio decisions. The developed model was converted into a second-order deterministic cone programming model. According to their findings, the number of project proposals, the funding amount, and the decision-maker tolerance for project failure all have positive effects on portfolio performance. Meanwhile, the probability of project failure has a negative impact.

Some of the meta-heuristic methods, like mPOEMS, could not deal with incomplete data sets; the ACOS method increased the number of unfeasible combinations, which affected the performance of the model. Also, it did not provide a unique solution or state the number of projects selected, and KRGH did not search for locally optimal solutions. Clustering analysis focused on how to facilitate project evaluation and priority, and the stochastic programming model had some negative impacts on the study. However, GA outperforms conventional algorithms in numerous areas, such as being able to find solutions to problems that are not easily defined, deal with large and complicated problems, find numerous solutions to a single problem, overcome problems with multiple objectives or constraints, and generate various optimal results from a variety of generations.

The best three approaches in this section are GA, SA and PSO.

2.4 The Hybrid model for project portfolio selection

Many researchers have employed hybrid models as an alternative approach for project portfolio selection. As a result, each organisation chooses a few methodologies that are suited to its organisational objectives and project requirements or attributes Kandakoglu et al., (2020).

2.4.1 Decision Support and Exact approaches of a hybrid model for PPS

These are some of the decision support and exact approaches of the hybrid method in project portfolio selection problems frequently used by researchers.

Lee & Kim, (2000) stated that previous approaches for information system (IS) project selection did not consider interconnection between criteria and possible projects. This study proposed an analytic network process (ANP) and zero-one goal programming (ZOGP) for six IS project selection problems with multi-criteria and interdependence features. The proposed models solved IS project selection problems by saving on costs and economising on resources related to multi-criteria problems, interdependence, and resource feasibility and provided other significant benefits to organizations.

Information System (IS) project selection problems, according to Lee & Kim, (2001), are MCDM problems. A hybrid method for interrelationship of six IS project selection problems was developed using the Delphi, ANP method, and 0-1 GP. The proposed method addressed multiple criteria problems, interdependence, and resource feasibility. Delphi's time consumption and complexity are its limitations.

Saghaei & Didehkhani, (2011) stated that project selection is one of the most complicated issues in business and industry. Because project selection is a MCDM problem, AHP, TOPSIS, and SAW models have been used to solve it. These models, however, do not operate effectively when there is a lack of complete information on the assessment hierarchy and criteria weights and when there are interrelationships between criteria. The optimal portfolio of projects was found using a fuzzy weighted additive goal programming model and an adaptive neuro-fuzzy inference system (ANFIS) capable of analysing interrelationships among criteria for Six Sigma project selection. The study demonstrated that an organization could choose a compelling portfolio of Six Sigma projects to solve its challenges while considering the company's constraints, such as budget and the desired financial benefits level. The proposed model could be tested in large-scale systems.

Studies by Mohammed, (2021); Zhou & Lu, (2012) integrated the analytic hierarchy process (AHP) and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), which is a multi-criteria decision analysis method, for project alternatives, evaluation and selection in four and twenty projects respectively. Zhou and Lu (2012) developed fuzzy AHP and TOPSIS for the evaluation and selection model because of information uncertainty and inaccuracy during the evaluation process. The integrated model was based on interval-valued triangular fuzzy numbers, and an index system for choosing the optimal project was developed. Also, the ranking of alternatives was based on their relative closeness. The study by Mohammed (2021) identified the use of fuzzy AHP and fuzzy TOPSIS to fill the gaps in projects (alternatives) to achieve the company's goals and interrelationships among projects. Twenty Iraqi Oil Company projects were assessed against five critical criteria, which showed the measurement of criteria weights as necessary and adjusted the ranking of projects to figure out the best project. The hybrid method assisted Decision Makers (DMs) in selecting the optimal portfolio management project in their decision-making process. The proposed method is more efficient in prioritization than the selection of projects.

Abbasianjahromi & Rajaie, (2013) presented a new bid/no-bid strategy framework by implementing the latest project portfolio selection methodology based on risk. They applied the fuzzy case-based reasoning (CBR) method to work with linguistic variables, which are the most important and applicable in evaluating alternatives for pre-screening proposed projects. They also determined the desired risk level of the company (DRLC) by evaluating project risk in the knowledge base (old cases) using fuzzy simple additive weighting (SAW). They likewise utilized zero-one linear goal programming to distribute the most relevant pre-screened projects to the company's portfolio. The proposed model was applied to 5 projects to find the optimal risk-income interaction point (portfolio theory). It can also effectively determine the optimal approach in bid/no-bid decision-making. However, the method was applied only to a small number of projects, and the assumed planning of the proposed projects, the expected cost and benefit might not be feasible for projects with criteria different from risk and benefit.

Khalili-Damghani & Sadi-Nezhad, (2013) proposed a hybrid multi-criteria decision-making (MCDM) approach based on goal programming. They modified fuzzy TOPSIS in project selection problems for sustainable criteria (economic, social and environmental) and supportive criteria (strategic alliance, organization readiness, and investment risk). Their proposed approach to sustainable investment selection has proven to be a promising and efficient solution for multi-criteria decision-making (MCDM) problems involving a group of DMs' preferences while also considering multi-dimensional perceptions. The proposed approach was only performed in sustainable investment selection and did not consider other sustainable environmental and social selection criteria.

In a related study by Khalili-Damghani, Sadi-Nezhad, & Tavana, (2013), PP decisions are seen as multi-objective problems involving many projects that will select the subset regardless of restrictions and preferences. The authors applied a GP method for PPS that incorporates inconsistent fuzzy goals with inaccurate priorities. The TOPSIS and fuzzy preference relations were utilised to simplify the multiple goals problem to a bi-objective problem.

Tavana et al., (2015) proposed a three-stage hybrid method for selecting an optimal combination of 30 projects. The proposed model was divided into three stages, each with its steps and procedures. They employed Data Envelopment Analysis (DEA) for preliminary screening, a Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) for project ranking, and Integer Linear Programming (ILP) for selecting the best project portfolios in a fuzzy environment based on organizational goals. The proposed model assisted decision makers (DMs) in systematically thinking about complex project portfolio selection (PPS) problems. The setback from the ILP model is used to solve a single objective problem.

Tabrizi et al., (2016) established an integrated framework for determining the optimal project portfolio selection based on the balanced scorecard (BSC) for specified criteria concerning higher priorities from the fuzzy DEMATEL approach and a multi-choice goal programming (MCGP) technique. They analysed project synergy and outsourcing options to create a more realistic decision process. The decision-making committee considered objective function weights instead of using weighting techniques.

De Souza et al., (2018) developed a hybrid Analytic Hierarchy Process ─Technique for Order of Preference by Similarity to Ideal Solution (AHP-TOPSIS-2N) method for multiple criteria decision-making for the prioritization of project portfolios. Their model showed the sorting and prioritization process of enterprise portfolios. However, the proposed method is more efficient for sorting and prioritization than the selection of projects.

Jafarzadeh et al., (2018) stated that many project portfolio selection methodologies failed to integrate the following essential elements: 1) prioritising selection criteria over each other, 2) uncertainty in decision-making, and 3) project interdependencies. They proposed a combined

Quality Function Development (QFD), fuzzy logic, and Data Envelopment Analysis (DEA) to integrate the three elements for 30 projects. Their research combined project interdependency and uncertainty into a single model to prioritise selection criteria before decision-making. The study in a single model for project interdependency, uncertainty and criteria selection could be tested for large and small projects in a real- world application.

The study by Chaparro et al. (2019) conducted a systematic review of project portfolio selection approaches from incremental to innovation conditions. They showed how the project selection methods evolved and presented a comprehensive characterization of the selection methods. They established four essential features to manage radical innovation portfolios: dynamism, interdependency management, uncertainty treatment, and input data. They proposed a framework for supporting the project portfolio selection (PPS) process to help managers choose and combine different methods among the alternatives according to a specific innovation level (either radical or incremental innovation). The framework did not discuss how it could be tested in various project portfolio selection problems.

Tavana et al., (2019) proposed a two-stage hybrid mathematical programming approach for selecting a list of 10 projects for optimal project portfolio by integrating the FAHP with the FIS. In the cybersecurity market, their hybrid approach took into account both quantitative and qualitative criteria that indicated the model's efficacy. The three objective functions, maximizing profit, maximizing total project value, and minimizing risk, were analysed separately and could affect the model results if tested in large project sizes.

As Hashemizadeh & Ju, (2019) stated, project portfolio selection (PPS) was recommended for building contractors based on several strategic, financial, and project specifications. In this study, multi-criteria decision-making (MCDM) approaches, and geographic information systems (GIS) are integrated to obtain a strategic score through employment of the analytical hierarchy process (AHP) model for 29 possible projects, including using the technique for order preference by similarity to the ideal solution (TOPSIS) to be ranked according to technical criteria.

Bellahcene et al., (2020) proposed an integrated Analytic Hierarchy Process (AHP) and Weighted Additive Fuzzy Goal Programming (WAFGP) method for the selection of 10 information system (IS) projects that can use all types of linear membership functions. Their results showed that the integrated AHP-WAFGP approach was more accessible and more straightforward than the previous methods (AHP, Zero-One Goal Programming (ZOGP) and combined AHP-ZOGP) and gives increased support for information system (IS) project selection decisions by choosing those projects that better satisfy the different decision goals and also make better use of the available resources. The proposed AHP-WAFGP approach considered the uncertain nature of the decision makers' judgements and the interdependencies among criteria and alternatives for the IS project.

Jafa, (2020) presented an integrated model to assist decision-makers in solving complicated selection problems by combining the Analytical Hierarchy Process (AHP) with the Quality Function Deployment (QFD) for multi-criteria decision-making (MCDM). The QFD and AHP proved their efficiency, except for the demerits involved in using each method alone. The integrated model should be considered in a real-life case study to demonstrate its efficiency.

Nakhaeinejad & Momenshad, (2020) provided a framework for selecting project portfolios by considering the triple interaction between projects using the correlation coefficient and the theory of cross-information for the risk factors affecting them. Their study revealed that considering pairwise and triple-wise interactions rather than individual interactions yielded different results. In their research, they discovered an unidentified relationship with paired interaction. The study did not consider meta-heuristic methods if problem dimensions changed. According to Keskin, (2020), selecting the best project portfolio is one of the essential factors in the transition to Industry 4.0. The problem was approached in two stages: (1) a literature review where expert opinions were used to decide the criteria and sub-criteria to be employed in the selection, and a Fuzzy Analytical Network Process (FANP) in a fuzzy environment was employed to reflect the uncertainty of the decision-making process (2) A multi-objective nonlinear programming model for 13 mutually exclusive projects, encompassing predecessors, resources, and output dependencies across projects, and multi-objectives was developed. However, although the system can apply different evaluation criteria to the sectoral and structural features of the sectors, it neglected time and labour force constraints.

According to a study by Ghannadpour et al. (2021), sustainable growth is one of the most essential scientific and practical growth disciplines in advanced communities and their research highlighted its significance in developing countries. Their research established a three-stage innovative combination approach for predicting project sustainability utility by combining an innovative multi-criteria portfolio house in an ANP and a QFD approach. They used a prioritization pattern in an automobile firm to choose sustainable projects for present and forthcoming projects by defining important indicators of sustainable growth and categorising them in the model of a Sustainable Balanced Scorecard. The models could be tested by a large-scale number of projects to prove their effectiveness and efficiency.

Wu and Chen (2021) developed a structured model that integrated a modified Delphi method (MDM), an analytic hierarchy process (AHP), and zero-one goal programming (ZOGP) to design a feasible portfolio of 5 categories of smart city projects. The hybrid method provided a structured model to assist decision-makers at public agencies in evaluating smart city projects. Also, it offered insights into the decision process for selecting a feasible portfolio of projects within the municipal administration. However, researchers, or practitioners should be cautious of using the proposed method in other areas regarding expert choice and surveys.

Hashemizadeh and Ju (2021) developed a tactical decision-making concept for optimizing REP portfolios to quantify how HD affects REP portfolio selection. According to their study, they developed a FANP to weigh the criteria, deduced the best options through the use of the MABAC method and then chose the required suitable project portfolio with the Fuzzy interval goal programming (FIGP). The findings of the technique aided policymakers in greater perception the importance of HD in REP portfolio selection.

Sarnataro et al., (2021) presented an Interactive Multi-Objective Optimization (IMO)-Dominance Rough Set Approach (DRSA) called the IMO-DRSA method for selecting and timing 16 portfolios of urban development projects for optimizing conflicting objectives. This method allows qualitative evaluations for criteria including uncertainty and also allows different stakeholders to express their opinions. The model could be applied in both qualitative and quantitative assessments.

Hesarsorkh et al., (2021) developed a comprehensive mixed-integer linear programming (MILP) model in external financing, technical and market risk, and outsourcing for R&D project selection scheduling problems in the pharmaceutical industry. This model employed risk-adjusted net present value (rNPV) and robust possibilistic programming (RPP) methodologies to optimise the mean value of the R&D PP and control both efficiency and feasibility strength.

Mokhtari & Imamzadeh, (2021) developed a genetic algorithm for dealing with the suggested Mixed-Integer Non-Linear Programming (MINLP) problem with a goal programming approach for a 15 portfolio of city and government projects with regard to completion time, regions, and tactical goals. The proposed genetic algorithm outperforms the Generalized Algebraic Modelling System (GAMS) [problem] solvers in terms of non-linear and linear constraints regarding solution time and quality. GP is one of the MCDM tools, and project selection is an MCDM problem; therefore, criteria to select a project could be considered.

Wang et al., (2021) proposed a design structure matrix (DSM) and fuzzy strategic distance for technology diffusion and project strategic contribution. Their research assists managers in achieving a more strategic output, synergistic relationships such as benefit, resource, technology, and strategic synergies between multiple projects, and a project portfolio selection model based on multi-project collaboration in an uncertain environment. However, using stochastic programming methods or heuristic methods to solve stochastic factors or large-scale projects for project portfolio selection could be considered.

According to Nabati & Ashrafi, (2021), one of the foremost essential elements utilised to assess the efficacy of the portfolio selection process is the model's capacity to assess interrelationships between projects. The Promethee II was developed as a multi-criteria decision-making method to prioritise projects in their study. An integer non-linear programming (INLP) approach was proposed to solve the problem of selecting the 15 projects portfolio. Their proposed approach is a more efficient project portfolio selection process to measure project interrelations, which results in more revenue than in the case where project synergies were not considered. The model could be tested or applied in significant-scale project selection problems.

Koohathongsumrit and Luangpaiboon (2022) proposed a novel integrated approach for selecting a list of 22 strategic marketing information system projects that combined the FAHP and ZODP. Under various objectives, limited resources, and preferences, the proposed hybrid FAHP–ZODP method maximizes overall desirability. The findings of the study can benefit decision-makers in project selection when competing attributes exist, and lead to effective decision-making with a complete understanding of the marketing environment and improve project management in specific and uncertain situations. The integrated approach could be extended to meta-heuristic for significant size problems.

Because of the COVID-19 pandemic, which had a significant impact on the global economy, construction projects faced numerous challenges and disruptions. Mahmoudi et al., (2022) proposed a comprehensive framework for portfolio selection with the goal of organisational resilience and related strategies. For aggregating stakeholder opinions, calculating the optimal number of portfolios, and clustering projects, they applied the Ordered Weighted Aggregation (OWA) operator, including Fuzzy C-Means and Elbow methods. While the Robust Ordinal Priority Approach (OPA-R) dealt with the uncertainty of the input data by providing weights for stakeholders, criteria, and projects, the best portfolio linked to the organisational resilience strategy was selected. Their proposed framework offers several advantages to the organisation regarding profitability and long-term resilience. However, in dealing with an enormous scenario in a real-world situation, the approach could increase the computational time.

Ranjbar et al., (2022) believes that hybrid decision-making about choosing and scheduling a PP can result in better performance. They presented a fuzzy hybrid multi-criteria methodology and a bi-objective mathematical programming model called FAHP, TOPSIS and an augmented epsilon constraint method with fuzzy uncertainty parameters in their study to address the quantitative and qualitative dimensions of the PPSSP. Their model result enables the company to optimally plan for all 23 possible potentials, such as project mode, external capital, reinvestment, penalty, and reward over a multi-period operation phase to achieve the highest NPV of profit and portfolio score. The proposed model could be tested in a large-scale project.

According to, De Souza et al., (2022), an integration of Multicriteria Decision Making (MCDM) methods in a fuzzy environment called analytic hierarchy process (AHP) and 'VlseKriterijumska Optimizacija I Kompromisno Resenje' (VIKOR), meaning multi-criteria optimization and compromise solution methods, was developed to enhance the project portfolio selection processes under uncertainty in the pharmaceutical industry with 24 projects. The developed model took into account the evaluators' indecision, increased the robustness of the project portfolio selection process, and optimized the company decision. However, the proposed model does not validate the correlation, interdependence, or cannibalization of the criteria and projects.

Ramedani et al., (2022) proposed a three-stage integrated approach for industrial project portfolio selection for risk indicators under uncertainty. They established fuzzy AHP and fuzzy TOPSIS methods. They used a hybrid technique known as Multi-Choice Goal Programming with Utility Function (MCGP-UF) and PSO to tackle 10 projects problem of (hybrid PSO-MCGP-UF). Their findings demonstrated an improvement in solution time and response quality, allowing decision-makers at all stages of the PPS to complete robust portfolios in a short period of time.

According to Al-sobai et al., (2022), strategic projects are critical for an organization's survival. Still, they are subject to various types of constraints in terms of risk, management capabilities, resources, and political and cultural factors. But prioritizing and selecting strategic projects becomes a difficult task in any organization that focuses on multiple strategic projects spanning different sectors or companies. A framework for analysing strategic projects that ranks heterogeneous projects across industries was proposed that uses multiple-criteria decision analysis called criteria importance through inter-criteria correlation (CRITIC) and technique for order of preference by similarity to ideal solution (TOPSIS). The study provided a comprehensive framework and analytical methodologies to help decision-makers choose one or more types of cross-industry strategic projects. However, the method could not be applicable to different industries in PPSP, and the sample size of decision-makers can be a limitation.

In the study by Jalilibal & Bozorgi-Amiri, (2022) a series of sustainability criteria was initiated, and hybrid MCDM approaches called fuzzy DEMATEL and ISM were devised to identify and classify a collection of criteria for selecting a project portfolio. Their proposed method has proved that profit, cost, soil, atmosphere, energy, waste, and risk were the most impactful criteria in project portfolio selection, particularly in construction project selection. They agreed that environmental sustainability was significant in project portfolio selection, but social sustainability was not as crucial as others. However, experts believe that biodiversity, social integration, and responsibility criteria are the most important criteria, while technical specifications, water, security, and public utility are less influential in project portfolio selection.

Mogbojuri and Olanrewaju (2023) designed an integrated technique called AHP and GP to choose projects for community development and needs. Using an agency of government as a case study, they explored the efficacy of the hybrid model to circumvent PPSP that were delaying community growth. The results showed that the hybrid approach (AHP-GP) outperformed the GP as an independent model, and that the goal programming model was used as an innovative approach on a large number of 100 projects. The AHP-GP proved to be an efficient system that is best for managerial application due to its ability to deal with MCDM circumstances. The integrated model can be used to prioritize project selection. In comparison to the standalone model (GP), this study demonstrated that an integration approach can select more projects and generate more jobs in the communities concerned.

2.4.2 Meta-heuristics approach of hybrid method for PPS

In furtherance of the research, some scholars applied a meta-heuristics approach as a hybrid method for PPS.

Ghorbani & Rabbani, (2009) opined that meta-heuristic approaches are well-known methods for solving various multi-objective problems that arise in real-world situations. Therefore, a meta-heuristic multi-objective scatter search was developed to achieve diverse locally non-dominated solutions for the project selection problem. The proposed approach was compared to NSGA-II in terms of various key metrics and outperformed NSGA-II in terms of performance and superiority. The proposed algorithm was tested with 11 projects but could be tested in a large-size real-life situation.

Yu et al., (2012) proposed a typical (EA)—(GA) to develop a viable and efficient solution to the complicated multi-criteria project portfolio selection problem.

Nikkhahnasab & Najafi, (2013) proposed simulated annealing (SA) and genetic algorithm (GA) for PPSP to maximize the net present value. The results proved that the genetic algorithm (GA) performed better than the simulated annealing (SA) with 5 projects and 5, 10, 30, 90 activities. The research would have addressed two objective functions: maximizing the NPV and minimizing the project portfolio's completion time or cost.

To solve the problem of resource-constrained project selection and scheduling, Naderi, (2013) developed three meta-heuristics based on an imperialist competitive algorithm (ICA), simulated annealing (SA) and genetic algorithm (GA). The imperialist competitive algorithm (ICA) performance was superior to the others. However, the proposed algorithms could have been tested with larger projects and studied project selection and project scheduling separately based on their importance to project management.

El-Kholany & Abdelsalam, (2017) proposed a method that combined a multi-objective binary cuckoo search (MOCS) algorithm with Monte Carlo simulation to assist decision makers in selecting the best portfolio based on a given set of parameters such as criteria and performance values while accounting for uncertainty, constraints, and multi-objectiveness. The proposed framework (PF) outperformed the genetic algorithm (GA) in 40, 80, and 150 projects, and it also exceeded non-dominated cuckoo search (NDCS) results when dealing with a multi-objective case. Meanwhile, increasing the population size did not significantly improve the maximum benefit value, while computational time was grown in a single objective.

Cruz-Reyes et al., (2017) proposed an approach called the Hybrid Multi-Criteria Sorting Genetic Algorithm(H-MCSGA) to develop a selection pressure towards the Region of Interest (ROI) instead of the whole Pareto front. Their approach achieved an excellent characterization of the Region of Interest (ROI), outperformed the standard NSGA-II in simple and complex problems, and could deal with 9 and 16 objectives in 17 problems. Meanwhile, criteria for public project selection were not stated in the proposed H-MCSGA.

Tofighian et al., (2018) proposed new meta-heuristic algorithms of GA, PSO and EM-like against an algorithm called Orthogonal array L_9 for a multi-period project portfolio selection problem. The orthogonal array L9 outperformed all other methods in terms of all indicators and performed better in all sizes. But when the problem is significant, the PSO has an advantage over the proposed algorithm in terms of computational time.

Abbasi et al., (2020) developed MOPSO and NSGA-II algorithms for new product development (NPD) project portfolio selection problems. Their work proved that NSGA-II performed better than MOPSO from 26 problem size. However, the researchers suggested other evolutionary algorithms or hybrid methods for quality solutions and to select the solution method.

Ha & Madanian, (2020) reviewed the present issues in IT PPS, as well as the accessible approaches and technologies and their drawbacks. They provided an outline of probable Artificial Intelligence (AI) programmes in project portfolio selection in the Information Technology (IT) industry. They claimed that many studies have offered AI approaches as a solution, such as a fuzzy or Artificial Neural Network (ANN). As a potential solution, they suggested a hybrid approach. The proposed approach could not be a perfect solution for all organizations in IT, but other areas of project portfolio selection problems may be ideal.

Song et al., (2021) discovered that choosing an adequate PP and beginning job at the appropriate period are two key decision-making difficulties in PM and engineering management. They developed four heuristics stochastic multi-attribute acceptability analysis (SMAA) algorithms such as SMAA-based PSO, SMAA-based GA, SMAA-based SA algorithm, and SMAA-based teaching–learning optimization in MAPPSSP with random attribute values and hidden attribute weights. PSO-SMAA was shown to have the optimum optimization efficiency to selected 6 projects portfolio from 10 projects with 1482 – 1659 profits. However, the algorithms rely on the probability distribution estimation of attribute values and also do not consider dependency among attributes.

In the study by Harrison et al., (2021), they developed a model for project portfolio selection in the framework of Future Defence Force Design (FDFD) in the Australian Defence Force (ADF) for capability development. The developed a model called custom heuristic and a genetic algorithm of the initial seeded population was presented. The genetic algorithm proved efficient or achieved optimal custom heuristic solutions on 10 and 300 small-large problem cases. However, the proposed PPSSP formulation and solution methods proffer a pragmatic and effective way to manage complex inter-dependencies in modern defence capability investment portfolios. The model doesn’t select exact projects nor show how the project could be scheduled.

According to Harrison et al., (2022), a usual difficulty encountered by companies is determining how to choose and schedule a best portfolio of projects within many limitations, such as a lack of funds. Despite the pervasive scope of the problem, they opined that no current approach fully covers an adequate collection of features that appear in real-world scenarios. As a result, an integrated meta-heuristic algorithm based on a custom basis heuristic and local search operator called Genetic Algorithm (GA), Biased Random-Key Genetic Algorithm (BRKGA), and Differential Evolution (DE) was proposed for two representative problems of

100 and 250 projects. The proposed model can adequately address the organization's complex planning task of selecting capability options (COs) to implement.

2.4.3 Decision Support, Exact and meta-heuristics approaches for PPS

Studies were also carried out by scholars who applied both exact and meta-heuristic approaches to PPS.

Khalili-Damghani, et al., (2013b) developed a hybrid approach of data mining, evolutionary algorithms called non-dominated sorting genetic algorithm II (NSGA-II), and Data Envelope Analysis (DEA) to design accurate-interpretable FRB for sustainable project portfolio selection. The statistical analysis revealed the performance dominance of the proposed hybrid framework over the Genetic Based Machine Learning (GBML) method based on selected accuracy and interoperability measures. The proposed approach could not apply to other business and engineering applications nor indicate chosen projects.

Also, for selecting a portfolio from a large number of potential projects, (Razi, 2014) modelled a hybrid model including meta-heuristic algorithms and multi-criteria decision-making techniques to select list of 20 projects for optimal Pareto portfolio of project risk and rank. The Grey relational analysis used to rank the candidate projects was not explicit nor elaborate enough to integrate the decision maker’s opinions in a multi-criteria situation. Neither does the proposed hybrid method show the number of projects selected.

Molavi & Rezaee Nik, (2016) proposed an integer non-linear goal programming model with stochastic constraints that was converted to a deterministic form utilizing the chance constraint programming method for project selection and scheduling. Imperialist competitive and genetic algorithms were presented due to the complex challenge, especially on a large scale. The analysis revealed that the exact method takes a long time to run, especially in large sizes, and that the ICA and GA algorithms were effective in producing relevant results in an acceptable amount of time of 13.27 and 6.53 seconds. The project scheduling problem could be studied separately.

Wu et al., (2018) proposed a combined fuzzy multi-attribute decision-making and fuzzy multi-objective programming framework for large-scale rooftop photovoltaic (LSR-PV) project portfolio selection, which included triangular intuitionistic fuzzy numbers (TIFNs), the Analytic Hierarchy Process (AHP), the Preference Ranking Organization Methods for Enrichment Evaluations (PROMETHEE II) method and the Non-Dominated Sorting Genetic Algorithm-II (NSGA-II) algorithm for optimal-Pareto set. Their results showed 2 non-dominated solutions from the seven (7) projects evaluated out of a list of 10 projects. The hybrid method could have been tested for an optimal solution for a large project size.

Kumar et al., (2018) investigated the difficulty of simultaneous selection and scheduling of interdependent projects called the project portfolio selection and scheduling problem (PPSSP), with mutual exclusiveness and complementarity between the projects. A zero-one integer linear programming model for maximising the portfolio's total expected benefit was developed and implemented. For the formulated model, three meta-heuristics were developed: teaching-learning-based optimization TLBO, TS, and a hybrid TLBO-TS. The hybrid TLBO-TS algorithm outperformed TLBO and TS regarding solution quality and convergence of 6150, 5850 and 5600 anticipated profits respectively. When projects are interconnected in exclusiveness and complementarity, the model will be valuable to project managers in simultaneously selecting projects in the portfolio and schedule. The schedules of the projects and the activity schedules could be considered separately with suitable algorithms.

Namazian et al., (2019) developed two approaches, exact and meta-heuristic, known as the goal programming (GP) method and genetic algorithm (GA), by considering aggregated risk and benefit. In the study, the problem was NP-hard (Non-deterministic Polynomial-time), and an integrated (GP) method and Genetic Algorithm (GA) were proposed (GPGA) for 30 number of projects. Moreover, the efficiency of the proposed metaheuristic algorithm (GA) was correlated with the exact method (GP) for both small- and medium-size cases. The study showed that the meta-heuristic algorithm efficiently managed significant pragmatic problems. The project scheduling activities could be tested or applied to a large-size problem.

Wu et al., (2019) developed a MCDM framework to choose the best (DEG) PP under strategic scenarios, variability and project interaction using intervals type-2 fuzzy analytic hierarchy process, a nonlinear integer programming, and non-dominated sorting genetic algorithm-II to obtain the optimal distributed energy generation project portfolio under different strategic scenarios. Their results showed 11 solutions objective function with 7 scenarios from 15 projects. However, the decision-makers and project managers should make the project portfolio simultaneous with enterprise strategic objectives in the project portfolio selection process for project-oriented enterprises.

Zhang et al., (2020) developed a three-phase PPS algorithm using fuzzy linguistic preference relations, EVIKOR model and goal programming (GP) multi-objective model against Non-Dominated Sorting Genetic Algorithm II (NSGA-II), Strength Pareto Evolutionary Algorithm 2 (SPEA2) and Multi-Objective Evolutionary Algorithm based on Decomposition (MOEA/D).

Therefore, MOEA/D performs better than the other algorithms in addressing this portfolio selection problem. But in terms of time efficiency, the GP method outperforms the evolutionary algorithms as 0.28, 35.87, 31.94 and 9.93 seconds. Thus, evolutionary algorithms may be inefficient in producing Pareto results. Conventional multi-criteria algorithms, on the other hand, may be more suited to optimizing portfolios in the present case due to their straightforward logic and calculation. Their proposed three-phase PPS algorithm proved to be a more stable and efficient project portfolio in a much shorter time. However, the researchers were sceptical about their proposed method's suitability for another portfolio.

Golghamat Raad et al., (2020) presented a hybrid framework by which the project portfolio selection process can be carried out with regard to strategic alignment, cost and risk, and balancing sub-portfolio efficiency. The developed framework is data-mining tools, a hybrid Fuzzy Analytical Hierarchy Process–Artificial Neural Network (FAHP-ANN) method with a multi-objective model to optimize the efficiency of sub-portfolios The framework selected 9 out of 20 projects based on sub-portfolio efficiency, risk monitor and optimization factors.

Panadero et al., (2020) were the first researchers to address the relevant problem of maximizing net present value in a stochastic project portfolio selection problem (PPSP) under uncertainty and risk conditions. They presented a sim-heuristic technique and integrated Monte Carlo simulation with a variable neighbourhood search framework to get efficient solutions. The findings revealed that the relationship between predicted NPV and risk is not always linear and that project interdependencies, as assessed by the correlation between cash flows from two projects, can be used to set a limit on the number of projects in a portfolio. However, a complete multi-objective model can be developed in a stochastic project portfolio selection problem (PPSP) under uncertainty and rich conditions.

In a study by Chen et al., (2021), a NMBP was developed to optimize 40 investment portfolios for multiple objectives, such as maximizing profits and oil reserve improvement while minimizing risk. In this study, an integrated Non-Dominated Sorting Genetic Algorithm II (NSGA-II) with a Technique for Order Preference by Similarity to the Ideal Solution (TOPSIS) was modelled to determine the Pareto optimal solutions and the best compromise solution based on the investors' preferences. The accomplishment of the NSGA-II-TOPSIS algorithm could be compared with other algorithms in terms of time and result robustness.

Beseiso & Kumar, (2021) presented a fuzzy mathematical method for choosing a PP by integrating fuzzy logic, QFD, and GA methods by prioritizing selection criteria for the organization's objectives. The proposed approaches addressed concerns such as expert uncertainty in project selection, prioritizing criteria before beginning the PS process, and assessing the 5 number of related projects for their maximum worths. The integrated approach might have been considered or used to select strategic projects by various levels of government and private organizations.

Mavrotas & Makryvelios, (2021) opined that R&D project portfolio selection is a vast task that needs to consider the multi-criteria evaluation of individual projects, the uncertainty of expert evaluation and the policy constraints that must be assigned to the final portfolio. Therefore, they proposed an Iterative Trichotomic Approach (ITA) that integrated Multi-Criteria Decision Analysis (MCDA), Mathematical Programming and Monte Carlo simulation to provide the optimal project portfolio in 2437 R&D funding problems. The developed model was based on allocating available budget to projects and beneficiaries of funds to 1125 R & D activities in 3 circles, not selecting projects for social benefits.

Mussoi & Teive, (2021) proposed an integrated multicriteria decision-making methodology, including optimization and solution ranking, for solving project prioritisation problems in the distribution utilities, taking into account various criteria and the decision-maker profile along with the company's goals. The optimization module identified a set of Pareto-optimal portfolios using a non-dominated sorting genetic algorithm II (NSGA-II) to select and schedule supplementary projects over a multistage planning horizon and also a multicriteria decision-making (MCDM) analysis to rank the attractiveness of each portfolio in the Pareto-optimal set for company goals and decision-maker preferences. The proposed approach is adaptable to handle forty (40) projects, Eleven (11) objectives, and seven (7) planning stages. The algorithm could have shown the parameters set for the optimization problem.

Turkmen & Topcu, (2021) used the PRISMA method to comprehensively review the R&D project selection problem between 1977 and 2019. Their research assists researchers and practitioners in better understanding selection procedures, decision-maker types and viewpoints, guides them in selecting the most appropriate PS method, and clarifies a common misunderstanding between R&D project selection and R&D portfolio selection by proposing a more precise definition. Hybrid models that combine different approaches and techniques, such as mathematical programming, multi-criteria decision-making (MCDM), and fuzzy/grey methods, were suggested in their study. Still, a hybrid method that includes heuristic algorithms could also be considered.

Wu et al., (2021) investigated the key uncertainty factors and how to avoid subjective bias in project selection uncertainty assessment. In their study, stochastic dominance (SD) and fuzzy theory were developed to reduce personal prejudice which could threaten the assessment when evaluating the anticipated worth concealed in the PP and contribute to project portfolio selection efficiency of 5 system development projects. The proposed method serves as a framework for project managers to improve project control and decision-making. Meanwhile, the project data could be expanded by incorporating projects from various industries.

Selecting an appropriate collection of projects is one of the best tactical and critical resolutions at the management level of project-based construction firms according to (Alinezhad et al., 2022). They presented an integrated issue of choosing the most suitable PP and scheduling interests of phased projects with limited resources and funds. A two-objective MINLP model performs resource levelling by maximising NPV and minimising the variation of renewable resources. Their proposed model was solved by utilising an augmented epsilon constraint and a non-dominated sorting meta-heuristic GA. In small-scale scenarios, the augmented epsilon constraint method produced better results and was more efficient. However, for bigger problems, the GA solves the situation reasonably and makes a consistent Pareto front with multiple result points. In practice, the GA identifies the Pareto efficient solutions of the problem in less than 3 hours. Their study aided in diminishing the tolerance for utilising resources and boosting revenues. The study did not present project scheduling as mentioned and could be separated by using the same methods.

Zhang & Liao, (2022) presented a two-stage integrated MADM and ILP model for distributed PV project portfolio selection. They developed mathematical programming for multiple attribute decision-making methods for determining the non-fiscal worth of 10 projects with insufficient necessary information, as well as a bi-objective ILP model to optimize PP focused on resources, carbon pollution, and other tactical constraints. The developed model was solved using the nondominated sorting genetic algorithm II (NSGA-II) to generated 5 non-dominated Pareto-optimal solutions to selected 4 projects, which demonstrated the validity and logic of the proposed model.

To justify the above references on using integrated methods for PPSP, Chaparro et al. (2019) opined that integrated methods enable managers to employ different techniques and input data are more convenient to adopt in project portfolio selection problems for both incremental and radical innovations. However, it is especially important for radical innovation since no single method has all the features required to respond adequately under uncertain circumstances. It has also been stated that optimization methods are more powerful. Still, combined with scoring, behavioural or mapping techniques, they would be more beneficial because inappropriate selection methods might restrain radical innovation projects' selection proposals. In the review by (Fernandes et al., 2020) on agile and hybrid project portfolio management in a bibliometric coupling study through Scopus and Web of Science search in five areas, such as algorithms for portfolio selection, hybrid approaches for portfolio selection problem, scaled agile portfolio management, agile portfolio theory, and Innovation and projects portfolio, they stated that there is no standard methodology for project portfolio selection practice in the literature. In an extensive review by Kandakoglu et al. (2020), they noted that the use of MCDA methods in tackling the project portfolio selection problem (PPSP) has received increased attention in recent years as more researchers and practitioners have exhibited the suitability of MCDA methods in dealing with multiple, conflicting and disparate criteria. Their review conducted between 2001 and 2020 revealed that many scholars focused on using MCDA methods integrated with optimization methods to deal with resource constraints and other constraints in the two approaches. Their study concluded that MCDA methods are utilized as a supporting tool for optimization techniques and stated that various probable MCDA methods could be used in selecting a portfolio. Still, they emphasised that there is no agreement on which methods are the most effective. Therefore, each organisation selects either one or several methodologies based on its organisational objectives and project requirements or attributes. (Kandakoglu et al., 2020). The best three methods in this section are AHP-GP; TIFNs, AHP, PROMETHEE II, NSGA-II; and Fuzzy linguistic preference relations, EVIKOR, GP, (NSGA-II, SPEA2 and MOEA/D).

The novel method outperforms others in terms of solely or integrated approaches. AHP is effective as a standalone method in decision-support tools when the decision maker wishes to add subjective assessments into the decision-making process. However, FAHP cope with ambiguous data in the decision-making process when accurate numerical data is unavailable. TOPSIS while the decision maker understands what defines the best and worst solutions. VIKOR is used when a decision maker seeks to evaluate overall performance against the disparities between the best and worst alternatives. SAW becomes helpful when the decision-maker understands the relative relevance of each criterion (Rane et al, 2023). In the exact optimization methods, the GP achieves all the goals simultaneously whereas the LP minimizes or maximizes the goals separately. GP is more useful when all the constraints are tough to satisfy. The GP model minimizes deviations from the specified targets, whereas the LP and MILP models minimize or maximize the value of each parameter explicitly (Hussain & Kim, 2020; Prišenk et al., 2014). GA outperformed other meta-heuristic models such as SA, PSO, DE, ACOS, and mPOEMs (Harrison et al., 2022; Ghorbani and Rabbani, 2009; Nikkhahnasab and Najafi, 2013; Kumari and Pushkar, 2015 and Abbas et al., 2020). The AHP-GP-GA outperformed other integrated approaches in selecting optimal pareto efficient projects with large-size projects using four criteria and 17 sub-criteria. However, AHP-GP can select 100 non-complex large-scale optimizations and a set of pareto optimum projects. TIFNs, AHP, PROMETHEE II, and NSGA-II were tested with seven projects and four criteria, including ten sub-criteria, whereas fuzzy linguistic preference relations, EVIKOR, and GP were tested with six projects and four criteria (Mogbojuri and Olanrewaju, 2023; Wu et al., 2018; Zhang et al., 2023). AHP is one of the MCDM tools and it is useful when there are multi-criteria for consideration and the decision maker wants to include subjective judgements in the decision-making process (Siekelova et al., 2021). GP finds ideas and solutions based on organizational goals and constraints conditions for multi-objective optimization to handle multiple and conflicting objectives. It also contains both pre-emptive and weighted types that can integrate with the AHP method (Kumar, 2019; Wu and Chen, 2021).

Therefore, this study proposed integrated AHP-GP-GA, looking at the merits of the techniques or approaches as a hybrid approach.

2.5 Gaps Identified

The gaps in the body of knowledge are identified as thus, there are limited number of studies on social sustainability benefits, there were no suitable criteria for public project selection mentioned, some integrated models were not applied to a real-life situation, the exact algorithms were not applied to number of large-scale projects, and some practitioners or researchers that employed GP model did not apply weighting techniques or decision support tools to generate the objective function weights.

2.6 Chapter Summary

The research has reviewed the studies on exact optimization and meta-heuristic optimization computational methods, where the proposed integrated model (AHP-GP-GA) was reviewed in line with exact and meta-heuristic optimization methods for the justification of the model. The hybrid methods in exact, meta-heuristic and both exact and meta-heuristics approaches were reviewed for PPSP. Furthermore, the study showed research that suggested or justified a hybrid method for PPSP, and gaps identified in the body of knowledge were stated.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter presents the methodology framework for the multi-objective optimization of the social sustainability and public project portfolio selection problem. The framework adopted decision support tools, exact and meta-heuristic modelling approaches. The decision support tool is Analytic Hierarchy Process, while the exact approach is Goal Programming, and the meta-heuristics modelling approach is the Genetic Algorithm. The methodology framework is called AHP-GP-GA. Data was collected by administering a more than 200 well-structured questionnaires to decision makers (project manager, executive director of projects, selected communities' leader or host) and previous projects executed in the area/region from a government agency whose mandate was to improve the lives of the citizens through infrastructural development within four (4) years. The questionnaire was pre-tested with integrated AHP-GP from three project alternatives. The common biases in the areas of project selection criteria, was technically resolved on what the decision makers indicated. The study considered Sanders Research Onion as; thus, Research Philosophy (pragmatism), Approach (quantitative method), Strategy (case study), Choice (mixed-method), Time horizon (longitudinal), Techniques and Procedure (questionnaire, stratified sampling, and software packages). Sourced data was analysed through the AHP and GP methods. The AHP method determines the relative importance weights and priorities, the preference of decision options/criteria and project alternatives. Both the relative weights and priorities determined by the AHP will be used to formulate the Pre-emptive and Weighted goal programming models for multi-objective project portfolio selection problems. According to Wu and Chen, 2021, both AHP and GP are effective techniques for decision-making since they are suitable for multi-criteria decision-making. Multi-criteria decision-making (MCDM) is a method that allows the procedure of multiple decision criteria to evaluate multiple choices and select, control, categorise or describe a collection of choices in critical decisions. These models typically have three stages: establish criteria and alternatives for the problem, quantify the importance of the criteria and alternatives, and determine values for the alternatives (Pariz et al., 2022).

The genetic algorithm (GA) will be used to solve the model formulated to obtain the optimal Pareto set or solution.

Therefore, the proposed multi-objective model framework is based on decision support tools, exact and meta-heuristics models in (Figure 3.1).

The proposed model framework for the PPSP is as follows:

1.) The Analytic Hierarchy Process (AHP) approach determines the relative importance weights and priorities of sub-criteria and criteria.

i. The project selection criteria are Social Development, Social Integration, Operating Factors, and Developmental Decision Strategy.

ii. The project selection sub-criteria are Job Creation, Social Amenities, Quality of life or Benefits for human life, Economic growths to communities, Eliminate unrest in the areas or communities, Political impact, Political threat that depends on the policy, Community acceptance, Place of the project, Abandonment of the project, Finish period of the project selected, Project threat, Technical support of the project department, Local contractors competency, Structure with company mission or goals, and Employment record of PM.

2.) The GP model formulates the mathematical model of a multi-objective project portfolio selection problem.

3.) The GA solves the multi-objective optimization problem for Pareto optimal solutions through the following procedures:

i.) The coding of chromosomes

ii.) Initialization of the process, i.e., population size, probability crossover, probability mutation

iii.) Fitness counting, i.e., multi-objective function.

iv.) Selection process

v.) Crossover operations

vi.) Mutation operations

vii.) Final generation or termination conditions

viii.) Select the best or optimal solution.

The AHP will be implemented using Spice Logic Software. GA will be solved using the Matlab software package for the multi-objective optimization model, and they will be interpreted and discussed based on set objectives in graphs, tables or charts.

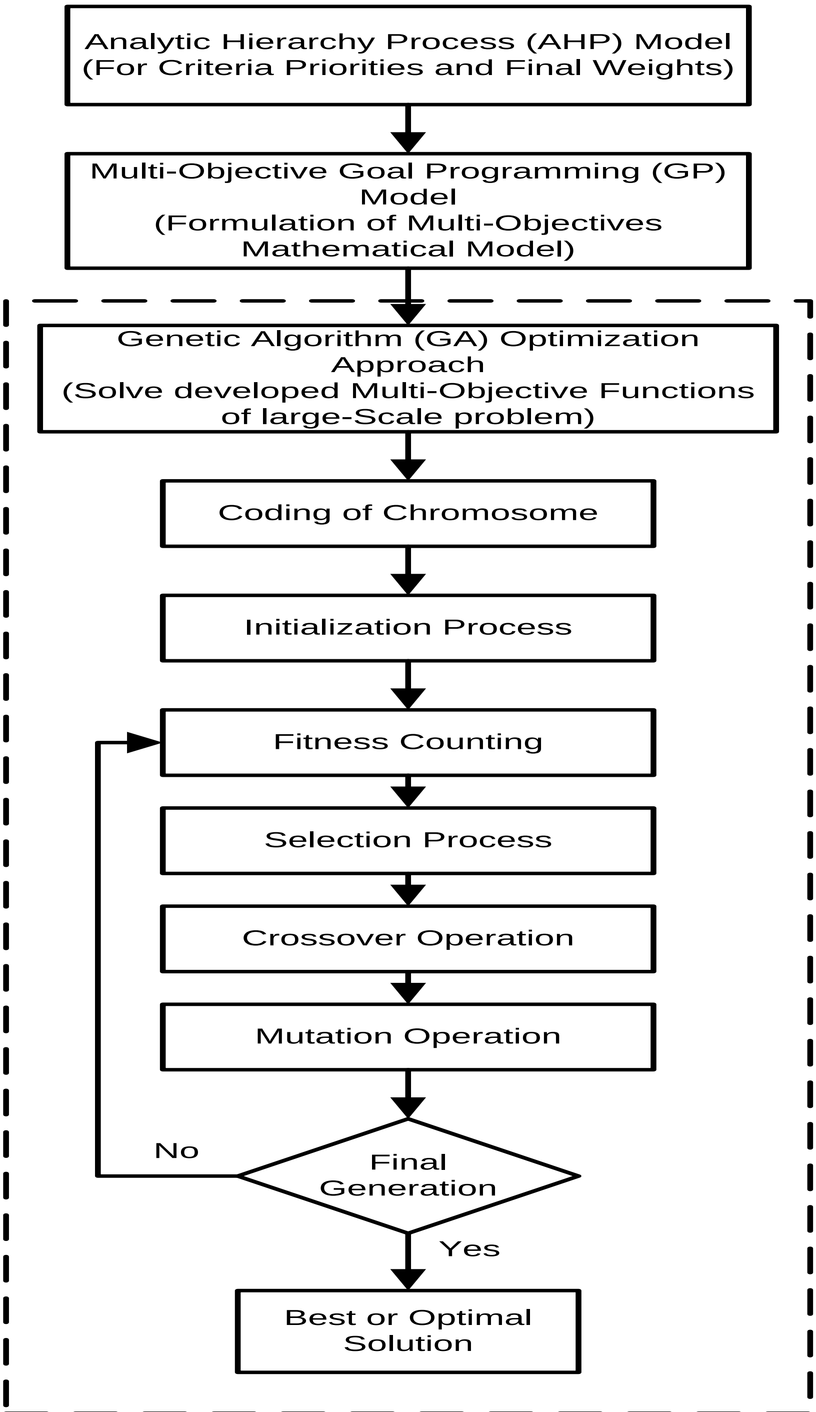

Figure 3.1. The Proposed Hybrid Approach for a Multi-Objective Optimization Model for a PPSP

3.2 Analytic Hierarchy Process

The Analytical Hierarchical Process (AHP) is a technique for making decisions in a complicated environment. It is designed to select the best option from several options with numerous variables to examine. It has been widely applied in healthcare systems, projects and organizations, environmental and community contexts, data and information systems, and other sectors because it has successfully solved many real-life problems (Hartanto & Mayasari, 2021). The AHP is a decision-making procedure for transforming unstructured circumstances into hierarchical structures. AHP is an approach for assessing, prioritizing, ranking, and evaluating decision possibilities and different factors in a hierarchical order. AHP is also a decision-making strategy that employs mathematical and psychological methods (Wiguna & Sudiartha, 2021). The AHP technique assists decision-makers in determining the best options and gaining better knowledge of a decision problem. When subjectivity is present, AHP is a valuable decision-making tool. When decision-making criteria are structured hierarchically into sub-criteria, it allows for better analysis. The Analytic Hierarchy Process (AHP) method is a Multi-Criteria Decision Making (MCDM) approach that examines the problem at several levels of hierarchy. The MCDM is a method that involves the simultaneous study of numerous criteria, such as economic, environmental, social, and technological considerations, to select a project and make the decision sustainable. Using a pairwise comparison matrix, the AHP approach can determine quantitative and qualitative variables. The pairwise comparison is the basis of the Analytical Hierarchical Process (AHP) technique (Solangi et al., 2021). According to (Shapiro & Koissi, 2017), the Analytic Hierarchy Process (AHP) is a measurement methodology that uses judgement to create priority scales from pair-wise comparisons. Building hierarchies implement the AHP, making judgements or performing measurements on pairs of elements concerning a criterion to create preference scales. These are then synthesized across the structure to select the preferable alternative. Bellahcene et al. (2020) stated that AHP addresses three fundamental problems: group decision-making, conflict resolution, pairwise comparisons and neural activity. The AHP evaluates and integrates qualitative and quantitative factors, as well as objective and subjective elements, depending on the decision maker's subjective judgments.

AHP, initially introduced by Saaty in 1971, has the features of flexibility, ease of use, and simplicity, according to Wu and Chen (2021). It has been widely used in urban planning and development for many reasons. The AHP uses pairwise comparison and a nine-point scale to determine the priority of the elements analysed. When the consistency ratio (CR) of the survey results equals or is less than 0.1, the AHP analyses the dependability of the responses, indicating that the survey result is logically viable.

The following six-step process sequences the general steps of the AHP approach, which is based on pairwise comparisons.

Step 1. Problem definition. The first step in AHP is identifying the problem and determining the objectives.

Step 2. Development of a hierarchical structure. This step is a hierarchical model for selecting the alternatives, consisting of various hierarchy levels, each describing an objective/goal of the decision-making, main criteria, sub-criteria and alternatives.

Step 3. Establishing a pairwise comparison matrix (n x n) using Saaty's 1 to 9 relative measurement scale. The pairwise comparison matrices are determined in terms of which element dominates the other.

Step 4. Computing the importance of pairwise comparison by determining a matrix of the relative rankings for each hierarchy level.

Step 5. Development of a global priority ranking to determine the best alternative arrangement. The global priority was calculated by multiplying each criterion's value by its alternative and summarising the results.

Step 6. Selection of the best alternative decision according to the global priority calculation results (Hamurcu et al., 2017; Hamurcu & Eren, 2018; Kaiser et al., 2019; Mogbojuri et al., 2022; Hartanto and Mayasari, 2021; Solangi et al., 2021).

The AHP is a method for decomposing, organizing, and analysing complicated multi-attribute decision-making situations. Because of its simplicity and convenience, AHP has been frequently used since its inception (Ramalho et al., 2021).

3.2.1 Priority Structure

The AHP will determine the priority scores of each sub-criterion and the final weight for the project alternatives. The priorities assigned based on the community needs are as follows:

1. Select projects for community benefit or satisfaction in terms of need. i.e., School, Health Care Centre, Housing, Solar Power Water Scheme, Road Infrastructure, Water Jetty, Town Hall/ Civic Centre, and Electrification in period y.
2. Minimize costs of construction for each project.
3. Maximize the number of community people employed/engaged in each project selected.
4. Minimize the time required to complete the project, or the project completion time.

The first objective will be assigned as priority one while objective two will be assigned as priority two, objective three will be assigned as priority three, and objective four will be assigned as priority four.

3.3 Goal Programming Model

The Goal Programming Model (GP) is the most extensively used approach in the field of multiple criteria decision-making (MCDM), allowing the decision-maker to incorporate many different constraints and goals. In 1955 Charnes, Copper, and Ferguson proposed the GP approach for the first time. GP is a variant of linear programming that allows you to create mathematical programming methods with multiple objectives (Dhahri et al., 2020).

Goal programming (GP) is one of the various methods created to cope with multiple-objective decision-making difficulties. The goal programming paradigm allows the decision-maker to consider many objectives simultaneously while searching for the optimal solution from a collection of feasible alternatives (Hamurcu and Eren, 2018).

There are two constraints in goal programming (GP) problems: goal constraints, and system or structural constraints. The initial function with a set of priorities/goals and positive and negative deviational variables is called a goal constraint. Without negative-positive deviational variables, the system constraint is strictly the classic linear programming function. The achievement function assesses the degree to which undesired goal deviational variables have been minimized. The positive deviation indicates overachievement of aspiration or target, while the negative deviation indicates underachievement of aspiration or target. A feasible area is a set of solutions that fit within the decision space and satisfy all constraints.

The Lexicographic (pre-emptive priority) goal programming model and the weighted goal programming model are two different sub-models in the Goal Programming model. The pre-emptive priority elements are graded based on the goal's importance. Pre-emptive goal programming (GP) is employed when the desired objectives have a clear priority order. This suggests that the priority/goal is far more important than the second, the second is far more important than the third, and so on until the last one; therefore, one must complete the first goal before moving on to the second. Weighted goal programming (GP) is the second type of goal programming used when the decision maker wants to compare the goals directly. This is accomplished by assigning weight to each of the deviational variables (Kumar, 2019).

One of the techniques used in multi-criteria decision-making (MCDM) is goal programming (GP). This sort of decision-making refers to a circumstance in which the decision maker (DM) weighs multiple criteria when evaluating specific alternatives like courses of action, decision variants, and options. Criteria are frequently in contradiction (Gaspars-Wieloch, 2020).

In a classic multi-criteria decision analysis (MCDA) framework, the decision maker (DM) has to deal with several conflicting criteria $f_1, f_2, \dots \dots, f_n$. that have to be maximized or minimized simultaneously. The DM aims to minimize any potential deviation from the objective goals within the GP framework, whether positive or negative. The GP model is a distance-function model in which the optimal solution is the best compromise between several objectives (Colapinto et al., 2020). GP is the most dynamic MCDM method that has been employed to tackle a diversity of decision-making difficulties. Goal programming is a decision-making technique aiming to address multi-objective decision problems. The process allows the decision maker to specify the level of multi-choice desire for each objective that can be avoided, ensuring that no one undervalues the decision. Goal programming is a decision-making methodology that allows a decision-maker to tackle multi-objective problems using the multi-criteria decision-making (MCDM) method. Goal programming is a type of linear programming that is used to solve issues with many objectives that are frequently incompatible and is used to identify a set of acceptable solutions (Wiguna & Sudiartha, 2021).

Therefore, a proposed Pre-emptive and Weighted goal programming model was constructed as follows:

$$Min\ Z = \sum_{i=1}^{m} \sum_{k=1}^{n} \begin{matrix} p_1 w_1(d_1^+, d_i^-) + p_2 w_2(d_2^+, d_i^-) \dots \dots piw_i(d_i^+, d_i^-); \\ i = 1,2,3 \dots \dots m \end{matrix} \quad \dots\dots (1)$$

Subject to

$$\sum_{j=1}^{n} a_{i,j} x_j - d_i^+ + d_i^- = \ \mathrm{G}_i\ ;\ \mathrm{j} = 1,2,3, \dots n \ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (2)$$

$$\sum_{j=1}^{n} a_{i,j} x_j \begin{vmatrix} \geq \\ = \\ \leq \end{vmatrix} G_i;\ \mathrm{i} = m+1, \dots m+p \qquad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3)$$

$$x_j, d_i^+, d_i^- \geq 0 \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (4)$$

x_i = 0 or 1

Equation (1) is referred to as the objective function, which is the summation of all deviational variables. Equations (2) and (3) are called goal and system constraint functions and are referred to as linear constraint functions. Equation (4) is the selection with binary and deviational variables equal to or exceeding zero.

m= the number of goals

p= the number of structural constraints

n = the number of decision variables

z = the objective function expressed as the summation of all the deviational variables

x_j = the jth decision variables

$a_{i,j}$= the coefficient of the jth decision variables in the ith goal

d_i^+, d_i^- = the amount of deviation below and above aspiration level, respectively. Also called overachievement and underachievement variables.

G_i= is the aspiration level or goal associated with the objective i. (Hamurcu et al., 2017; Kumar, 2019; Colapinto, et al., 2020; Dhahri et al. 2020 and Wu and Chen, 2021).

Goal programming (GP) is a multi-objective methodology that can help decision-makers find solutions that satisfy several conflicting objectives. GP was developed to handle decision-making situations in which all qualities have been assigned targets, and the decision maker wants to minimize the non-achievement of the corresponding goals (Akbari et al., 2021).

3.3.1 General Model Formulation

The model will be formulated based on the priority structure of community needs:

Priority one: (P_1)

- Select projects for community benefits or satisfaction in terms of need. i.e., School, Health Care Centre, Housing, Solar Power Water Scheme, Road Infrastructure, Water Jetty, Town Hall/ Civic Centre and Electrification in period y.

$$\sum_{j=1}^{n} a_{i,j}x_j - d_i^+ + d_i^- = \mathrm{S}_y, \mathrm{HC}_y, \mathrm{H}_y, \mathrm{SPW}_y, \mathrm{RI}_y, \mathrm{WJ}_y, \mathrm{CC}_y, \mathrm{E}_y$$

Priority two (P_2)

- Minimize costs of construction for each project, i.e., School, Health Care Centre, Housing, Solar Power Water Scheme, Road Infrastructure, Water Jetty, Town Hall/ Civic Centre and Electrification.

$$\sum_{j=1}^{n} c_{i,j}x_j - d_i^+ + d_i^- = \mathrm{TS}_y, \mathrm{T}HC_y, \mathrm{TC}_y, \mathrm{TPSW}_y, \mathrm{TRI}_y, \mathrm{TWJ}_y, \mathrm{TCC}_y, \mathrm{TE}_y$$

Priority Level three (3)

- Maximize the number of community people employed/engaged in projects selected, i.e., Schools, Health Care Centres, Housing, Solar Power Water Scheme, Road Infrastructure, Water Jetty, Town Hall/ Civic Centre and Electrification.

$$\sum_{j=1}^{n} E_{i,j}x_j - d_i^+ + d_i^- = \text{TES}_y, \text{TEHC}_y, \text{TEH}_y, \text{TESP}_y, \text{TERI}_y, \text{TEWJ}_y, \text{TECC}_y, \text{TEE}_y$$

Priority level four (4)

- Minimize the time required to complete the project, or the project completion time, i.e., School, Health Care Centre, Housing, Solar Power Water Scheme, Road Infrastructure, Water Jetty, Town Hall/ Civic Centre and Electrification.

$$\sum_{j=1}^{n} t_{i,j}x_j - d_i^+ + d_i^- = \text{TDS, TDHC, TDH, TDSPW, TDRI, TDWJ, TDCC, TDE}$$

3.4 Genetic Algorithm

John Henry Holland developed the genetic algorithm (GA) in 1960 and improved it in 1975 to comprehend biological adaptability and how it may be applied into electronic devices to solve complex problems. The method used models the evolution of a group of individuals in a limited environment. The most capable individuals have a better chance of survival, as do their offspring. The main reason for utilizing the genetic algorithm is that it is an influential and hopeful optimization tool described as a basic but computationally efficient technique (Reyna-Orta & Andrade, 2021).

The genetic algorithm is an iterative method for finding the best solution in a population with a fixed size. This population is made up of chromosomes, which are candidate points. The algorithm leads to a competition phenomenon between the chromosomes. Each chromosome encodes a potential solution; it comprises a group of elements called genes, each of which can take on various values (Sefiane & Benbouziane, 2012). Genetic algorithms (GA) are a general method for finding global minima or maxima in a quantized, restricted search space. A fitness function, a selection technique, and crossover and mutation operators are all governed by predetermined probabilities in the 'conventional' Genetic Algorithm (GA) (Mishra & Kumar, 2009).

According to (Limmun et al., 2021), GAs are influenced by natural selection, which selects the greatest individuals to regenerate and produce offspring. A chromosome is a possible alternative to an optimization problem, and a gene is a specific location on a chromosome. The GA selection procedure means that the fittest individuals in a population are kept for future generations of breeding. The crossover and mutation processes change the population of chromosomes over time. The fitness function returns a fitness score, which is used to calculate the fitness of the population chromosome. The GA chooses the chromosomes with the best fitness values to be parents to the subsequent generation based on the concept of survival. The algorithm terminates if the best chromosome is not enhanced after a stipulated number of generations.

Genetic algorithms imitate natural evolution by acting on a population to favour the formation of new individuals who 'perform' better than their predecessors, as measured by a set of criteria such as an objective function. The algorithm has a pool of trial solutions for each generation (that is, population). A population can be as small as 20 individuals or as large as several hundred. These individuals vie for the opportunity to reproduce (Chang et al., 2001). A genetic algorithm (GA) is a search and optimization technique for finding exact or approximate solutions to problems. It is a probabilistic optimization method that simulates the evolution process. The search procedure in the genetic algorithm is analogous to a set of competeing individual chromosomes represented by a string of binary codes. A fitness function is used to calculate an individual's fitness value. A population comprises chromosomes and fitness values (Sanjay et al., 2011). A GA, a meta-heuristic search algorithm for optimization problems, starts with a random initial solution and explores the optimum answer based on criteria and conditions. A gene is represented by an actual number or binary bit in the GA, while a chromosome is a collection of genes. A population is a collection of chromosomes produced in various generations. Typically, GA learning is accomplished using population selection, crossover, and mutation operators.

The primary task of the selection process is to select the best chromosomes from the population for the next generation, to select population members who are fitter and have a higher probability of reproducing. The crossover operation replaces two chromosomes in the people with two new chromosomes. The main goal of the crossover operation is to allow children to differ from their parents and to hope that some children will be closer to the optimal destination than their parents. One-point, two-point, multipoint, and uniform crossover are kinds of crossover. When chromosomes are extremely lengthy, a one- or two-point crossover approach can produce unsatisfactory outcomes, and learning variable benefits takes longer. A mutation operation converts a chromosome into a new chromosome by inversion randomly chosen chromosome genes at a specific mutation rate. The purpose of mutation operation, like crossover operation, is to provide children additional chances to find the optimal solution (Yu et al., 2012).

(Dutta et al., 2021; Yalçınkaya et al., 2021) stated some main advantages of the genetic algorithm (GA) as follows:

• Easy understanding of the concept
• Searching from a population of points, not from a single point
• The ability to reach the global or near global optima fairly well
• The ability to avoid trapping in local optima
• Using payoff (objective function) information, not derivatives
• Using probabilistic transition rules, not deterministic rules
• Robustness to local minima/maxima
• Having an excellent potential for applying parallel computing techniques
• Ability to work with ample search space
• Flexibility in handling the constraints
• The ability to work well on discrete/continuous problems
• Efficiency, even when many parameters are involved

They also mentioned some disadvantages of the genetic algorithm (GA):

• The implementation of GA is still an art, and it can be challenging to identify genetic algorithm operators (GA) correctly.
• In some cases, it is time-consuming (this situation can be reduced to a reasonable point with appropriate parameter selection and High-Performance Computing (HPC) facilities) (Yalcinkaya et al., 2021).

A GA is a type of search algorithm for global optimization. It depicts a set of problem-solving choices using population search technology. By completing a series of genetic operations on the present population, such as selection, crossover, and mutation, a new population generation is generated. The population progressively evolves to a state with an optimal or nearly optimal solution. Genetic algorithm (GA) is a heuristic Monte Carlo inversion method for solving nonlinear inversion problems of complex specific targets in artificial systems. It stimulates the process of life evolution in nature, conducts a guided random search rather than a blind search, and is suitable for solving nonlinear inversion problems of complex specific targets in artificial systems (Yin & Zhao, 2021).

An optimization algorithm based on natural selection and population genetic mechanisms is known as a genetic algorithm. Every feasible solution is encoded as an individual in a genetic algorithm, and all individuals make up a population (all possible solutions). Some individuals are generated at random at the start of the genetic algorithm. After that, each individual is assessed and assigned a fitness value based on a specified fitness function. A few individuals are selected for the next generation based on their fitness levels. Only individuals with fitness values close to the criteria are used to generate the next generation, reflecting the idea of 'survival of the fittest'. Then, after a crossover and mutation operation, selected individuals produce a new generation. Because the next generation of individuals inherited some positive characteristics from the previous generation, their performance is superior to that of the previous generation, and the population will progress towards the optimal solution (Wang & Wei, 2021).

The evolutionary algorithm (EA) technique, which includes the genetic algorithm (GA), has several advantages over the other methods. This approach does not require gradient information of the objective function as most non-linear programming (NLP) procedures do, and does not distinguish between linear and nonlinear problems, which is a critical criterion for the availability of effective approaches. Furthermore, this approach is not overly sensitive to problem dimension in terms of computer processing time, which is an essential drawback of the adaptable dynamic programming (DP) method. Nonlinear functions and huge search areas hamper traditional optimization methods in complex optimization problems; therefore, the genetic algorithm (GA) offers a promising and efficient means of finding near-optimal solutions (SeethaRam, 2021). It should also be highlighted that a GA is essentially a generic search principle, and there is no standard GA for solving every optimization problem. GA's components, such as chromosome encoding, crossover operation, mutation operation, and selection operation, or GA's structure, must be adapted to each problem at hand to be effective (Dutta et al., 2021).

The GA-based optimization method consists of the following key steps.

1. Chromosome: Each chromosome consists of several digits. The value of each bit is set to be either 0 or 1; 0 means the related project is not selected, and 1 means it is selected.

2. Population generation: Generates the chromosome-chromosome number of the population and the initialization value of the gene's chromosome-chromosome with a random value.

In the mathematical optimization problem, a gene corresponds to a variable x_n, and a chromosome corresponds to a solution represented in a set of genes:

$X = (x_1, x_2, x_3 \dots \dots \dots x_n)$ if N variables exist.

3. Fitness function: Evaluation of the fitness value of chromosomes by calculating objective function or evaluating the fitness f_x of each chromosome x in the population.

4. Selection: Select two parent chromosomes from a population according to their fitness (the better the fitness, the bigger the chance to be selected). Selection operation may be a Binary Tournament, Roulette Wheel approach, Rank or Elitism to select chromosomes from the current population with higher fitness.

5. Crossover: The main goal of the crossover operator is to generate different offspring chromosomes to obtain a more optimal solution than their parents. Crossover techniques such as one-point, two-point and multi-point can be applied to initial chromosomes to produce new offspring chromosomes.

6. Mutation: With a mutation, probability mutates new offspring at each locus (position in the chromosome). A mutation operator is applied to provide randomness to the search at the gene level. Mutation randomly changes the specified gene of the new offspring. The main goal of the mutation operation is to prevent the GA from converging too quickly in a small area of the search space.

7. Evaluate the final chromosome. The final chromosome will be evaluated in the last step to confirm its greatest result. If the answer is yes, the optimum results will be obtained. If not, the reproduction-crossover-mutation-selection stages will be repeated until a specific number of generations, a stated fitness target, or a population convergence threshold is met. In an ideal instance, all chromosomes of the final generation have the identical genes, which is the best result (Haldurai et al., 2016; Hermawanto, 2013; Kumari & Pushkar, 2015) (Yu et al., 2012; Polat et al., 2015; Yalcinkaya et al., 2021).

While a GA is not guaranteed to determine the optimum solution to a specific problem, findings indicate that when contrasted with other computational optimization algorithms, solutions of a satisfactory limit can be established in a reasonable timeframe. The widespread use of GAs is related to problems that lack specialized solutions. These algorithms are used in a wide range of applications, including engineering, planning, games, and image processing. In general, using GAs to plan multiple projects that will be executed concurrently has yielded positive results (Ruiz et al., 2021).

GA has been recognized as a practical algorithm for solving large-scale issues or when the search space is too extensive or complex for an analytical approach. Inheritance, mutation, selection, and crossover are some of the processes used in genetic algorithms inspired by the evolution of living organisms (Saleh et al., 2020).

However, if the initial population size is too large, it would result in longer fitness function calculation times, lowering solution efficiency. As a result, the starting population size cannot be too large or too small (Yin & Zhao, 2022).

3.4.1 Genetic Algorithm Process or Procedure

The set of available projects in the proposed model will be encoded by a binary string chromosome, with each gene block representing the decision variable x_j. The number of projects available in N determines the number of bits needed to encode a chromosome.

Step 1. Coding: Let the n proposed project be denoted as X = (x_1, x_2, x_3.........x_n) and chromosome C = (c_1, c_2, c_3........... c_n). The values of x_i are 0 or 1, i= 1, 2, 3……n.

Project i is selected if x_i = 1, or otherwise.

Step 2. Establish procedure: The population size *pop _size*, the crossover probability P_c, the mutation probability P_m, and the maximum iteration $\text{Iter}_{\max}$, the *pop _size* initial chromosomes will randomly generate.

Step 3. Fitness counting: The objective function will be used to evaluate the fitness of the chromosome.

Step 4. Selection procedure: The PPSP is multi-objective, and Binary Tournament Selection will be adopted. Tournament selection is a useful operator because it does not require any global population knowledge or a quantifiable measure of quality. It is based on an ordering relation that can compare and rank any two individuals. If the population is very large, or if the population is distributed in some way (maybe on a parallel system), it is based on some specific objective function to be optimized.

Step 5. Crossover operation: A two-point crossover point is adopted to set duo convergence at random in the common fitting of twain parents and then the partial genes between these duo junction locations, i.e., two parents' chromosomes are swapped to generate two children's/offspring's chromosomes. To end the crossover function when the amount of cross-individuals equals P_c (*Pop _ size*) - 1, the two-point crossover point will be set between any two points in the chromosome.

The two parents' chromosomes are below as follows.

$$C_1^1 = (x_1^1, x_2^1, x_3^1, x_4^1, x_5^1, x_6^1, x_7^1, x_8^1, x_9^1 \ldots\ldots\ldots\ldots x_n^1)$$

$$C_2^1 = (x_1^2, x_2^2, x_3^2, x_4^2, x_5^2, x_6^2, x_7^2, x_8^2, x_9^2 \ldots\ldots\ldots\ldots x_n^2)$$

The generated offspring are below as follows:

$$C_1^{11} = (x_1^1, x_2^1, x_3^1, x_4^1, x_5^2, x_6^2, x_7^2, x_8^2, x_9^1 \ldots\ldots\ldots\ldots x_n^1)$$
$$C_2^{11} = (x_1^2, x_2^2, x_3^2, x_4^2, x_5^1, x_6^1, x_7^1, x_8^1, x_9^2 \ldots\ldots\ldots\ldots x_n^2)$$

Step 6. Mutation operation: To define a mutation probability, a random variable among [0,1] will be created for each gene to perform a bit mutation operation from q=1 to *pop_size.*

The operation of the mutation chromosome $C_q = (x_1^q, x_2^q, x_3^q, x_4^q, x_5^q, x_6^q, x_7^q, x_8^q, x_9^q \ldots\ldots\ldots\ldots x_n^q)$.

The following procedure is proposed to implement mutation:

Step i: Randomly choose one parent's chromosome.

Step ii: Randomly choose two genes or initialize the genes on any positions between 1 and n, and keep the other ones unchanged.

Step iii: Swap the two genes selected in step (ii) to generate an offspring.

Step 7. The conclusion situation: We rerun Steps 3-6 using the optimum iteration Iter-max.

Step 8. Greatest result: The greatest chromosomes are reported as a final solution for PPS (Dutta et al., 2021; Eiben & Smith, 2015; Guo et al., 2018; Mussoi & Teive, 2021; Xu et al., 2017; Zhao & Huang, 2017).

3.5 Chapter Summary

The research developed hybrid models called AHP, GP and GA for multi-objective optimization models for PPS. Because the research involves optimization and multi-criteria decision making (MCDM), an AHP model of one of the most widely used tools of MCDM problems was developed for project criteria, assigning relative priority weights of decision makers and determining the final or global weight of project alternatives. GP is also an MCDM that handles large/multiple numbers of objectives and constraints. The relative priorities weights and final global preferences of decision makers obtained from AHP will be the coefficient of the goal programming model. GA is an effective and flexible optimisation tool that efficiently produces optimal or near-optimal solutions. It does not need to make as many assumptions regarding the form of the objective functions as other optimisation techniques do. It is a meta-heuristic algorithm and optimization technique for solving large-scale or complex problems with a large number of decision variables for optimal solution (Solangi et al., 2021; Wiguna & Sudiarth, 2021; Akbari et al., 2021; Wu & Chen, 2021) (Maghawry et al., 2021; Salehi et al., 2023). The AHP and GA will apply Spice Logic and MATLAB software packages to analyse, validate and enhance the research.

CHAPTER FOUR: MODEL APPLICATION AND VALIDATION

4.1 Introduction

The research is based on the PPSP using an agency of government whose obligation was to develop the infrastructures of the community by choosing and executing projects like Schools, Housing, Jetty including walkways, Health Care Centres, Solar Power Water Scheme, Road Infrastructure, Civic Centre/Community utilities and Electrification to improve inhabitants' lives and create a higher quality of life across the region, state/province. For four years, the agency provided ₦2,904,743,000.00, ₦45,668,688,335.17, ₦13,727,323,788.44 and ₦133,809,763,025.89 for each year respectively to select an optimal number of projects to execute from large numbers of projects. The research developed an integrated approach known as the Analytic Hierarchy Process-Goal Programming-Genetic Algorithm (AHP-GP-GA) because PPS is a complicated problem with many projects that must be assessed against multiple criteria by multiple DMs. As a result, MCDM and meta-heuristic approaches are appropriate methods for dealing with the PPS problem. The proposed projects' descriptions are shown in the appendixes A, B, C and D.

4.2 Methodology Process or Procedure

4.2.1 The AHP approach steps are performed as outlined in Chapter 3 (3.2)

1. Goal definition and development of the matrix criteria

Goal definition: To determine the relative importance weights of project alternatives and priorities preference of decision criteria.

The matrix criteria consist of the project criteria, including their sub-criteria and the project alternatives in Table 4.1 to derive relative relevance weights and decision preference priority from the scores.

Table 4.1: Project Selection Criteria and Scales or Scores

Click one number per row below using the following scale: **1:** Necessary; **2:** Absolutely Necessary; **3**: Very Necessary; **4:** Important; **5:** Absolutely Important; **6:** Very Important; **7:** Absolutely Important**; 8:** Extremely Important; **9:** Extremely Very Important. **SCORES**										
Criteria	Sub Criteria	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Social Development	Job Creation									
	Social Amenities									
	Quality of Life/Benefits for Human Life									
	Economic growth to communities									
	Eliminate unrest in the areas									

Social Integration	Political impact/alignment/context									
	Political threat that depends on the policy									
	Community acceptance									
Operating Factor	Place of the project									
	Abandonment of project									
	Period of the project selected									
	Project threat									
Developmental Decision Strategy	Technical support of project department									
	Local contractors' competency									
	Alignment with company objectives									
	Employment record of PM									
Project Alternatives	School									
	Housing									
	Water Jetty									
	Health Care Centre									
	Solar Power Water Scheme									
	Road Infrastructure									
	Civic Centre/Community utilities									
	Electrification									

Sources: (Chatterjee et al., 2018; De Souza et al., 2018; Dutra et al., 2014; Hamurcu & Eren, 2018; Huang et al., 2008; Kaiser et al., 2019; Khalili-Damghani, Sadi-Nezhad, Lotfi, et al., 2013a; Wu et al., 2019, 2018) (Wu & Chen, 2021); (Jalilibal & Bozorgi-Amiri, 2022) Authors.

2. Create a pairwise comparison matrix for each set of sub-criteria and prioritise them in tables 4.2, 4.3, 4.4 and 4.5.

3. Determination of relative importance weights, priority, and consistency ratios

To compute each criterion, pairwise comparison and the priority of each sub-criteria, including the consistency ratio (CR) in tables 4.2, 4.3, 4.4 and 4.5, Spice Logic software was utilised. The required consistency ratio is CR < 0.1. The overall weight and priority rankings are shown in Table 4.6.

Table 4.2: Pairwise Comparison of Social Development

Social Development	Job Creation	Social Amenities	Quality of Life	Economic developments to communities	Priorities
Job Creation	1	2	0,5	0,333	0,165
Social Amenities	0,5	1	0,333	0,333	0,107
Quality of Life	2	3	1	0,5	0,283
Economic growths to communities	3	3	2	1	0,445

CR = 0,026

Table 4.3: Pairwise Comparison of Social Integration

Social Integration	Eliminate unrest in the areas	Political impact/alignment	Political risk that depends on the policy	Community Acceptance	Priorities
Eliminate unrest in the areas	1	0,167	1	0,143	0,066
Political impact/alignment	6	1	6	0,5	0,345
Political threat that depends on the policy	1	0,167	1	0,143	0,066
Community Acceptance	7	2	1	1	0,532

CR = 0,014

Table 4.4: Pairwise Comparison of Operational Factors

Operational Factor	Location of project	Completion Time	Project Risk	Facilities of Local Contractor	Priorities
Place of the Project	1	1	1	9	0,321
Finish period of the project selected	1	1	1	9	0,321
Project Threat	1	1	1	9	0,321
Facilities of Local Contractor	0,111	0,111	0,111	1	0,036

CR = 0

Table 4.5: Pairwise Comparison of Developmental Decision Strategy

Developmental Decision Strategy	Technical Support of Project Department	Local Contractors Competency	Alignment with organization mission/objectives	Employment record of PM	Priorities
Technical Support of Project Department	1	1	0,111	0,111	0,05

Local Contractors Competency	1	1	0,111	0,111	0,05
Alignment with organization mission/objectives	9	9	1	1	0,45
Employment record of PM	9	9	1	1	0,45

CR = 0

Table 4.6: Overall Weight

Project	Overall Weight
School	0,037
Housing	0,032
Water Jetty	0,018
Health Care Centre	0,146
Solar-Power Water Scheme	0,329
Road Infrastructure	0,183
Civic Centre/Community utilities	0,072
Electrification	0,182

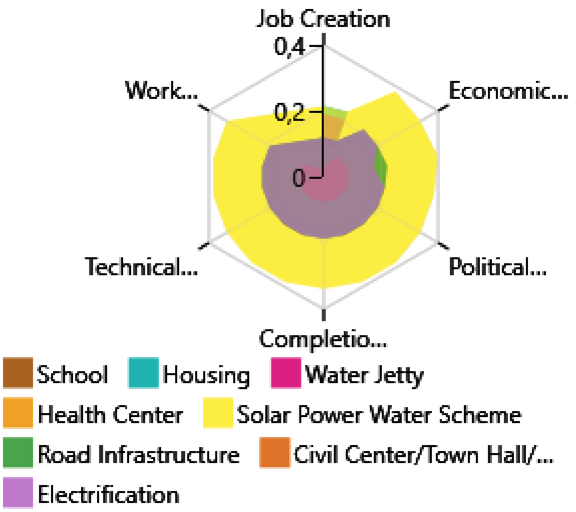

Figure 4.1: The attributes of the project selection criteria

4.2.2 Goal programming approach constructed from the overall weight obtained from AHP in section 4.2.1 for year one.

The multi-objective GP model was formulated with the concept of pre-emptive priority and weighted model types using the overall weight obtained from the AHP approach in Table 4.6.

The research determined the pre-emptive priority from the communities' needs for their benefit as follows:

1: Maximize select projects for social benefits

2: Minimize the cost of projects

3: Maximize the number of jobs created

4: Minimize the time required to complete the project

The projects to be selected and executed by the agency are School, Water Jetty and Housing.

Minimize Z=

$P_1(0.037d_1^- + 0.018d_2^- + 0.032d_3^-)$ Maximize Select Projects for Social Benefits

$P_2(d_4^+ + d_5^+ + d_6^+)$ Minimize Cost for Projects (School, Water Jetty and Housing)

$P_3(d_7^- + d_8^- + d_9^-)$ Maximize the number of jobs created.

$P_4(d_{10}^+ + d_{11}^+ + d_{12}^+)$ Minimize the time required to complete the project.

4.2.2.1 General Objectives function for year one

Minimize Z= $0.037d_1^- + 0.018d_2^- + 0.032d_3^- + d_4^+ + d_5^+ + d_6^+ + d_7^- + d_8^- + d_9^- + d_{10}^+ + d_{11}^+ + d_{12}^+$

Subject to:

4.2.2.2 Priority 1: Maximize select projects (School, Water Jetty and Housing) for community benefit.

[Maximize $(d_1^- + d_2^- + d_3^-)$]

School Projects

$$d_1^+ = 454 - 6x_1 + 6x_2 + 6x_3 + 6x_4 + 6x_5 + 6x_6 + 6x_7 + 6x_8 + 6x_9 + 6x_{10} + 6x_{11} + 6x_{12} + 3x_{13}$$
$$+6x_{14} + 6x_{15} + 6x_{16} + 6x_{17} + 6x_{18} + 6x_{19} + 6x_{20} + 6x_{21} + 6x_{22} + 6x_{23} + 6x_{24} + 6x_{25}$$
$$+6x_{26} + 6x_{27} + 6x_{28} + 6x_{29} + 6x_{30} + 6x_{31} + 6x_{32} + 6x_{33} + 6x_{34} + 6x_{35} + 6x_{36} + 6x_{37}$$
$$+6x_{38} + 6x_{39} + 6x_{40} + 6x_{41} + 6x_{42} + 6x_{43} + 6x_{44} + 6x_{45} + 6x_{46} + 6x_{47} + 6x_{48} + 6x_{49}$$
$$+6x_{50} + 3x_{51} + 6x_{52} + 6x_{53} + 6x_{54} + 6x_{55} + 6x_{56} + 6x_{57} + 6x_{58} + 3x_{59} + x_{60} + 6x_{61}$$
$$+6x_{62} + 6x_{63} + 6x_{64} + 6x_{65} + 12x_{66} + 12x_{67} + 6x_{68} + 6x_{69} + 6x_{70} + 6x_{71} + 6x_{72}$$
$$+6x_{73} + 3x_{74} + 6x_{75} + 3x_{76} + 6x_{77} - 0.037d_1^-$$

Water Jetty projects

$$d_2^+ = 87 - x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + x_8 + x_9 + x_{10} + x_{11} + x_{12} + x_{13} + x_{14} + x_{15} + x_{16}$$
$$+x_{17} + x_{18} + x_{19} + x_{20} + x_{21} + x_{22} + x_{23} + x_{24} + x_{25} + x_{26} + x_{27} + x_{28} + x_{29} + x_{30}$$
$$+x_{31} + x_{32} + x_{33} + x_{34} + x_{35} + x_{36} + x_{37} + x_{38} + x_{39} + x_{40} + x_{41} + x_{42} + x_{43} + x_{44}$$

$$+x_{45}+x_{46}+x_{47}+x_{48}+x_{49}+x_{50}+x_{51}+x_{52}+x_{53}+x_{54}+x_{55}+x_{56}+x_{57}+x_{58}$$
$$+x_{59}+x_{60}+x_{61}+x_{62}+x_{63}+x_{64}+x_{65}+x_{66}+x_{67}+x_{68}+x_{68}+x_{70}+x_{71}+x_{72}$$
$$+x_{73}+x_{74}+x_{75}+x_{76}+x_{77}+x_{78}+x_{79}+x_{80}+x_{81}+x_{82}+x_{83}+x_{84}+x_{85}+x_{86}$$
$$+x_{87}-0.018d_2^-$$

Housing projects

$$d_3^+=300-3x_1+3x_2+3x_3+3x_4+3x_5+3x_6+3x_7+3x_8+3x_9+3x_{10}+3x_{11}$$
$$+3x_{12}+3x_{13}$$
$$+3x_{14}+3x_{15}+3x_{16}+3x_{17}+3x_{18}+3x_{19}+3x_{20}+3x_{21}+3x_{22}+3x_{23}+3x_{24}+3x_{25}$$
$$+3x_{26}+3x_{27}+3x_{28}+3x_{29}+3x_{30}+3x_{31}+3x_{32}+3x_{33}+3x_{34}+3x_{35}+3x_{36}+3x_{37}$$
$$+3x_{38}+3x_{39}+3x_{40}+3x_{41}+3x_{42}+3x_{43}+3x_{44}+3x_{45}+3x_{46}+3x_{47}+3x_{48}+3x_{49}$$
$$+3x_{50}+3x_{51}+3x_{52}+3x_{53}+3x_{54}+3x_{55}+3x_{56}+3x_{57}+3x_{58}+3x_{59}+3x_{60}+3x_{61}$$
$$+3x_{62}+3x_{63}+3x_{64}+3x_{65}+3x_{66}+3x_{67}+3x_{68}+3x_{68}+3x_{70}+3x_{71}+3x_{72}+3x_{73}$$
$$+3x_{74}+3x_{75}+3x_{76}+3x_{77}+3x_{78}+3x_{79}+3x_{80}+3x_{81}+3x_{82}+3x_{83}+3x_{84}+3x_{85}$$
$$+3x_{86}+3x_{87}+3x_{88}+3x_{89}+3x_{90}+3x_{91}+3x_{92}+3x_{93}+3x_{94}+3x_{95}+3x_{96}+3x_{97}$$
$$+3x_{98}+3x_{99}+3x_{100}-0.032d_3^-$$

4.2.2.3 Priority 2: Minimize the cost of projects.

[Minimize $(d_4^+ + d_5^+ + d_6^+)$]

Cost of School Projects

$$d_4^-=1{,}039-17x_1+17x_2+17x_3+17x_4+17x_5+17x_6+17x_7+17x_8+3x_9$$
$$+3x_{10}+3x_{11}$$
$$+17x_{12}+17x_{13}+17x_{14}+13x_{15}+13x_{16}+13x_{17}+17x_{18}+17x_{19}+3x_{20}+13x_{21}$$
$$+13x_{22}+13x_{23}+13x_{24}+13x_{25}+13x_{26}+13x_{27}+13x_{28}+13x_{29}+13x_{30}+13x_{31}$$
$$+13x_{32}+13x_{33}+13x_{34}+13x_{35}+13x_{36}+13x_{37}+13x_{38}+13x_{39}+13x_{40}+13x_{41}$$
$$+13x_{42}+13x_{43}+13x_{44}+17x_{45}+17x_{46}+13x_{47}+13x_{48}+13x_{49}+13x_{50}+7x_{51}$$
$$+17x_{52}+13x_{53}+13x_{54}+13x_{55}+13x_{56}+13x_{57}+13x_{58}+13x_{59}+7x_{60}+13x_{61}$$
$$+13x_{62}+13x_{63}+13x_{64}+13x_{65}+34x_{66}+26x_{67}+13x_{68}+13x_{69}+7x_{70}+13x_{71}$$
$$+13x_{72}+13x_{73}+7x_{74}+13x_{75}+7x_{76}+13x_{77}-d_4^+$$

Cost of Water Jetty Projects

$$d_5^-=774{,}648-7{,}913x_1+4{,}372x_2+4{,}372x_3+6{,}257x_4+6{,}257x_5+4{,}372x_6$$
$$+4{,}372x_7+6{,}257x_8$$
$$+6{,}257x_9+6{,}041x_{10}+4{,}156x_{11}+6{,}041x_{12}+7{,}083x_{13}+6{,}537x_{14}+6{,}537x_{15}$$
$$+6{,}257x_{16}+8{,}230x_{17}+18{,}108x_{18}+7{,}125x_{19}+6{,}340x_{20}+6{,}340x_{21}+18{,}324x_{22}$$
$$+4{,}987x_{23}+6{,}340x_{24}+7{,}688x_{25}+7{,}477x_{26}+6{,}936x_{27}+7{,}135x_{28}+6{,}257x_{29}$$
$$+6{,}257x_{30}+6{,}041x_{31}+6{,}257x_{32}+12{,}683x_{33}+13{,}098x_{34}+9{,}391x_{35}+7{,}911x_{36}$$
$$+7{,}082x_{37}+9{,}272x_{38}+8{,}526x_{39}+8{,}526x_{40}+9{,}193x_{41}+8{,}893x_{42}+24{,}144x_{43}$$
$$+14{,}741x_{44}+14{,}570x_{45}+18{,}324x_{46}+7{,}298x_{47}+15{,}513x_{48}+9{,}279x_{49}+10{,}084x_{50}$$
$$+14{,}703x_{51}+12{,}288x_{52}+5{,}184x_{53}+6{,}257x_{54}+7{,}683x_{55}+12{,}893x_{56}+4{,}446x_{57}$$
$$+27{,}233x_{58}+4{,}245x_{59}+3{,}735x_{60}+4{,}132x_{61}+6{,}128x_{62}+4{,}672x_{63}+6{,}281x_{64}$$
$$+7{,}789x_{65}+5{,}092x_{66}+8{,}320x_{67}+6{,}281x_{68}+6{,}281x_{69}+17{,}186x_{70}+7{,}484x_{71}$$
$$+15{,}908x_{72}+13{,}308x_{73}+24{,}636x_{74}+15{,}283x_{75}+7{,}323x_{76}+5{,}108x_{77}+17{,}300x_{78}$$
$$+4{,}644x_{79}+4{,}649x_{80}+5{,}920x_{81}+7{,}247x_{82}+15{,}303x_{83}+8{,}924x_{84}+7{,}660x_{85}$$
$$+6{,}939x_{86}+4{,}741x_{87}-d_5^+$$

Cost of Housing Projects

$$d_6^- = 1{,}091{,}086 - 8{,}606x_1 + 8{,}606x_2 + 8{,}606x_3 + 8{,}606x_4 + 8{,}606x_5 + 8{,}606x_6 + 8{,}606x_7 + 8{,}606x_8$$
$$+8{,}376x_9 + 8{,}376x_{10} + 8{,}376x_{11} + 8{,}376x_{12} + 8{,}376x_{13} + 8{,}376x_{14} + 8{,}376x_{15}$$
$$+8{,}376x_{16} + 8{,}376x_{17} + 8{,}376x_{18} + 8{,}376x_{19} + 8{,}376x_{20} + 8{,}376x_{21} + 8{,}376x_{22}$$
$$+8{,}146x_{23} + 8{,}146x_{24} + 8{,}146x_{25} + 8{,}146x_{26} + 12{,}882x_{27} + 12{,}882x_{28} + 12{,}882x_{29}$$
$$+12{,}882x_{30} + 8{,}376x_{31} + 8{,}376x_{32} + 8{,}376x_{33} + 8{,}376x_{34} + 12{,}882x_{35} + 12{,}882x_{36}$$
$$+12{,}882x_{37} + 12{,}882x_{38} + 12{,}882x_{39} + 12{,}882x_{40} + 12{,}882x_{41} + 12{,}882x_{42}$$
$$+12{,}882x_{43} + 12{,}882x_{44} + 12{,}882x_{45} + 12{,}882x_{46} + 12{,}882x_{47} + 12{,}882x_{48}$$
$$+12{,}882x_{49} + 12{,}882x_{50} + 12{,}882x_{51} + 12{,}882x_{52} + 12{,}882x_{53} + 12{,}882x_{54}$$
$$+12{,}882x_{55} + 12{,}882x_{56} + 12{,}882x_{57} + 12{,}882x_{58} + 12{,}882x_{59} + 12{,}882x_{60}$$
$$+12{,}882x_{61} + 12{,}882x_{62} + 12{,}882x_{63} + 12{,}882x_{64} + 12{,}882x_{65} + 12{,}882x_{66}$$
$$+12{,}882x_{67} + 12{,}882x_{68} + 12{,}882x_{68} + 12{,}882x_{70} + 12{,}882x_{71} + 12{,}882x_{72}$$
$$+12{,}882x_{73} + 12{,}882x_{74} + 12{,}882x_{75} + 12{,}882x_{76} + 12{,}882x_{77} + 12{,}882x_{78}$$
$$+12{,}882x_{79} + 12{,}882x_{80} + 12{,}882x_{81} + 12{,}882x_{82} + 12{,}882x_{83} + 8{,}606x_{84}$$
$$+12{,}882x_{85} + 12{,}882x_{86} + 12{,}882x_{87} + 8{,}376x_{88} + 8{,}376x_{89} + 8{,}376x_{90} + 8{,}376x_{91}$$
$$+8{,}376x_{92} + 8{,}376x_{93} + 8{,}376x_{94} + 8{,}376x_{95} + 8{,}376x_{96} + 8{,}376x_{97} + 8{,}376x_{98}$$
$$+8{,}376x_{99} + 8{,}376x_{100} - d_6^+$$

4.2.2.4 Priority 3: Maximize the number of jobs created for selected projects.

[Maximize $(d_7^- + d_8^- + d_9^-)$]

School Projects

$$d_7^+ = 1078 - 14x_1 + 14x_2 + 14x_3 + 14x_4 + 14x_5 + 14x_6 + 14x_7 + 14x_8 + 14x_9 + 14x_{10} + 14x_{11}$$
$$+14x_{12} + 14x_{13} + 14x_{14} + 14x_{15} + 14x_{16} + 14x_{17} + 14x_{18} + 14x_{19} + 14x_{20} + 14x_{21}$$
$$+14x_{22} + 14x_{23} + 14x_{24} + 14x_{25} + 14x_{26} + 14x_{27} + 14x_{28} + 14x_{29} + 14x_{30} + 14x_{31}$$
$$+14x_{32} + 14x_{33} + 14x_{34} + 14x_{35} + 14x_{36} + 14x_{37} + 14x_{38} + 14x_{39} + 14x_{40} + 14x_{41}$$
$$+14x_{42} + 14x_{43} + 14x_{44} + 14x_{45} + 14x_{46} + 14x_{47} + 14x_{48} + 14x_{49} + 14x_{50} + 14x_{51}$$
$$+14x_{52} + 14x_{53} + 14x_{54} + 14x_{55} + 14x_{56} + 14x_{57} + 14x_{58} + 14x_{59} + 14x_{60} + 14x_{61}$$
$$+14x_{62} + 14x_{63} + 14x_{64} + 14x_{65} + 14x_{66} + 14x_{67} + 14x_{68} + 14x_{69} + 14x_{70} + 14x_{71}$$
$$+14x_{72} + 14x_{73} + 14x_{74} + 14x_{75} + 14x_{76} + 14x_{77} - d_7^-$$

Water Jetty Projects

$$d_8^+ = 7569 - 87x_1 + 87x_2 + 87x_3 + 87x_4 + 87x_5 + 87x_6 + 87x_7 + 87x_8 + 87x_9 + 87x_{10} + 87x_{11}$$
$$+87x_{12} + 87x_{13} + 87x_{14} + 87x_{15} + 87x_{16} + 87x_{17} + 87x_{18} + 87x_{19} + 87x_{20} + 87x_{21}$$
$$+87x_{22} + 87x_{23} + 87x_{24} + 87x_{25} + 87x_{26} + 87x_{27} + 87x_{28} + 87x_{29} + 87x_{30} + 87x_{31}$$
$$+87x_{32} + 87x_{33} + 87x_{34} + 87x_{35} + 87x_{36} + 87x_{37} + 87x_{38} + 87x_{39} + 87x_{40} + 87x_{41}$$
$$+87x_{42} + 87x_{43} + 87x_{44} + 87x_{45} + 87x_{46} + 87x_{47} + 87x_{48} + 87x_{49} + 87x_{50} + 87x_{51}$$
$$+87x_{52} + 87x_{53} + 87x_{54} + 87x_{55} + 87x_{56} + 87x_{57} + 87x_{58} + 87x_{59} + 87x_{60} + 87x_{61}$$
$$+87x_{62} + 87x_{63} + 87x_{64} + 87x_{65} + 87x_{66} + 87x_{67} + 87x_{68} + 87x_{68} + 87x_{70} + 87x_{71}$$
$$+87x_{72} + 87x_{73} + 87x_{74} + 87x_{75} + 87x_{76} + 87x_{77} + 87x_{78} + 87x_{79} + 87x_{80} + 87x_{81}$$
$$+87x_{82} + 87x_{83} + 87x_{84} + 87x_{85} + 87x_{86} + 87x_{87} - d_8^-$$

Housing projects

$$d_9^+ = 10000 - 100x_1 + 100x_2 + 100x_3 + 100x_4 + 100x_5 + 100x_6 + 100x_7 + 100x_8 + 100x_9$$
$$+100x_{10} + 100x_{11} + 100x_{12} + 100x_{13} + 100x_{14} + 100x_{15} + 100x_{16} + 100x_{17}$$
$$+100x_{18} + 100x_{19} + 100x_{20} + 100x_{21} + 100x_{22} + 100x_{23} + 100x_{24} + 100x_{25}$$
$$+100x_{26} + 100x_{27} + 100x_{28} + 100x_{29} + 100x_{30} + 100x_{31} + 100x_{32} + 100x_{33}$$
$$+100x_{34} + 100x_{35} + 100x_{36} + 100x_{37} + 100x_{38} + 100x_{39} + 100x_{40} + 100x_{41}$$
$$+100x_{42} + 100x_{43} + 100x_{44} + 100x_{45} + 100x_{46} + 100x_{47} + 100x_{48} + 100x_{49}$$
$$+100x_{50} + 100x_{51} + 100x_{52} + 100x_{53} + 100x_{54} + 100x_{55} + 100x_{56} + 100x_{57}$$
$$+100x_{58} + 100x_{59} + 100x_{60} + 100x_{61} + 100x_{62} + 100x_{63} + 100x_{64} + 100x_{65}$$
$$+100x_{66} + 100x_{67} + 100x_{68} + 100x_{68} + 100x_{70} + 100x_{71} + 100x_{72} + 100x_{73}$$
$$+100x_{74} + 100x_{75} + 100x_{76} + 100x_{77} + 100x_{78} + 100x_{79} + 100x_{80} + 100x_{81}$$
$$+100x_{82} + 100x_{83} + 100x_{84} + 100x_{85} + 100x_{86} + 100x_{87} + 100x_{88} + 100x_{89}$$
$$+100x_{90} + 100x_{91} + 100x_{92} + 100x_{93} + 100x_{94} + 100x_{95} + 100x_{96} + 100x_{97}$$
$$+100x_{98} + 100x_{99} + 100x_{100} - d_9^-$$

4.2.2.5 Priority 4: Minimize the time required to complete project or project completion time.

[Minimize $(d_{10}^+ + d_{11}^+ + d_{12}^+)$]

School Projects

$$d_{10}^- = 904 - 12x_1 + 12x_2 + 12x_3 + 12x_4 + 12x_5 + 12x_6 + 12x_7 + 12x_8 + 12x_9 + 12x_{10} + 12x_{11}$$
$$+12x_{12} + 7x_{13} + 12x_{14} + 12x_{15} + 12x_{16} + 12x_{17} + 12x_{18} + 12x_{19} + 7x_{20} + 12x_{21}$$
$$+12x_{22} + 12x_{23} + 12x_{24} + 12x_{25} + 12x_{26} + 12x_{27} + 12x_{28} + 12x_{29} + 12x_{30} + 12x_{31}$$
$$+12x_{32} + 12x_{33} + 12x_{34} + 12x_{35} + 12x_{36} + 12x_{37} + 12x_{38} + 12x_{39} + 12x_{40} + 12x_{41}$$
$$+12x_{42} + 12x_{43} + 12x_{44} + 12x_{45} + 12x_{46} + 12x_{47} + 12x_{48} + 12x_{49} + 12x_{50} + 7x_{51}$$
$$+7x_{52} + 12x_{53} + 12x_{54} + 12x_{55} + 12x_{56} + 12x_{57} + 12x_{58} + 12x_{59} + 7x_{60} + 12x_{61}$$
$$+12x_{62} + 12x_{63} + 12x_{64} + 12x_{65} + 17x_{66} + 17x_{67} + 12x_{68} + 12x_{69} + 12x_{70} + 12x_{71}$$
$$+12x_{72} + 12x_{73} + 7x_{74} + 12x_{75} + 7x_{76} + 12x_{77} - d_{10}^+$$

Water Jetty Projects

$$d_{11}^- = 783 - 9x_1 + 9x_2 + 9x_3 + 9x_4 + 9x_5 + 9x_6 + 9x_7 + 9x_8 + 9x_9 + 9x_{10} + 9x_{11} + 9x_{12} + 9x_{13}$$
$$+9x_{14} + 9x_{15} + 9x_{16} + 9x_{17} + 9x_{18} + 9x_{19} + 9x_{20} + 9x_{21} + 9x_{22} + 9x_{23} + 9x_{24}$$
$$+9x_{25} + 9x_{26} + 9x_{27} + 9x_{28} + 9x_{29} + 9x_{30} + 9x_{31} + 9x_{32} + 9x_{33} + 9x_{34} + 9x_{35}$$
$$+9x_{36} + 9x_{37} + 9x_{38} + 9x_{39} + 9x_{40} + 9x_{41} + 9x_{42} + 9x_{43} + 9x_{44} + 9x_{45} + 9x_{46}$$
$$+9x_{47} + 9x_{48} + 9x_{49} + 9x_{50} + 9x_{51} + 9x_{52} + 9x_{53} + 9x_{54} + 9x_{55} + 9x_{56} + 9x_{57}$$
$$+9x_{58} + 9x_{59} + 9x_{60} + 9x_{61} + 9x_{62} + 9x_{63} + 9x_{64} + 9x_{65} + 9x_{66} + 9x_{67} + 9x_{68}$$
$$+9x_{68} + 9x_{70} + 9x_{71} + 9x_{72} + 9x_{73} + 9x_{74} + 9x_{75} + 9x_{76} + 9x_{77} + 9x_{78} + 9x_{79}$$
$$+9x_{80} + 9x_{81} + 9x_{82} + 9x_{83} + 9x_{84} + 9x_{85} + 9x_{86} + 9x_{87} - d_{11}^+$$

Housing projects

$$d_{12}^{-} = 1200 - 12x_1 + 12x_2 + 12x_3 + 12x_4 + 12x_5 + 12x_6 + 12x_7 + 12x_8 + 12x_9$$
$$+12x_{10} + 12x_{11} + 12x_{12} + 12x_{13} + 12x_{14} + 12x_{15} + 12x_{16} + 12x_{17} + 12x_{18} + 12x_{19} + 12x_{20} + 12x_{21}$$
$$+12x_{22} + 12x_{23} + 12x_{24} + 12x_{25} + 12x_{26} + 12x_{27} + 12x_{28} + 12x_{29} + 12x_{30} + 12x_{31}$$
$$+12x_{32} + 12x_{33} + 12x_{34} + 12x_{35} + 12x_{36} + 12x_{37} + 12x_{38} + 12x_{39} + 12x_{40} + 12x_{41}$$
$$+12x_{42} + 12x_{43} + 12x_{44} + 12x_{45} + 12x_{46} + 12x_{47} + 12x_{48} + 12x_{49} + 12x_{50} + 12x_{51}$$
$$+12x_{52} + 12x_{53} + 12x_{54} + 12x_{55} + 12x_{56} + 12x_{57} + 12x_{58} + 12x_{59} + 12x_{60} + 12x_{61}$$
$$+12x_{62} + 12x_{63} + 12x_{64} + 12x_{65} + 12x_{66} + 12x_{67} + 12x_{68} + 12x_{68} + 12x_{70} + 12x_{71}$$
$$+12x_{72} + 12x_{73} + 12x_{74} + 12x_{75} + 12x_{76} + 12x_{77} + 12x_{78} + 12x_{79} + 12x_{80} + 12x_{81}$$
$$+12x_{82} + 12x_{83} + 12x_{84} + 12x_{85} + 12x_{86} + 12x_{87} + 12x_{88} + 12x_{89} + 12x_{90} + 12x_{91}$$
$$+12x_{92} + 12x_{93} + 12x_{94} + 12x_{95} + 12x_{96} + 12x_{97} + 12x_{98} + 12x_{99} + 12x_{100} - d_{12}^{+}$$

4.2.3 Goal programming approach constructed from the overall weight obtained from AHP in section 4.2.1 for year two

The multi-objective GP model was formulated with the concept of pre-emptive priority and weighted model types using the overall weight obtained from the AHP approach in Table 4.6. The projects to be selected and executed by the agency are Schools, Solar Powered Projects, Community Utility and Civic Centres, and Roads.

Minimize Z=

$P_1(0.037d_1^- + 0.329d_2^- + 0.072d_3^- + 0.183d_4^-)$ Maximize Select Projects for Social Benefits

$P_2(d_5^+ + d_6^+ + d_7^+ + d_8^+)$ Minimize Cost for Projects (Schools, Solar Powered Projects, Communities' Utilities and Civic Centre, and Road Projects)

$P_3(d_9^- + d_{10}^- + d_{11}^- + d_{12}^-)$ Maximize the number of jobs created

$P_4(d_{13}^+ + d_{14}^+ + d_{15}^+ + d_{16}^+)$ Minimize duration for selected projects (Months)

4.2.3.1 General Objectives Function for year two

Minimize Z= $0.037d_1^- + 0.329d_2^- + 0.072d_3^- + 0.183d_4^- + d_5^+ + d_6^+ + d_7^+ + d_8^+ + d_9^- + d_{10}^- + d_{11}^- + d_{12}^- + d_{13}^+ + d_{14}^+ + d_{15}^+ + d_{16}^+$

Subject to:

4.2.3.2 Priority 1: Maximize Selected Projects (Schools, Solar Powered Water, Communities Utility and Civic Centre, and Road Projects) for community benefit.

[Minimize $(d_1^- + d_2^- + d_3^- + d_4^-)$]

School projects

$$d_1^+ = 416 - x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + 24x_8 + 6x_9 + x_{10} + x_{11} + x_{12} + x_{13} + 12x_{14} + x_{15}$$
$$+x_{16} + x_{17} + x_{18} + x_{19} + 6x_{20} + x_{21} + x_{22} + x_{23} + x_{24} + 12x_{25} + 12x_{26} + x_{27} + 12x_{28}$$
$$+3x_{29} + 6x_{30} + 6x_{31} + 6x_{32} + 6x_{33} + 6x_{34} + 6x_{35} + 6x_{36} + 6x_{37} + 6x_{38} + 6x_{39} + 4x_{40}$$
$$+6x_{41} + 12x_{42} + 12x_{43} + 22x_{44} + 22x_{45} + 12x_{46} + 24x_{47} + 12x_{48} + 12x_{49} + 3x_{50}$$
$$+6x_{51} + 6x_{52} + 6x_{53} + 12x_{54} + 3x_{55} + 3x_{56} + x_{57} + 6x_{58} + 3x_{59} + 6x_{60} + 6x_{61} + 6x_{62}$$
$$+3x_{63} + x_{64} + x_{65} + x_{66} + x_{67} + x_{68} + 12x_{69} + 22x_{70} + x_{71} - 0.037d_1^-$$

Solar-powered water projects

$$d_2^+ = 73 - x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + x_8 + x_9 + x_{10} + x_{11} + x_{12} + x_{13} + x_{14} + x_{15} + x_{16}$$
$$+x_{17} + x_{18} + x_{19} + x_{20} + x_{21} + x_{22} + x_{23} + x_{24} + x_{25} + x_{26} + x_{27} + x_{28} + x_{29} + x_{30}$$
$$+x_{31} + x_{32} + x_{33} + x_{34} + x_{35} + x_{36} + x_{37} + x_{38} + x_{39} + x_{40} + x_{41} + x_{42} + x_{43} + x_{44}$$
$$+x_{45} + x_{46} + x_{47} + x_{48} + x_{49} + x_{50} + x_{51} + x_{52} + x_{53} + x_{54} + x_{55} + x_{56} + x_{57} + x_{58}$$
$$+x_{59} + x_{60} + x_{61} + x_{62} + x_{63} + x_{64} + x_{65} + x_{66} + x_{67} + x_{68} + x_{68} + x_{70} + x_{71} + x_{72} + x_{73} - 0.329d_2^-$$

Communities' utility and civic centres

$$d_3^+ = 71 - x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + x_8 + x_9 + x_{10} + x_{11} + x_{12} + x_{13} + x_{14} + x_{15} + x_{16}$$
$$+x_{17} + x_{18} + x_{19} + x_{20} + x_{21} + x_{22} + x_{23} + x_{24} + x_{25} + x_{26} + x_{27} + x_{28} + x_{29} + x_{30}$$
$$+x_{31} + x_{32} + x_{33} + x_{34} + x_{35} + x_{36} + x_{37} + x_{38} + x_{39} + x_{40} + x_{41} + x_{42} + x_{43} + x_{44}$$
$$+x_{45} + x_{46} + x_{47} + x_{48} + x_{49} + x_{50} + x_{51} + x_{52} + x_{53} + x_{54} + x_{55} + x_{56} + x_{57} + x_{58}$$
$$+x_{59} + x_{60} + x_{61} + x_{62} + x_{63} + x_{64} + x_{65} + x_{66} + x_{67} + x_{68} + x_{68} + x_{70} + x_{71} - 0.072d_3^-$$

Road projects

$$d_4^+ = 114 - x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + x_8 + x_9 + x_{10} + x_{11} + x_{12} + x_{13} + x_{14} + x_{15} + x_{16}$$
$$+x_{17} + x_{18} + x_{19} + x_{20} + x_{21} + x_{22} + x_{23} + x_{24} + x_{25} + x_{26} + x_{27} + x_{28} + x_{29} + x_{30}$$
$$+x_{31} + x_{32} + x_{33} + x_{34} + x_{35} + x_{36} + x_{37} + x_{38} + x_{39} + x_{40} + x_{41} + x_{42} + x_{43} + x_{44}$$
$$+x_{45} + x_{46} + x_{47} + x_{48} + x_{49} + x_{50} + x_{51} + x_{52} + x_{53} + x_{54} + x_{55} + x_{56} + x_{57} + x_{58}$$
$$+x_{59} + x_{60} + x_{61} + x_{62} + x_{63} + x_{64} + x_{65} + x_{66} + x_{67} + x_{68} + x_{68} + x_{70} + x_{71} + x_{72}$$
$$+x_{73} + x_{74} + x_{75} + x_{76} + x_{77} + x_{78} + x_{79} + x_{80} + x_{81} + x_{82} + x_{83} + x_{84} + x_{85} + x_{86}$$
$$+x_{87} + x_{88} + x_{89} + x_{90} + x_{91} + x_{92} + x_{93} + x_{94} + x_{95} + x_{96} + x_{97} + x_{98} + x_{99} + x_{100}$$
$$+x_{101} + x_{102} + x_{103} + x_{104} + x_{105} + x_{106} + x_{107} + x_{108} + x_{109} + x_{110} + x_{111} + x_{112} + x_{113} + x_{114} - 0.183d_4^-$$

4.2.3.3 Priority 2: Minimize the cost of projects.

[Minimize $(d_5^+ + d_6^+ + d_7^+ + d_8^+)$]

School projects

$$d_5^- = 4748499 + 250000x_1 + 60000x_2 + 60000x_3 + 53439x_4 + 60000x_5 + 54987x_6 + 99500x_7$$
$$+149999x_8 + 12897x_9 + 53439x_{10} + 54987x_{11} + 54987x_{12} + 54987x_{13} + 49866x_{14}$$
$$+54987x_{15} + 64877x_{16} + 52654x_{17} + 54987x_{18} + 61343x_{19} + 12897x_{20} + 54987x_{21}$$

$$+54987x_{22} + 59900x_{23} + 100000x_{24} + 49692x_{25} + 149986x_{26} + 44635x_{27}$$
$$+49855x_{28} + 10900x_{29} + 17345x_{30} + 25327x_{31} + 21647x_{32} + 15575x_{33} + 21398x_{34}$$
$$+13155x_{35} + 20342x_{36} + 13854x_{37} + 11876x_{38} + 14696x_{39} + 9625x_{40} + 21398x_{41}$$
$$+67634x_{42} + 67670x_{43} + 112306x_{44} + 107213x_{45} + 69464x_{46} + 124490x_{47}$$
$$+62619x_{48} + 66131x_{49} + 8382x_{50} + 16328x_{51} + 16146x_{52} + 16500x_{53} + 99361x_{54}$$
$$+8200x_{55} + 8200x_{56} + 61343x_{57} + 37179x_{58} + 8500x_{59} + 43286x_{60} + 42897x_{61}$$
$$+32500x_{62} + 8304x_{63} + 54987x_{64} + 54987x_{65} + 997645x_{66} + 59900x_{67} + 100000x_{68}$$
$$+49692x_{69} + 149986x_{70} + 44635x_{71} + d_5^+$$

Solar-powered water projects

$$d_6^- = 4626053 + 51975x_1 + 88105x_2 + 41703x_3 + 41703x_4 + 63221x_5 + 91594x_6 + 89036x_7 + 89915x_8$$
$$+100000x_9 + 61035x_{10} + 41703x_{11} + 41703x_{12} + 41703x_{13} + 50000x_{14} + 42305x_{15}$$
$$+81265x_{16} + 42305x_{17} + 42000x_{18} + 42305x_{19} + 98500x_{20} + 81265x_{21} + 240020x_{22}$$
$$+47825x_{23} + 49999x_{24} + 47825x_{25} + 61243x_{26} + 48690x_{27} + 49825x_{28} + 60179x_{29}$$
$$+54262x_{30} + 100000x_{31} + 49788x_{32} + 42305x_{33} + 51975x_{34} + 55913x_{35} + 99999x_{36}$$
$$+50838x_{37} + 60624x_{38} + 41800x_{39} + 79999x_{40} + 100000x_{41} + 83328x_{42} + 41703x_{43}$$
$$+41703x_{44} + 81265x_{45} + 55000x_{46} + 46501x_{47} + 50800x_{48} + 59999x_{49} + 49999x_{50}$$
$$+50000x_{51} + 41703x_{52} + 47825x_{53} + 41703x_{54} + 47825x_{55} + 42305x_{56} + 65825x_{57}$$
$$+42000x_{58} + 59870x_{59} + 47825x_{60} + 42825x_{61} + 41703x_{62} + 88105x_{63} + 100000x_{64}$$
$$+100000x_{65} + 100000x_{66} + 171767x_{67} + 45000x_{68} + 45000x_{69} + 45000x_{70}$$
$$+45000x_{71} + 45000x_{72} + 45000x_{73} + d_6^+$$

Communities' utility and civic centres

$$d_7^- = 5720463 + 179000x_1 + 100000x_2 + 99361x_3 + 60000x_4 + 18680x_5 + 99361x_6 + 157896x_7$$
$$+30000x_8 + 30858x_9 + 30000x_{10} + 170000x_{11} + 99361x_{12} + 39091x_{13} + 99361x_{14}$$
$$+99361x_{15} + 39875x_{16} + 47789x_{17} + 99361x_{18} + 59879x_{19} + 99361x_{20} + 47789x_{21}$$
$$+86088x_{22} + 169836x_{23} + 39091x_{24} + 26130x_{25} + 60987x_{26} + 99815x_{27}$$
$$+100000x_{28} + 99361x_{29} + 60000x_{30} + 18680x_{31} + 99361x_{32} + 157896x_{33}$$
$$+30858x_{34} + 170000x_{35} + 99361x_{36} + 39091x_{37} + 99361x_{38} + 39875x_{39} + 47789x_{40}$$
$$+99361x_{41} + 47789x_{42} + 169836x_{43} + 39091x_{44} + 26130x_{45} + 60987x_{46} + 99815x_{47}$$
$$+60987x_{48} + 100000x_{49} + 18680x_{50} + 26130x_{51} + 30858x_{52} + 39091x_{53} + 39091x_{54}$$
$$+39875x_{55} + 47789x_{56} + 47789x_{57} + 60000x_{58} + 60987x_{59} + 60987x_{60} + 99361x_{61}$$
$$+99361x_{62} + 99361x_{63} + 99361x_{64} + 99361x_{65} + 99815x_{66} + 157896x_{67}$$
$$+169836x_{68} + 170000x_{69} + 30858x_{70} + 70000x_{71} + d_7^+$$

Road projects

$$d_8^- = 31228116 + 118215x_1 + 108490x_2 + 112151x_3 + 237317x_4 + 240020x_5 + 48786x_6 + 158003x_7$$
$$+249557x_8 + 113694x_9 + 193294x_{10} + 113694x_{11} + 238522x_{12} + 100000x_{13} + 99633x_{14}$$
$$+149860x_{15} + 234470x_{16} + 99865x_{17} + 49855x_{18} + 249560x_{19} + 240020x_{20} + 236371x_{21}$$

$$+399500x_{22} + 237249x_{23} + 75572x_{24} + 75000x_{25} + 192070x_{26} + 99633x_{27} + 86096x_{28}$$
$$+1304259x_{29} + 53258x_{30} + 199500x_{31} + 249500x_{32} + 149500x_{33} + 149860x_{34} + 244002x_{35}$$
$$+241193x_{36} + 99633x_{37} + 99633x_{38} + 113694x_{39} + 1044039x_{40} + 112635x_{41} + 214967x_{42}$$
$$+249875x_{43} + 232903x_{44} + 99633x_{45} + 200809x_{46} + 163310x_{47} + 240000x_{48} + 184506x_{49}$$
$$+247370x_{50} + 399500x_{51} + 238262x_{52} + 149718x_{53} + 179480x_{54} + 155822x_{55} + 298456x_{56}$$
$$+209713x_{57} + 113694x_{58} + 122610x_{59} + 249500x_{60} + 96463x_{61} + 79435x_{62} + 200000x_{63}$$
$$+72000x_{64} + 249500x_{65} + 239171x_{66} + 150000x_{67} + 6136367x_{68} + 99500x_{69} + 148486x_{70}$$
$$+221584x_{71} + 189215x_{72} + 66689x_{73} + 164903x_{74} + 114474x_{75} + 249500x_{76} + 156439x_{77}$$
$$+199500x_{78} + 99633x_{79} + 236371x_{80} + 195230x_{81} + 489080x_{82} + 180000x_{83} + 102000x_{84}$$
$$+248000x_{85} + 480650x_{86} + 149860x_{87} + 719430x_{88} + 249500x_{89} + 239720x_{90} + 209713x_{91}$$
$$+209713x_{92} + 209713x_{93} + 209713x_{94} + 209713x_{95} + 965080x_{96} + 249500x_{97} + 239750x_{98}$$
$$+249500x_{99} + 249500x_{100} + 230000x_{101} + 230000x_{102} + 230000x_{103} + 230000x_{104}$$
$$+230000x_{105} + 230000x_{106} + 230000x_{107} + 239500x_{108} + 399500x_{109} + 195230x_{110}$$
$$+249500x_{111} + 244630x_{112} + 248900x_{113} + 248900x_{114} + d_8^+$$

4.2.3.4. Priority 3: Maximize the number of jobs created for selected projects.

[Minimize $(d_9^- + d_{10}^- + d_{11}^- + d_{12}^-)$]

School projects

$$d_9^+ = 994 + 14x_1 + 14x_2 + 14x_3 + 14x_4 + 14x_5 + 14x_6 + 14x_7 + 14x_8 + 14x_9 + 14x_{10} + 14x_{11}$$
$$+14x_{12} + 14x_{13} + 14x_{14} + 14x_{15} + 14x_{16} + 14x_{17} + 14x_{18} + 14x_{19} + 14x_{20} + 14x_{21}$$
$$+14x_{22} + 14x_{23} + 14x_{24} + 14x_{25} + 14x_{26} + 14x_{27} + 14x_{28} + 14x_{29} + 14x_{30} + 14x_{31}$$
$$+14x_{32} + 14x_{33} + 14x_{34} + 14x_{35} + 14x_{36} + 14x_{37} + 14x_{38} + 14x_{39} + 14x_{40} + 14x_{41}$$
$$+14x_{42} + 14x_{43} + 14x_{44} + 14x_{45} + 14x_{46} + 14x_{47} + 14x_{48} + 14x_{49} + 14x_{50} + 14x_{51}$$
$$+14x_{52} + 14x_{53} + 14x_{54} + 14x_{55} + 14x_{56} + 14x_{57} + 14x_{58} + 14x_{59} + 14x_{60} + 14x_{61}$$
$$+14x_{62} + 14x_{63} + 14x_{64} + 14x_{65} + 14x_{66} + 14x_{67} + 14x_{68} + 14x_{69} + 14x_{70} + 14x_{71} + d_9^-$$

Solar-powered water projects

$$d_{10}^+ = 6{,}351 + 87x_1 + 87x_2 + 87x_3 + 87x_4 + 87x_5 + 87x_6 + 87x_7 + 87x_8 + 87x_9$$
$$+87x_{10} + 87x_{11} + 87x_{12} + 87x_{13} + 87x_{14} + 87x_{15} + 87x_{16} + 87x_{17}$$
$$+87x_{18} + 87x_{19} + 87x_{20} + 87x_{21} + 87x_{22} + 87x_{23} + 87x_{24} + 87x_{25}$$
$$+87x_{26} + 87x_{27} + 87x_{28} + 87x_{29} + 87x_{30} + 87x_{31} + 87x_{32} + 87x_{33}$$
$$+87x_{34} + 87x_{35} + 87x_{36} + 87x_{37} + 87x_{38} + 87x_{39} + 87x_{40} + 87x_{41}$$
$$+87x_{42} + 87x_{43} + 87x_{44} + 87x_{45} + 87x_{46} + 87x_{47} + 87x_{48} + 87x_{49}$$

$$+87x_{50} + 87x_{51} + 87x_{52} + 87x_{53} + 87x_{54} + 87x_{55} + 87x_{56} + 87x_{57}$$
$$+87x_{58} + 87x_{59} + 87x_{60} + 87x_{61} + 87x_{62} + 87x_{63} + 87x_{64} + 87x_{65}$$
$$+87x_{66} + 87x_{67} + 87x_{68} + 87x_{68} + 87x_{70} + 87x_{71} + 87x_{72} + 87x_{73} + d_{10}^{-}$$

Communities' utility and civic centres

$$d_{11}^{+} = 994 + 14x_1 + 14x_2 + 14x_3 + 14x_4 + 14x_5 + 14x_6 + 14x_7 + 14x_8 + 14x_9$$
$$+ 14x_{10} + 14x_{11}$$
$$+14x_{12} + 14x_{13} + 14x_{14} + 14x_{15} + 14x_{16} + 14x_{17} + 14x_{18} + 14x_{19} + 14x_{20} + 14x_{21}$$
$$+14x_{22} + 14x_{23} + 14x_{24} + 14x_{25} + 14x_{26} + 14x_{27} + 14x_{28} + 14x_{29} + 14x_{30} + 14x_{31}$$
$$+14x_{32} + 14x_{33} + 14x_{34} + 14x_{35} + 14x_{36} + 14x_{37} + 14x_{38} + 14x_{39} + 14x_{40} + 14x_{41}$$
$$+14x_{42} + 14x_{43} + 14x_{44} + 14x_{45} + 14x_{46} + 14x_{47} + 14x_{48} + 14x_{49} + 14x_{50} + 14x_{51}$$
$$+14x_{52} + 14x_{53} + 14x_{54} + 14x_{55} + 14x_{56} + 14x_{57} + 14x_{58} + 14x_{59} + 14x_{60} + 14x_{61}$$
$$+14x_{62} + 14x_{63} + 14x_{64} + 14x_{65} + 14x_{66} + 14x_{67} + 14x_{68} + 14x_{69} + 14x_{70} + 14x_{71}$$
$$+ d_{11}^{-}$$

Road projects

$$d_{12}^{+} = 5{,}700 + 50x_1 + 50x_2 + 50x_3 + 50x_4 + 50x_5 + 50x_6 + 50x_7 + 50x_8 + 50x_9$$
$$+ 50x_{10} + 50x_{11} + 50x_{12}$$
$$+50x_{13} + 50x_{14} + 50x_{15} + 50x_{16} + 50x_{17} + 50x_{18} + 50x_{19} + 50x_{20} + 50x_{21} + 50x_{22}$$
$$+50x_{23} + 50x_{24} + 50x_{25} + 50x_{26} + 50x_{27} + 50x_{28} + 50x_{29} + 50x_{30} + 50x_{31} + 50x_{32}$$
$$+50x_{33} + 50x_{34} + 50x_{35} + 50x_{36} + 50x_{37} + 50x_{38} + 50x_{39} + 50x_{40} + 50x_{41} + 50x_{42}$$
$$+50x_{43} + 50x_{44} + 50x_{45} + 50x_{46} + 50x_{47} + 50x_{48} + 50x_{49} + 50x_{50} + 50x_{51} + 50x_{52}$$
$$+50x_{53} + 50x_{54} + 50x_{55} + 50x_{56} + 50x_{57} + 50x_{58} + 50x_{59} + 50x_{60} + 50x_{61} + 50x_{62}$$
$$+50x_{63} + 50x_{64} + 50x_{65} + 50x_{66} + 50x_{67} + 50x_{68} + 50x_{68} + 50x_{70} + 50x_{71} + 50x_{72}$$
$$+50x_{73} + 50x_{74} + 50x_{75} + 50x_{76} + 50x_{77} + 50x_{78} + 50x_{79} + 50x_{80} + 50x_{81} + 50x_{82}$$
$$+50x_{83} + 50x_{84} + 50x_{85} + 50x_{86} + 50x_{87} + 50x_{88} + 50x_{89} + 50x_{90} + 50x_{91} + 50x_{92}$$
$$+50x_{93} + 50x_{94} + 50x_{95} + 50x_{96} + 50x_{97} + 50x_{98} + 50x_{99} + 50x_{100} + 50x_{101}$$
$$+ 50x_{102}$$
$$+50x_{103} + 50x_{104} + 50x_{105} + 50x_{106} + 50x_{107} + 50x_{108} + 50x_{109} + 50x_{110} + 50x_{111}$$
$$+ 50x_{112} + 50x_{113} + 50x_{114} + d_{12}^{-}$$

4.2.3.5 Priority 4: Minimize duration for selected projects (months)

[Minimize $(d_{13}^{+} + d_{14}^{+} + d_{15}^{+} + d_{16}^{+})$]

School projects

$$d_{13}^{-} = 882 - 15x_1 + 15x_2 + 15x_3 + 15x_4 + 15x_5 + 15x_6 + 15x_7 + 15x_8 + 15x_9$$
$$+ 15x_{10} + 15x_{11} + 15x_{12}$$
$$+15x_{13} + 15x_{14} + 15x_{15} + 15x_{16} + 15x_{17} + 15x_{18} + 15x_{19} + 15x_{20} + 15x_{21} + 15x_{22}$$
$$+15x_{23} + 15x_{24} + 15x_{25} + 15x_{26} + 15x_{27} + 15x_{28} + 6x_{29} + 6x_{30} + 6x_{31} + 6x_{32}$$
$$+ 6x_{33}$$
$$+6x_{34} + 6x_{35} + 6x_{36} + 6x_{37} + 6x_{38} + 6x_{39} + 6x_{40} + 6x_{41} + 15x_{42} + 15x_{43} + 18x_{44}$$
$$+ 18x_{45}$$
$$+15x_{46} + 18x_{47} + 15x_{48} + 15x_{49} + 6x_{50} + 6x_{51} + 6x_{52} + 6x_{53} + 15x_{54} + 6x_{55}$$
$$+ 6x_{56}$$
$$+15x_{57} + 15x_{58} + 6x_{59} + 15x_{60} + 6x_{61} + 15x_{62} + 6x_{63} + 15x_{64} + 15x_{65} + 18x_{66}$$
$$+ 15x_{67} + 15x_{68} + 15x_{69} + 18x_{70} + 15x_{71} - d_{13}^{+}$$

Solar-powered water projects

$$d_{14}^{-} = 1095 - 15x_1 + 15x_2 + 15x_3 + 15x_4 + 15x_5 + 15x_6 + 15x_7 + 15x_8 + 15x_9 + 15x_{10} + 15x_{11} + 15x_{12}$$
$$+15x_{13} + 15x_{14} + 15x_{15} + 15x_{16} + 15x_{17} + 15x_{18} + 15x_{19} + 15x_{20} + 15x_{21} + 15x_{22}$$
$$+15x_{23} + 15x_{24} + 15x_{25} + 15x_{26} + 15x_{27} + 15x_{28} + 15x_{29} + 15x_{30} + 15x_{31} + 15x_{32}$$
$$+15x_{33} + 15x_{34} + 15x_{35} + 15x_{36} + 15x_{37} + 15x_{38} + 15x_{39} + 15x_{40} + 15x_{41} + 15x_{42}$$
$$+15x_{43} + 15x_{44} + 15x_{45} + 15x_{46} + 15x_{47} + 15x_{48} + 15x_{49} + 15x_{50} + 15x_{51} + 15x_{52}$$
$$+15x_{53} + 15x_{54} + 15x_{55} + 15x_{56} + 15x_{57} + 15x_{58} + 15x_{59} + 15x_{60} + 15x_{61} + 15x_{62}$$
$$+15x_{63} + 15x_{64} + 15x_{65} + 15x_{66} + 15x_{67} + 15x_{68} + 15x_{68} + 15x_{70} + 15x_{71} + 15x_{72} + 15x_{73} - d_{14}^{+}$$

Communities’ utility and civic centres

$$d_{15}^{-} = 1065 + \quad -15x_1 + 15x_2 + 15x_3 + 15x_4 + 15x_5 + 15x_6 + 15x_7 + 15x_8 + 15x_9 +$$
$$15x_{10} + 15x_{11} + 15x_{12} + 15x_{13} + 15x_{14} + 15x_{15} + 15x_{16} + 15x_{17} + 15x_{18} + 15x_{19} +$$
$$15x_{20} + 15x_{21} + 15x_{22} + 15x_{23} + 15x_{24} + 15x_{25} + 15x_{26} + 15x_{27} + 15x_{28} + 15x_{29} +$$
$$15x_{30} + 15x_{31} + 15x_{32} + 15x_{33} + 15x_{34} + 15x_{35} + 15x_{36} + 15x_{37} + 15x_{38} + 15x_{39} +$$
$$15x_{40} + 15x_{41} + 15x_{42} + 15x_{43} + 15x_{44} + 15x_{45} + 15x_{46} + 15x_{47} + 15x_{48} + 15x_{49} +$$
$$15x_{50} + 15x_{51} + 15x_{52} + 15x_{53} + 15x_{54} + 15x_{55} + 15x_{56} + 15x_{57} + 15x_{58} + 15x_{59} +$$
$$15x_{60} + 15x_{61} + 15x_{62} + 15x_{63} + 15x_{64} + 15x_{65} + 15x_{66} + 15x_{67} + 15x_{68} + 15x_{68} +$$
$$15x_{70} + 15x_{71} - d_{15}^{+}$$

Road projects

$$d_{16}^{-} = 1710 - 15x_1 + 15x_2 + 15x_3 + 15x_4 + 15x_5 + 15x_6 + 15x_7 + 15x_8 + 15x_9 + 15x_{10} + 15x_{11} + 15x_{12}$$
$$+15x_{13} + 15x_{14} + 15x_{15} + 15x_{16} + 15x_{17} + 15x_{18} + 15x_{19} + 15x_{20} + 15x_{21} + 15x_{22}$$
$$+15x_{23} + 15x_{24} + 15x_{25} + 15x_{26} + 15x_{27} + 15x_{28} + 15x_{29} + 15x_{30} + 15x_{31} + 15x_{32}$$
$$+15x_{33} + 15x_{34} + 15x_{35} + 15x_{36} + 15x_{37} + 15x_{38} + 15x_{39} + 15x_{40} + 15x_{41} + 15x_{42}$$
$$+15x_{43} + 15x_{44} + 15x_{45} + 15x_{46} + 15x_{47} + 15x_{48} + 15x_{49} + 15x_{50} + 15x_{51} + 15x_{52}$$
$$+15x_{53} + 15x_{54} + 15x_{55} + 15x_{56} + 15x_{57} + 15x_{58} + 15x_{59} + 15x_{60} + 15x_{61} + 15x_{62}$$
$$+15x_{63} + 15x_{64} + 15x_{65} + 15x_{66} + 15x_{67} + 15x_{68} + 15x_{68} + 15x_{70} + 15x_{71} + 15x_{72}$$
$$+15x_{73} + 15x_{74} + 15x_{75} + 15x_{76} + 15x_{77} + 15x_{78} + 15x_{79} + 15x_{80} + 15x_{81} + 15x_{82}$$
$$+15x_{83} + 15x_{84} + 15x_{85} + 15x_{86} + 15x_{87} + 15x_{88} + 15x_{89} + 15x_{90} + 15x_{91} + 15x_{92}$$
$$+15x_{93} + 15x_{94} + 15x_{95} + 15x_{96} + 15x_{97} + 15x_{98} + 15x_{99} + 15x_{100} + 15x_{101} + 15x_{102}$$
$$+15x_{103} + 15x_{104} + 15x_{105} + 15x_{106} + 15x_{107} + 15x_{108} + 15x_{109} + 15x_{110} + 15x_{111} + 15x_{112} + 15x_{113} + 15x_{114} - d_{16}^{+}$$

4.2.4 Goal programming approach construction or formulation from the overall weight obtained from AHP in section 4.2.1 for year three

The multi-objective GP model was formulated with the concept of pre-emptive priority and weighted model types employing the overall weight obtained from the AHP method in Table 4.6.

The projects to be chosen and executed by the agency are Model Health Care, School and Housing.

Minimize Z=

$P_1(0.146d_1^- + 0.037d_2^- + 0.032d_3^-)$ Maximize Select Projects for Social Benefits

$P_2(d_4^+ + d_5^+ + d_6^+)$ Minimize Cost for Projects (Model Health Care, School and Housing)

$P_3(d_7^- + d_8^- + d_9^-)$ Maximize the number of jobs created.

$P_4(d_{10}^+ + d_{11}^+ + d_{12}^+)$ Minimize the time required to complete the project.

4.2.4.1 General Objectives Functions for year three

Minimize Z= $0.146d_1^- + 0.037d_2^- + 0.032d_3^- + d_4^+ + d_5^+ + d_6^+ + d_7^- + d_8^- + d_9^- + d_{10}^+ + d_{11}^+ + d_{12}^+$

Subject to:

4.2.4.2 Priority 1: Maximize Select Projects (Model Health Care, School and Housing) for community benefit.

[Maximize $(d_1^- + d_2^- + d_3^-)$]

Model Health Care

$$d_1^+ = 59 - x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + x_8 + x_9 + x_{10} + x_{11} + x_{12} + x_{13} + x_{14} + x_{15} + x_{16} + x_{17} + x_{18} + x_{19} + x_{20} + x_{21} + x_{22} + x_{23} + x_{24} + x_{25} + x_{26} + x_{27} + x_{28} + x_{29} + x_{30} + x_{31} + x_{32} + x_{33} + x_{34} + x_{35} + x_{36} + x_{37} + x_{38} + x_{39} + x_{40} + x_{41} + x_{42} + x_{43} + x_{44} + x_{45} + x_{46} + x_{47} + x_{48} + x_{49} + x_{50} + x_{51} + x_{52} + x_{53} + x_{54} + x_{55} + x_{56} + x_{57} + x_{58} + x_{59} - 0.146d_1^-$$

School projects

$$d_2^+ = 489 - 6x_1 + x_2 + 3x_3 + x_4 + 3x_5 + 3x_6 + 3x_7 + 6x_8 + 6x_9 + 12x_{10} + x_{11} + x_{12} + 3x_{13} + x_{14} + 3x_{15} + 3x_{16} + x_{17} + 6x_{18} + 6x_{19} + 6x_{20} + 6x_{21} + 3x_{22} + 6x_{23} + x_{24} + x_{25} + 3x_{26} + x_{27} + 3x_{28} + 12x_{29} + 12x_{30} + 6x_{31} + 3x_{32} + 3x_{33} + 6x_{34} + 6x_{35} + 3x_{36} + x_{37} + 6x_{38} + 6x_{39} + 3x_{40} + 6x_{41} + 3x_{42} + 3x_{43} + 3x_{44} + 6x_{45} + 6x_{46} + x_{47} + x_{48} + 3x_{49} + 3x_{50} + 3x_{51} + 6x_{52} + 6x_{53} + x_{54} + 6x_{55} + 3x_{56} + 6x_{57} + 3x_{58} + 6x_{59} + 3x_{60} + 6x_{61} + 12x_{62} + 22x_{63} + 3x_{64} + 3x_{65} + 6x_{66} + x_{67} + x_{68} + x_{69} + 3x_{70} + 6x_{71} + 6x_{72} + 3x_{73} + 3x_{74}$$

$$+x_{75}+x_{76}+6x_{77}+6x_{78}+6x_{79}+3x_{80}+12x_{81}+3x_{82}+6x_{83}+6x_{84}+6x_{85}+12x_{86}$$
$$+3x_{87}+3x_{88}+x_{89}+6x_{90}+3x_{91}+6x_{92}+6x_{93}+6x_{94}+3x_{95}+x_{96}+x_{97}+22x_{98}$$
$$+x_{99}+x_{100}+12x_{101}+22x_{102}+x_{103}-0.037d_2^-$$

Housing/Hostel projects

$$d_3^+ = 218-3x_1+3x_2+3x_3+x_4+3x_5+x_6+x_7+3x_8+x_9+x_{10}+x_{11}+3x_{12}+x_{13}+3x_{14}$$
$$+3x_{15}+3x_{16}+3x_{17}+3x_{18}+3x_{19}+3x_{20}+3x_{21}+3x_{22}+3x_{23}+3x_{24}+x_{25}+3x_{26}$$
$$+x_{27}+x_{28}+3x_{29}+3x_{30}+3x_{31}+3x_{32}+3x_{33}+3x_{34}+3x_{35}+3x_{36}+3x_{37}+3x_{38}$$
$$+3x_{39}+3x_{40}+3x_{41}+3x_{42}+3x_{43}+3x_{44}+3x_{45}+3x_{46}+3x_{47}+3x_{48}+3x_{49}+3x_{50}$$
$$+3x_{51}+3x_{52}+3x_{53}+3x_{54}+3x_{55}+3x_{56}+3x_{57}+3x_{58}+3x_{59}+3x_{60}+3x_{61}+3x_{62}$$
$$+3x_{63}+3x_{64}+3x_{65}+3x_{66}+3x_{67}+3x_{68}+3x_{69}+3x_{70}+3x_{71}+3x_{72}+3x_{73}+3x_{74}$$
$$+3x_{75}+3x_{76}+3x_{77}+3x_{78}+3x_{79}+x_{80}-0.032d_3^-$$

4.2.4.3 Priority 2: Minimize the cost of projects.

[Minimize $(d_4^+ + d_5^+ + d_6^+)$]

Cost of Model Health Care Centres

$$d_4^- = 6{,}879{,}187-249{,}050x_1+250{,}000x_2+200{,}000x_3+24{,}287x_4+29{,}309x_5+29{,}600x_6+29{,}309x_7$$
$$+33{,}409x_8+43{,}948x_9+249{,}500x_{10}+249{,}500x_{11}+19{,}240x_{12}+43{,}436x_{13}$$
$$+22{,}682x_{14}+79{,}743x_{15}+22{,}682x_{16}+43{,}436x_{17}+43{,}436x_{18}+27{,}167x_{19}$$
$$+90{,}175x_{20}+49{,}952x_{21}+43{,}436x_{22}+199{,}402x_{23}+29{,}309x_{24}+100{,}000x_{25}$$
$$+149{,}586x_{26}+238{,}756x_{27}+43{,}436x_{28}+43{,}436x_{29}+43{,}436x_{30}+43{,}436x_{31}$$
$$+249{,}050x_{32}+250{,}000x_{33}+200{,}000x_{34}+43{,}948x_{35}+249{,}500x_{36}$$
$$+249{,}500x_{37}79{,}743x_{38}+90{,}175x_{39}+19{,}9402x_{40}+100{,}000x_{41}+149{,}586x_{42}$$
$$+238{,}756x_{43}+43{,}436x_{44}+43{,}436x_{45}+200{,}000x_{46}+187{,}286x_{47}+118{,}715x_{48}$$
$$+98{,}455x_{49}+149{,}586x_{50}+43{,}436x_{51}+200{,}000x_{52}+79{,}743x_{53}+249{,}500x_{54}$$
$$+100{,}000x_{55}+43{,}436x_{56}+24{,}9500x_{57}+118{,}715x_{58}+90{,}175x_{59}-d_4^+$$

Cost of School projects

$$d_5^- = 4{,}559{,}781-12{,}853x_1+60{,}000x_2+6{,}200x_3+60{,}000x_4+6{,}500x_5+6{,}200x_6+6{,}200x_7$$
$$+14{,}204x_8+15{,}500x_9+43{,}397x_{10}+53{,}439x_{11}+60{,}000x_{12}+6{,}200x_{13}+35{,}430x_{14}$$
$$+6{,}469x_{15}+18{,}350x_{16}+9{,}664x_{17}+12{,}500x_{18}+17{,}179x_{19}+12{,}500x_{20}+10{,}880x_{21}$$
$$+10{,}339x_{22}+17{,}750x_{23}+11{,}327x_{24}+38{,}145x_{25}+6{,}450x_{26}54{,}987x_{27}99{,}500x_{28}$$
$$+99{,}500x_{29}+69{,}999x_{30}+15{,}328x_{31}+6{,}200x_{32}+6{,}200x_{33}+17{,}179x_{34}+12{,}897x_{35}$$
$$+53{,}439x_{36}+54{,}987x_{37}+12{,}500x_{38}+45{,}995x_{39}+16{,}845x_{40}+46{,}872x_{41}$$
$$+20{,}420x_{42}+6{,}200x_{43}+6{,}200x_{44}+47{,}179x_{45}+12{,}500x_{46}+654{,}987x_{47}+6{,}291x_{48}$$
$$+16{,}200x_{49}+53{,}368x_{50}+6{,}463x_{51}+17{,}179x_{52}+17{,}179x_{53}+54{,}987x_{54}$$
$$+32{,}500x_{55}+6{,}200x_{56}+32{,}500x_{57}+26{,}200x_{58}+33{,}671x_{59}+4{,}671x_{60}+28{,}637x_{61}$$

$$+49{,}855x_{62} + 99{,}361x_{63} + 6{,}500x_{64} + 6{,}200x_{65} + 17{,}179x_{66} + 54{,}987x_{67} + 8{,}014x_{68}$$
$$+11{,}200x_{69} + 64{,}877x_{70} + 17{,}500x_{71} + 19{,}778x_{72} + 6{,}047x_{73} + 6{,}200x_{74} + 52{,}654x_{75}$$
$$+54{,}987x_{76} + 17{,}179x_{77} + 12{,}500x_{78} + 12{,}500x_{79} + 25{,}286x_{80} + 59{,}879x_{81}$$
$$+5{,}382x_{82} + 16{,}328x_{83} + 16{,}146x_{84} + 18{,}500x_{85} + 99{,}361x_{86} + 6{,}200x_{87} + 6{,}200x_{88}$$
$$+61{,}343x_{89} + 17{,}179x_{90} + 6{,}500x_{91} + 23{,}386x_{92} + 17{,}897x_{93} + 18{,}500x_{94} + 7{,}304x_{95}$$
$$+54{,}987x_{96} + 54{,}987x_{97} + 997{,}645x_{98} + 59{,}900x_{99} + 100{,}000x_{100} + 49{,}692x_{101}$$
$$+149{,}986x_{102} + 44{,}635x_{103} - d_5^+$$

Cost of Housing / Hostel projects

$$d_6^- = 2{,}248{,}355 - 4{,}030x_1 + 6{,}651x_2 + 4{,}730x_3 + 36{,}645x_4 + 12{,}476x_5 + 6{,}651x_6 + 8{,}568x_7 + 4{,}730x_8$$
$$+18{,}105x_9 + 6{,}000x_{10} + 20{,}608x_{11} + 4{,}730x_{12} + 13{,}000x_{13} + 17{,}000x_{14} + 4{,}030x_{15}$$
$$+12{,}981x_{16} + 18{,}134x_{17} + 10{,}229x_{18} + 13{,}139x_{19} + 10{,}659x_{20} + 11{,}982x_{21}$$
$$+10{,}000x_{22} + 86{,}088x_{23} + 12{,}228x_{24} + 52{,}796x_{25} + 10{,}228x_{26} + 175{,}837x_{27}$$
$$+192{,}990x_{28} + 15{,}892x_{29} + 15{,}892x_{30} + 10{,}376x_{31} + 10{,}376x_{32} + 10{,}376x_{33}$$
$$+10{,}376x_{34} + 15{,}892x_{35} + 15{,}892x_{36} + 15{,}892x_{37} + 15{,}892x_{38} + 15{,}892x_{39}$$
$$+15{,}892x_{40} + 15{,}892x_{41} + 15{,}892x_{42} + 15{,}892x_{43} + 15{,}892x_{44} + 15{,}892x_{45}$$
$$+15{,}892x_{46} + 15{,}892x_{47} + 15{,}892x_{48} + 15{,}892x_{49} + 15{,}892x_{50} + 15{,}892x_{51}$$
$$+15{,}892x_{52} + 15{,}892x_{53} + 15{,}892x_{54} + 15{,}892x_{55} + 15{,}892x_{56} + 15{,}892x_{57}$$
$$+15{,}892x_{58} + 15{,}892x_{59} + 15{,}892x_{60} + 15{,}892x_{61} + 15{,}892x_{62} + 15{,}892x_{63}$$
$$+15{,}892x_{64} + 15{,}892x_{65} + 15{,}892x_{66} + 15{,}892x_{67} + 15{,}892x_{68} + 15{,}892x_{68}$$
$$+12{,}882x_{70} + 12{,}882x_{71} + 12{,}882x_{72} + 12{,}882x_{73} + 12{,}882x_{74} + 15{,}892x_{75}$$
$$+15{,}892x_{76} + 15{,}892x_{77} + 15{,}892x_{78} + 15{,}892x_{79} + 674{,}682x_{80} - d_6^+$$

4.2.4.4 Priority 3: Maximize the number of jobs created for selected projects.

[Maximize $(d_7^- + d_8^- + d_9^-)$]

Health Care projects

$$d_7^+ = 2360 - 40x_1 + 40x_2 + 40x_3 + 40x_4 + 40x_5 + 40x_6 + 40x_7 + 40x_8 + 40x_9 + 40x_{10} + 40x_{11}$$
$$+40x_{12} + 40x_{13} + 40x_{14} + 40x_{15} + 40x_{16} + 40x_{17} + 40x_{18} + 40x_{19} + 40x_{20} + 40x_{21}$$
$$+40x_{22} + 40x_{23} + 40x_{24} + 40x_{25} + 40x_{26} + 40x_{27} + 40x_{28} + 40x_{29} + 40x_{30} + 40x_{31}$$
$$+40x_{32} + 40x_{33} + 40x_{34} + 40x_{35} + 40x_{36} + 40x_{37} + 40x_{38} + 40x_{39} + 40x_{40} + 40x_{41}$$
$$+40x_{42} + 40x_{43} + 40x_{44} + 40x_{45} + 40x_{46} + 40x_{47} + 40x_{48} + 40x_{49} + 40x_{50} + 40x_{51}$$
$$+40x_{52} + 40x_{53} + 40x_{54} + 40x_{55} + 40x_{56} + 40x_{57} + 40x_{58} + 40x_{59} - d_7^-$$

School projects

$$d_8^+ = 1442 - 14x_1 + 14x_2 + 14x_3 + 14x_4 + 14x_5 + 14x_6 + 14x_7 + 14x_8 + 14x_9 + 14x_{10} + 14x_{11}$$
$$+14x_{12} + 14x_{13} + 14x_{14} + 14x_{15} + 14x_{16} + 14x_{17} + 14x_{18} + 14x_{19} + 14x_{20} + 14x_{21}$$
$$+14x_{22} + 14x_{23} + 14x_{24} + 14x_{25} + 14x_{26} + 14x_{27} + 14x_{28} + 14x_{29} + 14x_{30} + 14x_{31}$$
$$+14x_{32} + 14x_{33} + 14x_{34} + 14x_{35} + 14x_{36} + 14x_{37} + 14x_{38} + 14x_{39} + 14x_{40} + 14x_{41}$$
$$+14x_{42} + 14x_{43} + 14x_{44} + 14x_{45} + 14x_{46} + 14x_{47} + 14x_{48} + 14x_{49} + 14x_{50} + 14x_{51}$$
$$+14x_{52} + 14x_{53} + 14x_{54} + 14x_{55} + 14x_{56} + 14x_{57} + 14x_{58} + 14x_{59} + 14x_{60} + 14x_{61}$$

$$+14x_{62}+14x_{63}+14x_{64}+14x_{65}+14x_{66}+14x_{67}+14x_{68}+14x_{69}+14x_{70}+14x_{71}$$
$$+14x_{72}+14x_{73}+14x_{74}+14x_{75}+14x_{76}+14x_{77}+14x_{78}+14x_{79}+14x_{80}+14x_{81}$$
$$+14x_{82}+14x_{83}+14x_{84}+14x_{85}+14x_{86}+14x_{87}+14x_{88}+14x_{89}+14x_{90}+14x_{91}$$
$$+14x_{92}+14x_{93}+14x_{94}+14x_{95}+14x_{96}+14x_{97}+14x_{98}+14x_{99}+14x_{100}$$
$$+14x_{101}+14x_{102}+14x_{103}-d_8^-$$

Housing projects

$$d_9^+ = 8000-100x_1+100x_2+100x_3+100x_4+100x_5+100x_6+100x_7+100x_8$$
$$+100x_9$$
$$+100x_{10}+100x_{11}+100x_{12}+100x_{13}+100x_{14}+100x_{15}+100x_{16}+100x_{17}$$
$$+100x_{18}+100x_{19}+100x_{20}+100x_{21}+100x_{22}+100x_{23}+100x_{24}+100x_{25}$$
$$+100x_{26}+100x_{27}+100x_{28}+100x_{29}+100x_{30}+100x_{31}+100x_{32}+100x_{33}$$
$$+100x_{34}+100x_{35}+100x_{36}+100x_{37}+100x_{38}+100x_{39}+100x_{40}+100x_{41}$$
$$+100x_{42}+100x_{43}+100x_{44}+100x_{45}+100x_{46}+100x_{47}+100x_{48}+100x_{49}$$
$$+100x_{50}+100x_{51}+100x_{52}+100x_{53}+100x_{54}+100x_{55}+100x_{56}+100x_{57}$$
$$+100x_{58}+100x_{59}+100x_{60}+100x_{61}+100x_{62}+100x_{63}+100x_{64}+100x_{65}$$
$$+100x_{66}+100x_{67}+100x_{68}+100x_{68}+100x_{70}+100x_{71}+100x_{72}+100x_{73}$$
$$+100x_{74}+100x_{75}+100x_{76}+100x_{77}+100x_{78}+100x_{79}+100x_{80}-d_9^-$$

4.2.4.5 Priority 4: Minimize the time required to complete project or project completion time.

[Minimize $(d_{10}^+ + d_{11}^+ + d_{12}^+)$]

Health Care projects

$$d_{10}^- = 840-15x_1+15x_2+15x_3+12x_4+12x_5+15x_6+12x_7+15x_8+15x_9$$
$$+15x_{10}+15x_{11}$$
$$+12x_{12}+12x_{13}+12x_{14}+12x_{15}+12x_{16}+15x_{17}+15x_{18}+15x_{19}+15x_{20}+15x_{21}$$
$$+15x_{22}+15x_{23}+12x_{24}+12x_{25}+15x_{26}+15x_{27}+15x_{28}+15x_{29}+12x_{30}+12x_{31}$$
$$+15x_{32}+15x_{33}+15x_{34}+15x_{35}+15x_{36}+15x_{37}+15x_{38}+15x_{39}+15x_{40}+15x_{41}$$
$$+15x_{42}+15x_{43}+15x_{44}+15x_{45}+15x_{46}+12x_{47}+12x_{48}+12x_{49}+15x_{50}+15x_{51}$$
$$+15x_{52}+15x_{53}+15x_{54}+15x_{55}+15x_{56}+15x_{57}+15x_{58}+15x_{59}-d_{10}^+$$

School projects

$$d_{11}^- = 973-\ 6x_1+15x_2+15x_3+15x_4+6x_5+6x_6+6x_7+10x_8+10x_9+15x_{10}$$
$$+10x_{11}$$
$$+15x_{12}+6x_{13}+10x_{14}+6x_{15}+8x_{16}+8x_{17}+12x_{18}+8x_{19}+12x_{20}+8x_{21}+6x_{22}$$
$$+12x_{23}+12x_{24}+12x_{25}+6x_{26}+15x_{27}+12x_{28}+15x_{29}+15x_{30}+12x_{31}+6x_{32}$$
$$+6x_{33}+6x_{34}+6x_{35}+15x_{36}+15x_{37}+6x_{38}+6x_{39}+6x_{40}+6x_{41}+6x_{42}+6x_{43}$$
$$+6x_{44}+6x_{45}+6x_{46}+10x_{47}+6x_{48}+6x_{49}+15x_{50}+6x_{51}+12x_{52}+12x_{53}$$
$$+15x_{54}+12x_{55}+6x_{56}+6x_{57}+6x_{58}+12x_{59}+6x_{60}+12x_{61}+12x_{62}+18x_{63}$$
$$+6x_{64}+6x_{65}+6x_{66}+15x_{67}+6x_{68}+6x_{69}+15x_{70}+6x_{71}+6x_{72}+6x_{73}+6x_{74}$$
$$+15x_{75}+15x_{76}+6x_{77}+12x_{78}+6x_{79}+6x_{80}+12x_{81}+6x_{82}+6x_{83}+6x_{84}+6x_{85}$$
$$+12x_{86}+6x_{87}+6x_{88}+15x_{89}+6x_{90}+6x_{91}+6x_{92}+6x_{93}+6x_{94}+6x_{95}+15x_{96}$$
$$+15x_{97}+18x_{98}+15x_{99}+15x_{100}+12x_{101}+18x_{102}+6x_{103}-d_{11}^+$$

Housing projects

$$d_{12}^{-} = 934 - 12x_1 + 12x_2 + 12x_3 + 12x_4 + 12x_5 + 6x_6 + 6x_7 + 12x_8 + 12x_9 + 6x_{10}$$
$$+10x_{11} + 12x_{12} + 6x_{13} + 12x_{14} + 12x_{15} + 12x_{16} + 12x_{17} + 12x_{18} + 12x_{19} + 12x_{20}$$
$$+12x_{21} + 12x_{22} + 12x_{23} + 12x_{24} + 12x_{25} + 12x_{26} + 12x_{27} + 12x_{28} + 12x_{29} + 12x_{30}$$
$$+12x_{31} + 12x_{32} + 12x_{33} + 12x_{34} + 12x_{35} + 12x_{36} + 12x_{37} + 12x_{38} + 12x_{39} + 12x_{40}$$
$$+12x_{41} + 12x_{42} + 12x_{43} + 12x_{44} + 12x_{45} + 12x_{46} + 12x_{47} + 12x_{48} + 12x_{49} + 12x_{50}$$
$$+12x_{51} + 12x_{52} + 12x_{53} + 12x_{54} + 12x_{55} + 12x_{56} + 12x_{57} + 12x_{58} + 12x_{59} + 12x_{60}$$
$$+12x_{61} + 12x_{62} + 12x_{63} + 12x_{64} + 12x_{65} + 12x_{66} + 12x_{67} + 12x_{68} + 12x_{68} + 12x_{70}$$
$$+12x_{71} + 12x_{72} + 12x_{73} + 12x_{74} + 12x_{75} + 12x_{76} + 12x_{77} + 12x_{78} + 12x_{79} + 12x_{80}$$
$$- d_{12}^{+}$$

4.2.5 Goal programming approach construction from the overall weight obtained from AHP in section 4.2.1 for year four

The multi-objective GP model was formulated with the concept of pre-emptive priority and weighted model types employing the final or global weight obtained from the AHP method in Table 4.6.

The projects to be selected and executed by the agency are Solar Water Projects, Road, Electrification and Water Jetty.

Minimize Z=

$P_1(0.329d_1^- + 0.183d_2^- + 0.182d_3^- + 0.018d_4^-)$ Maximize Select Projects for Social benefit.

$P_2(d_5^+ + d_6^+ + d_7^+ + d_8^+)$ Minimize Cost for Projects (Solar Water Projects, Road, Electrification and Water Jetty)

$P_3(d_9^- + d_{10}^- + d_{11}^- + d_{12}^-)$ Maximize the number of jobs created.

$P_4(d_{13}^+ + d_{14}^+ + d_{15}^+ + d_{16}^+)$ Minimize duration for selected projects (months).

4.2.5.1 General Objectives Functions for year four

Minimize Z= $0.329d_1^- + 0.183d_2^- + 0.182d_3^- + 0.018d_4^- + d_5^+ + d_6^+ + d_7^+ + d_8^+ + d_9^- + d_{10}^- + d_{11}^- + d_{12}^- + d_{13}^+ + d_{14}^+ + d_{15}^+ + d_{16}^+$

Subject to:

4.2.5.2 Priority 1: Maximize Select projects (Solar Water Project, Road, Electrification and Water Jetty) for community benefit.

[Minimize $d_1^- + d_2^- + d_3^- + d_4^-$]

Solar-powered water projects

$$d_1^+ = 126 - x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + x_8 + x_9 + x_{10} + x_{11} + x_{12} + x_{13} + x_{14} + x_{15} + x_{16}$$
$$+x_{17} + x_{18} + x_{19} + x_{20} + x_{21} + x_{22} + x_{23} + x_{24} + x_{25} + x_{26} + x_{27} + x_{28} + x_{29} + x_{30}$$
$$+x_{31} + x_{32} + x_{33} + x_{34} + x_{35} + x_{36} + x_{37} + x_{38} + x_{39} + x_{40} + x_{41} + x_{42} + x_{43} + x_{44}$$
$$+x_{45} + x_{46} + x_{47} + x_{48} + x_{49} + x_{50} + x_{51} + x_{52} + x_{53} + x_{54} + x_{55} + x_{56} + x_{57} + x_{58}$$
$$+x_{59} + x_{60} + x_{61} + x_{62} + x_{63} + x_{64} + x_{65} + x_{66} + x_{67} + x_{68} + x_{69} + x_{70} + x_{71} + x_{72}$$
$$+x_{73} + x_{74} + x_{75} + x_{76} + x_{77} + x_{78} + x_{79} + x_{80} + x_{81} + x_{82} + x_{83} + x_{84} + x_{85} + x_{86}$$
$$+x_{87} + x_{88} + x_{89} + x_{90} + x_{91} + x_{92} + x_{93} + x_{94} + x_{95} + x_{96} + x_{97} + x_{98} + x_{99} + x_{100}$$
$$+x_{101} + x_{102} + x_{103} + x_{104} + x_{105} + x_{106} + x_{107} + x_{108} + x_{109} + x_{110} + x_{111} + x_{112}$$
$$+x_{113} + x_{114} + x_{115} + x_{116} + x_{117} + x_{118} + x_{119} + x_{120} + x_{121} + x_{122} + x_{123} + x_{124}$$
$$+x_{125} + x_{126} + 0.037d_1^-$$

Road projects

$$d_2^+ = 197 - x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + x_8 + x_9 + x_{10} + x_{11} + x_{12} + x_{13} + x_{14} + x_{15} + x_{16}$$
$$+x_{17} + x_{18} + x_{19} + x_{20} + x_{21} + x_{22} + x_{23} + x_{24} + x_{25} + x_{26} + x_{27} + x_{28} + x_{29} + x_{30}$$
$$+x_{31} + x_{32} + x_{33} + x_{34} + x_{35} + x_{36} + x_{37} + x_{38} + x_{39} + x_{40} + x_{41} + x_{42} + x_{43} + x_{44}$$
$$+x_{45} + x_{46} + x_{47} + x_{48} + x_{49} + x_{50} + x_{51} + x_{52} + x_{53} + x_{54} + x_{55} + x_{56} + x_{57} + x_{58}$$
$$+x_{59} + x_{60} + x_{61} + x_{62} + x_{63} + x_{64} + x_{65} + x_{66} + x_{67} + x_{68} + x_{68} + x_{70} + x_{71} + x_{72}$$
$$+x_{73} + x_{74} + x_{75} + x_{76} + x_{77} + x_{78} + x_{79} + x_{80} + x_{81} + x_{82} + x_{83} + x_{84} + x_{85} + x_{86}$$
$$+x_{87} + x_{88} + x_{89} + x_{90} + x_{91} + x_{92} + x_{93} + x_{94} + x_{95} + x_{96} + x_{97} + x_{98} + x_{99} + x_{100}$$
$$+x_{101} + x_{102} + x_{103} + x_{104} + x_{105} + x_{106} + x_{107} + x_{108} + x_{109} + x_{110} + x_{111} + x_{112}$$
$$+x_{113} + x_{114} + x_{115} + x_{116} + x_{117} + x_{118} + x_{119} + x_{120} + x_{121} + x_{122} + x_{123} + x_{124}$$
$$+x_{125} + x_{126} + x_{127} + x_{128} + x_{129} + x_{130} + x_{131} + x_{132} + x_{133} + x_{134} + x_{135} + x_{136}$$
$$+x_{137} + x_{138} + x_{139} + x_{140} + x_{141} + x_{142} + x_{143} + x_{144} + x_{145} + x_{146} + x_{147} + x_{148}$$
$$+x_{149} + x_{150} + x_{151} + x_{152} + x_{153} + x_{154} + x_{155} + x_{156} + x_{157} + x_{158} + x_{159} + x_{160}$$
$$+x_{161} + x_{162} + x_{163} + x_{164} + x_{165} + x_{166} + x_{167} + x_{168} + x_{169} + x_{169} + x_{170} + x_{171}$$
$$+x_{172} + x_{173} + x_{174} + x_{175} + x_{176} + x_{177} + x_{178} + x_{179} + x_{180} + x_{181} + x_{182} + x_{183}$$
$$+x_{184} + x_{185} + x_{186} + x_{187} + x_{188} + x_{189} + x_{190} + x_{191} + x_{192} + x_{193} + x_{194} + x_{195}$$
$$+ x_{196} + x_{197} + 0.183d_2^-$$

Electrification projects

$$d_3^+ = 234 - x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + x_8 + x_9 + x_{10} + x_{11} + x_{12} + x_{13} + x_{14} + x_{15}$$
$$+ x_{16} + x_{17} + x_{18} + x_{19} + x_{20} + x_{21} + x_{22} + x_{23} + x_{24} + x_{25} + x_{26} + x_{27} + x_{28}$$
$$+ + x_{29} + x_{30} + x_{31} + x_{32} + x_{33} + x_{34} + x_{35} + x_{36} + x_{37} + x_{38} + x_{39} + x_{40} +$$
$$x_{41} + x_{42} + x_{43} + x_{44} + x_{45} + x_{46} + x_{47} + x_{48} + x_{49} + x_{50} + x_{51} + x_{52} + x_{53} +$$
$$x_{54} + x_{55} + x_{56} + x_{57} + x_{58} + x_{59} + x_{60} + x_{61} + x_{62} + x_{63} + x_{64} + x_{65} + x_{66} +$$
$$x_{67} + x_{68} + x_{69} + x_{70} + x_{71} + x_{71} + x_{73} + x_{74} + x_{75} + x_{76} + x_{77} + x_{78} + x_{79} +$$

$x_{80} + x_{81} + x_{82} + x_{83} + x_{84} + x_{85} + x_{86} + x_{87} + x_{88} + x_{89} + x_{90} + x_{91} + x_{91} + x_{92} + x_{93} + x_{94} + x_{95} + x_{96} + x_{97} + x_{98} + x_{99} + x_{100} + x_{101} + x_{102} + x_{103} + x_{104} + x_{105} + x_{106} + x_{107} + x_{108} + x_{109} + x_{110} + x_{111} + x_{112} + x_{113} + x_{114} + x_{115} + x_{116} + x_{117} + x_{118} + x_{119} + x_{120} + x_{121} + x_{122} + x_{123} + x_{124} + x_{125} + x_{126} + x_{127} + x_{128} + x_{129} + x_{130} + x_{131} + x_{132} + x_{133} + x_{134} + x_{135} + x_{136} + x_{137} + x_{138} + x_{139} + x_{140} + x_{141} + x_{142} + x_{143} + x_{144} + x_{145} + x_{146} + x_{147} + x_{148} + x_{149} + x_{150} + x_{151} + x_{152} + x_{153} + x_{154} + x_{155} + x_{156} + x_{157} + x_{158} + x_{159} + x_{160} + x_{161} + x_{162} + x_{163} + x_{164} + x_{165} + x_{166} + x_{167} + x_{168} + x_{169} + x_{170} + x_{171} + x_{172} + x_{173} + x_{174} + x_{175} + x_{176} + x_{177} + x_{178} + x_{179} + x_{180} + x_{181} + x_{182} + + x_{183} + x_{184} + x_{185} + x_{186} + x_{187} + x_{188} + x_{189} + x_1 + x_{190} + x_{191} + x_{192} + x_{193} + x_{194} + x_{195} + x_{196} + x_{197} + x_{198} + x_{199} + x_{200} + x_{201} + x_{202} + x_{203} + x_{204} + x_{205} + x_{206} + x_{207} + x_{208} + x_{209} + x_{210} + x_{211} + x_{212} + x_{213} + x_{214} + x_{215} + x_{216} + x_{217} + x_{218} + x_{219} + x_{220} + x_{221} + x_{222} + x_{223} + x_{224} + x_{225} + x_{226} + x_{227} + x_{228} + x_{229} + x_{230} + x_{231} + x_{232} + x_{233} + x_{234} + 0.182d_3^-$

Water Jetty projects

$$d4^+ = 102 - x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + x_8 + x_9 + x_{10} + x_{11} + x_{12} + x_{13} + x_{14} + x_{15} + x_{16} + x_{17} + x_{18} + x_{19} + x_{20} + x_{21} + x_{22} + x_{23} + x_{24} + x_{25} + x_{26} + x_{27} + x_{28} + x_{29} + x_{30} + x_{31} + x_{32} + x_{33} + x_{34} + x_{35} + x_{36} + x_{37} + x_{38} + x_{39} + x_{40} + x_{41} + x_{42} + x_{43} + x_{44} + x_{45} + x_{46} + x_{47} + x_{48} + x_{49} + x_{50} + x_{51} + x_{52} + x_{53} + x_{54} + x_{55} + x_{56} + x_{57} + x_{58} + x_{59} + x_{60} + x_{61} + x_{62} + x_{63} + x_{64} + x_{65} + x_{66} + x_{67} + x_{68} + x_{69} + x_{70} + x_{71} + x_{72} + x_{73} + x_{74} + x_{75} + x_{76} + x_{77} + x_{78} + x_{79} + x_{80} + x_{81} + x_{82} + x_{83} + x_{84} + x_{85} + x_{86} + x_{87} + x_{88} + x_{89} + x_{90} + x_{91} + x_{92} + x_{93} + x_{94} + x_{95} + x_{96} + x_{97} + x_{98} + x_{99} + x_{100} + x_{101} + x_{102} + 0.018d4^-$$

4.2.5.3 Priority 2: Minimize the cost of projects.

[Minimize $d_5^+ + d_6^+ + d_7^+ + d_8^+$]

Solar-powered water projects

$$d_5^+ = 9{,}084{,}908 + 89{,}036x_1 + 88{,}105x_2 + 89{,}036x_3 + 89{,}036x_4 + 63{,}221x_5 + 91{,}594x_6 + 89{,}036x_7 + 89{,}915x_8 + 100{,}000x_9 + 61{,}035x_{10} + 89{,}036x_{11} + 41{,}703x_{12} + 89{,}036x_{13} + 98{,}401x_{14} + 98{,}401x_{15} + 50{,}000x_{16} + 98{,}401x_{17} + 89{,}036x_{18} + 98{,}401x_{19} + 89{,}036x_{20} + 98{,}401x_{21} + 42{,}305x_{22} + 89{,}036x_{23} + 42{,}305x_{24} + 42{,}000x_{25} + 42{,}305x_{26} + 98{,}500x_{27} + 81{,}265x_{28} + 98{,}401x_{29} + 240{,}020x_{30} + 81{,}265x_{31} + 49{,}999x_{32} + 47{,}825x_{33} + 61{,}243x_{34} + 81{,}265x_{35} + 98{,}401x_{36} + 81{,}265x_{37} + 60{,}179x_{38} + 81{,}265x_{39} + 100{,}000x_{40} + 49{,}788x_{41} + 81{,}265x_{42} + 98{,}401x_{43} + 51{,}975x_{44} + 55{,}913x_{45} + 99{,}999x_{46} + 50{,}838x_{47} + 81{,}265x_{48} + 98{,}401x_{49} + 81{,}265x_{50} + 79{,}999x_{51} + 100{,}000x_{52} + 98{,}401x_{53} + 98{,}401x_{54} + 98{,}401x_{55} + 83{,}328x_{56} + 41{,}703x_{57} + 98{,}401x_{58} + 81{,}265x_{59} + 98{,}401x_{60} + 98{,}401x_{61} + 46{,}501x_{62} + 98{,}401x_{63} + 98{,}401x_{64} + 59{,}999x_{65} + 49{,}999x_{66} + 50{,}000x_{67} + 98{,}401x_{68} + 47{,}825x_{69} + 98{,}401x_{70} + 47{,}825x_{71} + 42{,}305x_{72} + 65{,}825x_{73} + 98{,}401x_{74} + 59{,}870x_{75} + 47{,}825x_{76} + 42{,}825x_{77} + 98{,}401x_{78} + 88{,}105x_{79}$$

$+72{,}116x_{80} + 66{,}793x_{81} + 45{,}770x_{82} + 45{,}770x_{83} + 66{,}793x_{84} + 98{,}401x_{85}$
$+100{,}000x_{86} + 45{,}770x_{87} + 98{,}401x_{88} + 98{,}401x_{89} + 72{,}106x_{90} + 72{,}106x_{91}$
$+66{,}793x_{92} + 45{,}770x_{93} + 98{,}401x_{94} + 53{,}010x_{95} + 22{,}246x_{96} + 98{,}401x_{97}$
$+72{,}677x_{98} + 72{,}877x_{99} + 39{,}663x_{100} + 72{,}533x_{101} + 66{,}793x_{102} + 98{,}401x_{103}$
$+120{,}000x_{104} + 88{,}401x_{105} + 34{,}337x_{106} + 98{,}401x_{107} + 45{,}770x_{108} + 98{,}401x_{109}$
$+23{,}163x_{110} + 18{,}416x_{111} + 27{,}733x_{112} + 72{,}333x_{113} + 28{,}867x_{114} + 98{,}401x_{115}$
$+100{,}000x_{116} + 100{,}000x_{117} + 23{,}424x_{118} + 98{,}401x_{119} + 45{,}000x_{120} + 45{,}000x_{121}$
$+85{,}000x_{122} + 55{,}000x_{123} + 65{,}000x_{124} + 75{,}000x_{125} + 98{,}401x_{126} + d5^{-}$

Road projects

$d6^{+} = 86{,}303{,}594 + 108{,}490x_1 + 108{,}490x_2 + 112{,}151x_3 + 237{,}317x_4 + 237{,}317x_5 + 240{,}020x_6$
$+237{,}317x_7 + 158{,}003x_8 + 249{,}557x_9 + 113{,}694x_{10} + 193{,}294x_{11} + 113{,}694x_{12}$
$+238{,}522x_{13} + 100{,}000x_{14} + 237{,}317x_{15} + 149{,}860x_{16} + 234{,}470x_{17} + 99{,}865x_{18}$
$+49{,}855x_{19} + 249{,}560x_{20} + 240{,}020x_{21} + 236{,}371x_{22} + 399{,}500x_{23} + 237{,}249x_{24}$
$+75{,}572x_{25} + 75{,}000x_{26} + 192{,}070x_{27} + 99{,}633x_{28} + 86{,}096x_{29} + 1{,}304{,}259x_{30}$
$+53{,}258x_{31} + 199{,}500x_{32} + 249{,}500x_{33} + 149{,}860x_{34} + 149{,}500x_{35} + 244{,}002x_{36}$
$+241{,}193x_{37} + 99{,}633x_{38} + 99{,}633x_{39} + 113{,}694x_{40} + 1{,}044{,}039x_{41} + 112{,}635x_{42}$
$+214{,}967x_{43} + 249{,}875x_{44} + 232{,}903x_{45} + 99{,}663x_{46} + 200{,}809x_{47} + 163{,}310x_{48}$
$+240{,}000x_{49} + 184{,}506x_{50} + 247{,}370x_{51} + 399{,}500x_{52} + 238{,}262x_{53} + 149{,}718x_{54}$
$+179{,}480x_{55} + 155{,}822x_{56} + 298{,}456x_{57} + 209{,}713x_{58} + 113{,}694x_{59} + 122{,}610x_{60}$
$+249{,}500x_{61} + 96{,}463x_{62} + 19{,}409{,}143x_{63} + 79{,}435x_{64} + 200{,}000x_{65} + 72{,}000x_{66}$
$+249{,}500x_{67} + 239{,}171x_{68} + 150{,}00x_{69} + 6{,}136{,}367x_{70} + 587{,}793x_{71} + 94{,}527x_{72}$
$+99{,}500x_{73} + 148{,}486x_{74} + 434{,}000x_{75} + 221{,}584x_{76} + 189{,}215x_{77} + 66{,}689x_{78}$
$+164{,}903x_{79} + 114{,}474x_{80} + 249{,}500x_{81} + 1{,}692{,}712x_{82} + 156{,}439x_{83} + 199{,}500x_{84}$
$+99{,}633x_{85} + 236{,}371x_{86} + 195{,}230x_{87} + 489{,}080x_{88} + 237{,}317x_{89} + 180{,}000x_{90}$
$+102{,}000x_{91} + 248{,}000x_{92} + 480{,}650x_{93} + 149{,}860x_{94} + 719{,}430x_{95} + 249{,}50x_{96}$
$+239{,}720x_{97} + 249{,}500x_{98} + 249{,}500x_{99} + 249{,}500x_{100} + 249{,}500x_{101} + 249{,}500x_{102}$
$+965{,}080x_{103} + 249{,}500x_{104} + 239{,}750x_{105} + 249{,}500x_{106} + 249{,}500x_{107}$
$+237{,}317x_{108} + 230{,}000x_{109} + 230{,}000x_{110} + 230{,}000x_{111} + 230{,}00x_{112}$
$+230{,}000x_{113} + 230{,}000x_{114} + 230{,}000x_{115} + 239{,}500x_{116} + 399{,}500x_{117}$
$+237{,}317x_{118} + 237{,}317x_{119} + 244{,}630x_{120} + 237{,}317x_{121} + 248{,}900x_{122}$
$+248{,}900x_{123} + 89{,}564x_{124} + 467{,}848x_{125} + 319{,}916x_{126} + 465{,}340x_{127} + 81{,}435x_{128}$
$+144{,}855x_{129} + 506{,}541x_{130} + 415{,}263x_{131} + 258{,}070x_{132} + 246{,}921x_{133}$
$+648{,}620x_{134} + 346{,}316x_{135} + 336{,}320x_{136} + 317{,}957x_{137} + 346{,}316x_{138}$
$+494{,}935x_{139} + 402{,}609x_{140} + 232{,}647x_{141} + 307{,}657x_{142} + 96{,}610x_{143}$
$+465{,}340x_{144} + 205{,}187x_{145} + 200{,}917x_{146} + 205{,}917x_{147} + 115{,}917x_{148}$
$+88{,}921x_{149} + 205{,}917x_{150} + 441{,}424x_{151} + 369{,}498x_{152} + 205{,}917x_{153}$
$+505{,}900x_{154} + 605{,}917x_{155} + 487{,}282x_{156} + 586{,}131x_{157} + 405{,}917x_{158}$
$+737{,}185x_{159} + 735{,}736x_{160} + 459{,}581x_{161} + 45{,}000x_{162} + 628{,}654x_{163}$
$+426{,}896x_{164} + 426{,}896x_{165} + 442{,}504x_{166} + 343{,}729x_{167} + 343{,}729x_{168}$
$+439{,}383x_{169} + 439{,}383x_{170} + 657{,}256x_{171} + 657{,}256x_{172} + 439{,}383x_{173}$
$+657{,}256x_{174} + 343{,}729x_{175} + 657{,}256x_{176} + 670{,}274x_{177} + 455{,}247x_{178}$
$+363{,}568x_{179} + 242{,}681x_{180} + 732{,}880x_{181} + 733{,}870x_{182} + 733{,}128x_{183}$
$+733{,}400x_{184} + 732{,}578x_{185} + 736{,}750x_{186} + 729{,}445x_{187} + 450{,}737x_{188}$
$+457{,}022x_{189} + 478{,}814x_{190} + 445{,}626x_{191} + 445{,}626x_{192} + 445{,}626x_{193}$
$+ 440{,}883x_{194} + 803{,}879x_{195} + 440{,}883x_{196} + 440{,}883x_{197} + d6^{-}$

Electrification projects

$d_7^+ = 16{,}955{,}636 + 100{,}000x_1 + 199{,}724x_2 + 149{,}900x_3 + 170{,}000x_4 + 199{,}963x_5 + 150{,}000x_6 + 100{,}000x_7 + 200{,}000x_8 + 100{,}000x_9 + 119{,}974x_{10} + 24{,}357x_{11} + 9{,}000x_{12} + 10{,}804x_{13} + 9{,}000x_{14} + 4{,}500x_{15} + 4{,}500x_{16} + 4{,}500x_{17} + 4{,}500x_{18} + 4{,}500x_{19} + 4{,}500x_{20} + 4{,}500x_{21} + 43{,}879x_{22} + 4{,}500x_{23} + 4{,}500\ x_{24} + 4{,}500\ x_{25} + 4{,}500x_{26} + 4{,}500x_{27} + 150{,}000x_{28} + 10{,}380x_{29} + 4{,}500x_{30} + 11{,}160x_{31} + 4{,}500x_{32} + 4{,}500x_{33} + 15{,}383x_{34} + 4{,}500x_{35} + 4{,}500x_{36} + 99{,}737x_{37} + 4{,}500x_{38} + 4{,}500x_{39} + 200{,}225x_{40} + 199{,}863x_{41} + 56{,}806x_{42} + 4{,}500x_{43} + 69{,}979x_{44} + 4{,}500x_{45} + 4{,}500x_{46} + 39{,}995x_{47} + 99{,}845x_{48} + 99{,}899x_{49} + 119{,}974x_{50} + 249{,}999x_{51} + 249{,}999x_{52} + 4{,}500x_{53} + 4{,}500x_{54} + 32{,}155x_{55} + 4{,}500x_{56} + 4{,}500x_{57} + 39{,}998x_{58} + 4{,}500x_{59} + 4{,}500x_{60} + 150{,}000x_{61} + 4{,}500x_{62} + 34{,}711x_{63} + 9{,}143x_{64} + 45{,}928x_{65} + 4{,}500x_{66} + 79{,}899x_{67} + 99{,}412x_{68} + 39{,}994x_{69} + 13{,}991x_{70} + 4{,}500x_{71} + 4{,}500x_{72} + 4{,}500x_{73} + 4{,}500x_{74} + 100{,}000x_{75} + 4{,}500x_{76} + 4500x_{77} + 100{,}000x_{78} + 4{,}500x_{79} + 80{,}000x_{80} + 12{,}980x_{81} + 18{,}628x_{82} + 64{,}455x_{83} + 39{,}999x_{84} + 13{,}991x_{85} + 4{,}500x_{86} + 70{,}064x_{87} + 4{,}500x_{88} + 99{,}899x_{89} + 100{,}000x_{90} + 106{,}759x_{91} + 121{,}442x_{92} + 4{,}500x_{93} + 4{,}500x_{94} + 4{,}500x_{95} + 17{,}957x_{96} + 200{,}000x_{97} + 4{,}500x_{98} + 4{,}500x_{99} + 4{,}500x_{100} + 4{,}500x_{101} + 99{,}899x_{102} + 4{,}500x_{103} + 4{,}500x_{105} + 150{,}000x_{106} + 4{,}500x_{107} + 247{,}675x_{108} + 49{,}199x_{109} + 4{,}500x_{110} + 4{,}500x_{111} + 4{,}500x_{112} + 4{,}500x_{113} + 4{,}500x_{114} + 200{,}00x_{115} + 4.500x_{116} + 4{,}500x_{117} + 46{,}789x_{118} + 121{,}442x_{119} + 24{,}994x_{120} + 4{,}500x_{121} + 4{,}500x_{122} + 120{,}000x_{123} + 4{,}500x_{124} + 100{,}000x_{125} + 4{,}500x_{126} + 9{,}000x_{127} + 13{,}500x_{128} + 4{,}500x_{129} + 99{,}899x_{130} + 4{,}500x_{131} + 4{,}500x_{132} + 4{,}500x_{133} + 4{,}500x_{135} + 4{,}500x_{136} + 4{,}500x_{137} + 4{,}500x_{138} + 4{,}500x_{139} + 4{,}500x_{140} + 4{,}500x_{141} + 4{,}500x_{142} + 150{,}000x_{143} + 4{,}500x_{144} + 247{,}675x_{145} + 49{,}199x_{146} + 4{,}500x_{147} + 4{,}500x_{147} + 4{,}500x_{148} + 4{,}500x_{149} + 4{,}500x_{150} + 4{,}500x_{151} + 200{,}000x_{152} + 4{,}500x_{153} + 4{,}500x_{154} + 46{,}789x_{155} + 121{,}442x_{156} + 24{,}994x_{157} + 4{,}500x_{158} + 4{,}500x_{159} + 120{,}000x_{160} + 4{,}500x_{161} + 100{,}000x_{162} + 4{,}500x_{163} + 4{,}500x_{164} + 13{,}500x_{165} + 4{,}500x_{166} + 4{,}500x_{167} + 4{,}500x_{168} + 4{,}500x_{169} + 4{,}500x_{170} + 4{,}500x_{171} + 4{,}500x_{172} + 4{,}500x_{173} + 199{,}999x_{174} + 95{,}684x_{175} + 4{,}500x_{176} + 4{,}500x_{177} + 6{,}073379x_{178} + 249{,}975x_{179} + 570{,}601x_{180} + 4{,}500x_{181} + 4{,}500x_{182} + 4{,}500x_{183} + 4{,}500x_{184} + 12{,}735x_{185} + 4{,}500x_{186} + 4{,}500x_{187} + 4{,}500x_{188} + 4{,}500x_{189} + 4{,}500x_{190} + 40{,}501x_{191} + 20{,}046x_{192} + 16{,}777x_{193} + 4{,}500x_{194} + 4{,}500x_{195} + 4{,}500x_{196} + 4{,}500x_{197} + 4{,}500x_{198} + 4{,}500x_{199} + 4{,}500x_{200} + 4{,}500x_{201} + 4{,}500x_{202} + 4{,}500x_{203} + 4{,}500x_{204} + 4{,}500x_{205} + 4{,}500x_{206} + 4{,}500x_{207} + 4{,}500x_{208} + 4{,}500x_{209} + 4{,}500x_{210} + 4{,}500x_{211} + 4{,}500x_{212} + 4{,}500x_{213} + 4{,}500x_{214} + 4{,}500x_{215} + 80{,}000x_{216} + 80{,}000x_{217} + 4{,}500x_{218} + 4{,}500x_{219} + 4{,}500x_{220} + 4{,}500x_{221} + 52{,}542x_{222} + 249{,}999x_{223} + 4{,}500x_{224} + 4{,}500x_{225} + 199{,}863x_{226} + 4{,}500x_{227} + 4{,}500x_{228} + 4{,}500x_{229} + 4{,}500x_{230} + 99{,}690x_{231} + 199{,}780x_{232} + 249{,}896x_{233} + 249{,}895x_{234} + d_7^-$

Water Jetty projects

$$d8^+ = 21{,}465{,}623 + 174{,}394x_1 + 150{,}000x_2 + 225{,}000x_3 + 229{,}050x_4 + 53{,}766x_5 + 216{,}500x_6 + 82{,}830x_7$$
$$+82{,}830x_8 + 82{,}830x_9 + 198{,}810x_{10} + 200{,}000x_{11} + 200{,}000x_{12} + 39{,}680x_{13}$$
$$+117{,}913x_{14} + 214{,}372x_{15} + 214{,}372x_{16} + 226{,}257x_{17} + 216{,}257x_{18} + 214{,}372x_{19}$$
$$+214{,}372x_{20} + 226{,}257x_{21} + 226{,}257x_{22} + 226{,}041x_{23} + 224{,}156x_{24} + 216{,}041x_{25}$$
$$+217{,}083x_{26} + +226{,}257x_{27} + 226{,}537x_{28} + 226{,}257x_{29} + 218{,}230x_{30} + 218{,}108x_{31}$$
$$+227{,}125x_{32} + 226{,}340x_{33} + 226{,}340x_{34} + 218{,}324x_{35} + 214{,}987x_{36} + 226{,}340x_{37}$$

$$+227{,}688x_{38} + 227{,}477x_{39} + 226{,}936x_{40} + 227{,}135x_{41} + 226{,}257x_{42} + 226{,}257x_{43}$$
$$+226{,}041x_{44} + 226{,}257x_{45} + 212{,}683x_{46} + 213{,}098x_{47} + 229{,}391x_{48} + 227{,}911x_{49}$$
$$+227{,}082x_{50} + 229{,}272x_{51} + 228{,}526x_{52} + 228{,}526x_{53} + 229{,}193x_{54} + 228{,}893x_{55}$$
$$+224{,}144x_{56} + 214{,}741x_{57} + 214{,}570x_{58} + 218{,}324x_{59} + 217{,}298x_{60} + 215{,}513x_{61}$$
$$+ 219{,}279x_{62} + 210{,}084x_{63} + 214{,}703x_{64} + 212{,}288x_{65} + 225{,}184x_{66}$$
$$+ 226{,}257x_{67} + 227{,}683x_{68} + 212{,}893x_{69} + 214{,}446x_{70} + 227{,}233x_{71}$$
$$+224{,}245x_{72} + 213{,}735x_{73} + 214{,}123x_{74} + 226{,}128x_{75} + 214{,}672x_{76} + 216{,}281x_{77}$$
$$+217{,}789x_{78} + 215{,}092x_{79} + 218{,}320x_{80} + 226{,}281x_{81} + 228{,}281x_{82} + 217{,}186x_{83}$$
$$+217{,}484x_{84} + 215{,}908x_{85} + 213{,}308x_{86} + 224{,}636x_{87} + 215{,}283x_{88} + 227{,}323x_{89}$$
$$+215{,}108x_{90} + 217{,}300x_{91} + 214{,}644x_{92} + 214{,}649x_{93} + 215{,}920x_{94} + 217{,}247x_{95}$$
$$+215{,}302x_{96} + 218{,}925x_{97} + 217{,}660x_{98} + 216{,}939x_{99} + 214{,}741x_{100} + 217{,}913x_{101}$$
$$+ 214{,}372x_{102} + d8^{-}$$

4.2.5.4 Priority 3: Maximize the number of jobs created for selected projects.

[Minimize $d_9^- + d_{10}^- + d_{11}^- + d_{12}^-$]

Solar-powered water projects

$$d_9^+ = 10962 + 87x_1 + 87x_2 + 87x_3 + 87x_4 + 87x_5 + 87x_6 + 87x_7 + 87x_8 + 87x_9$$
$$+ 87x_{10}$$
$$+87x_{11} + 87x_{12} + 87x_{13} + 87x_{14} + 87x_{15} + 87x_{16} + 87x_{17} + 87x_{18} + 87x_{19}$$
$$+87x_{20} + 87x_{21} + 87x_{22} + 87x_{23} + 87x_{24} + 87x_{25} + 87x_{26} + 87x_{27}$$
$$+87x_{28} + 87x_{29} + 87x_{30} + 87x_{31} + 87x_{32} + 87x_{33} + 87x_{34} + 87x_{35}$$
$$+87x_{36} + 87x_{37} + 87x_{38} + 87x_{39} + 87x_{40} + 87x_{41} + 87x_{42} + 87x_{43}$$
$$+87x_{44} + 87x_{45} + 87x_{46} + 87x_{47} + 87x_{48} + 87x_{49} + 87x_{50} + 87x_{51}$$
$$+87x_{52} + 87x_{53} + 87x_{54} + 87x_{55} + 87x_{56} + 87x_{57} + 87x_{58} + 87x_{59}$$
$$+87x_{60} + 87x_{61} + 87x_{62} + 87x_{63} + 87x_{64} + 87x_{65} + 87x_{66} + 87x_{67}$$
$$+87x_{68} + 87x_{68} + 87x_{70} + 87x_{71} + 87x_{72} + 87x_{73} + 87x_{74} + 87x_{75}$$
$$+87x_{76} + 87x_{77} + 87x_{78} + 87x_{79} + 87x_{80} + 87x_{81} + 87x_{82} + 87x_{83}$$
$$+87x_{84} + 87x_{85} + 87x_{86} + 87x_{87} + 87x_{88} + 87x_{89} + 87x_{90} + 87x_{91}$$
$$+87x_{92} + 87x_{93} + 87x_{94} + 87x_{95} + 87x_{96} + 87x_{97} + 87x_{98} + 87x_{99}$$
$$+87x_{100} + 87x_{101} + 87x_{102} + 87x_{103} + 87x_{104} + 87x_{105} + 87x_{106} + 87x_{107}$$
$$+87x_{108} + 87x_{109} + 87x_{110} + 87x_{111} + 87x_{112} + 87x_{113} + 87x_{114} + 87x_{115}$$
$$+87x_{116} + 87x_{117} + 87x_{118} + 87x_{119} + 87x_{120} + 87x_{121} + 87x_{122} + 87x_{123}$$
$$+87x_{124} + 87x_{125} + 87x_{126} + d_9^-$$

Road projects

$$d_{10}^+ = 9850 + 50x_1 + 50x_2 + 50x_3 + 50x_4 + 50x_5 + 50x_6 + 50x_7 + 50x_8 + 50x_9$$
$$+ 50x_{10} + 50x_{11}$$
$$+50x_{12} + 50x_{13} + 50x_{14} + 50x_{15} + 50x_{16} + 50x_{17} + 50x_{18} + 50x_{19} + 50x_{20} + 50x_{21}$$
$$+50x_{22} + 50x_{23} + 50x_{24} + 50x_{25} + 50x_{26} + 50x_{27} + 50x_{28} + 50x_{29} + 50x_{30} + 50x_{31}$$
$$+50x_{32} + 50x_{33} + 50x_{34} + 50x_{35} + 50x_{36} + 50x_{37} + 50x_{38} + 50x_{39} + 50x_{40} + 50x_{41}$$
$$+50x_{42} + 50x_{43} + 50x_{44} + 50x_{45} + 50x_{46} + 50x_{47} + 50x_{48} + 50x_{49} + 50x_{50} + 50x_{51}$$
$$+50x_{52} + 50x_{53} + 50x_{54} + 50x_{55} + 50x_{56} + 50x_{57} + 50x_{58} + 50x_{59} + 50x_{60} + 50x_{61}$$
$$+50x_{62} + 50x_{63} + 50x_{64} + 50x_{65} + 50x_{66} + 50x_{67} + 50x_{68} + 50x_{68} + 50x_{70} + 50x_{71}$$
$$+50x_{72} + 50x_{73} + 50x_{74} + 50x_{75} + 50x_{76} + 50x_{77} + 50x_{78} + 50x_{79} + 50x_{80} + 50x_{81}$$
$$+50x_{82} + 50x_{83} + 50x_{84} + 50x_{85} + 50x_{86} + 50x_{87} + 50x_{88} + 50x_{89} + 50x_{90} + 50x_{91}$$

$$+50x_{92} + 50x_{93} + 50x_{94} + 50x_{95} + 50x_{96} + 50x_{97} + 50x_{98} + 50x_{99} + 50x_{100} + 50x_{101}$$
$$+50x_{102} + 50x_{103} + 50x_{104} + 50x_{105} + 50x_{106} + 50x_{107} + 50x_{108} + 50x_{109} + 50x_{110}$$
$$+50x_{111} + 50x_{112} + 50x_{113} + 50x_{114} + 50x_{115} + 50x_{116} + 50x_{117} + 50x_{118} + 50x_{119}$$
$$+50x_{120} + 50x_{121} + 50x_{122} + 50x_{123} + 50x_{124} + 50x_{125} + 50x_{126} + 50x_{127} + 50x_{128}$$
$$+50x_{129} + 50x_{130} + 50x_{131} + 50x_{132} + 50x_{133} + 50x_{134} + 50x_{135} + 50x_{136} + 50x_{137}$$
$$+50x_{138} + 50x_{139} + 50x_{140} + 50x_{141} + 50x_{142} + 50x_{143} + 50x_{144} + 50x_{145} + 50x_{146}$$
$$+50x_{147} + 50x_{148} + 50x_{149} + 50x_{150} + 50x_{151} + 50x_{152} + 50x_{153} + 50x_{154} + 50x_{155}$$
$$+50x_{156} + 50x_{157} + 50x_{158} + 50x_{159} + 50x_{160} + 50x_{161} + 50x_{162} + 50x_{163} + 50x_{164}$$
$$+50x_{165} + 50x_{166} + 50x_{167} + 50x_{168} + 50x_{169} + 50x_{170} + 50x_{171} + 50x_{172} + 50x_{173}$$
$$+50x_{174} + 50x_{175} + 50x_{176} + 50x_{177} + 50x_{178} + 50x_{179} + 50x_{180} + 50x_{181} + 50x_{182}$$
$$+50x_{183} + 50x_{184} + 50x_{185} + 50x_{186} + 50x_{187} + 50x_{188} + 50x_{189} + 50x_{190}$$
$$+50x_{191} + 50x_{192} + 50x_{193} + 50x_{194} + 50x_{195} + 50x_{196} + 50x_{197} + d_{10}^{-}$$

Electrification projects

$d_{11}^{+} = 11{,}700 +50x_1 + 50x_2 +50x_3 + 50x_4 + 50x_5 + 50x_6 + 50x_7 + 50x_8 + 50x_9 +$
$50x_{10} + 50x_{11} + 50x_{12} + 50x_{13} + 50x_{14} + 50x_{15} + 50x_{16} + 50x_{17} + 50x_{18} + 50x_{19} +$
$50x_{20} + 50x_{21} + 50x_{22} + 50x_{23} + 50x_{24} +50x_{25} + 50x_{26} + 50x_{27} + 50x_{28} + 50x_{29} +$
$50x_{30} + 50x_{31} + 50x_{32} + 50x_{33} + 50x_{34} + 50x_{35} + 50x_{36} + 50x_{37} + 50x_{38} + 50x_{39} +$
$50x_{40} + 50x_{41} + 50x_{42} + 50x_{43} + 50x_{44} + 50x_{45} + 50x_{46} + 50x_{47} + 50x_{48} + 50x_{49} +$
$50x_{50} + 50x_{51} + 50x_{52} + 50x_{53} + 50x_{54} + 50x_{55} + 50x_{56} + 50x_{57} + 50x_{58} + 50x_{59} +$
$50x_{60} + 50x_{61} + 50x_{62} + 50x_{63} + 50x_{64} + 50x_{65} + 50x_{66} + 50x_{67} + 50x_{68} + 50x_{69} +$
$50x_{70} + 50x_{71} + 50x_{72} + 50x_{73} + 50x_{74} + 50x_{75} + 50x_{76} + 50x_{77} + 50x_{78} + 50x_{79} +$
$50x_{80} + 50x_{81} + 50x_{82} + 50x_{83} + 50x_{84} + 50x_{85} + 50x_{86} + 50x_{87} + 50x_{88} + 50x_{89} +$
$50x_{90} + 50x_{91} + 50x_{92} + 50x_{93} + 50x_{94} + 50x_{95} + 50x_{96} + 50x_{97} + 50x_{98} + 50x_{99} +$
$50x_{100} + 50x_{101} + 50x_{102} + 50x_{103} + 50x_{104} + 50x_{105} + 50x_{106} + 50x_{107} + 50x_{108} +$
$50x_{109} + 50x_{110} + 50x_{111} + 50x_{112} + 50x_{113} + 50x_{114} + 50x_{115} + 50x_{116} + 50x_{117} +$
$50x_{118} + 50x_{119} + 50x_{120} + 50x_{121} + 50x_{122} + 50x_{123} + 50x_{124} + 50x_{125} + 50x_{126} +$
$50x_{127} + 50x_{128} + 50x_{129} + 50x_{130} + 50x_{131} + 50x_{132} + 50x_{133} + 50x_{134} + 50x_{135} +$
$50x_{136} + 50x_{137} + 50x_{138} + 50x_{139} + 50x_{140} + 50x_{141} + 50x_{142} + 50x_{143} +50x_{144} +$
$50x_{145} + 50x_{146} + 50x_{147} + 50x_{148} + 50x_{149} + 50x_{150} + 50x_{151} + 50x_{152} + 50x_{153} +$
$50x_{154} + 50x_{155} + 50x_{156} + 50x_{157} + 50x_{158} + 50x_{159} + 50x_{160} + 50x_{161} + 50x_{162} +$
$50x_{163} + 50x_{164} + 50x_{165} + 50x_{166} + 50x_{167} + 50x_{168} + 50x_{169} + 50x_{170} + 50x_{171} +$
$50x_{172} + 50x_{173} + 50x_{`74} + 50x_{175} +50x_{176} + 50x_{177} + 50x_{178} + 50x_{179} + 50x_{180} +$
$50x_{180} + 50x_{181} + 50x_{182} + 50x_{183} + 50x_{184} + 50x_{185} +50x_{186} + 50x_{187} + 50x_{188} +$
$50x_{189} + 50x_{190} + 50x_{191} + 50x_{192} + 50x_{193} + 50x_{194} + 50x_{195} + 50x_{196} + 50x_{197} +$
$50x_{198} + 50x_{199} + 50x_{200} + 50x_{201} + 50x_{202} + 50x_{203} + 50x_{204} + 50x_{205} + 50x_{206} +$
$50x_{207} + 50x_{208} + 50x_{209} + 50x_{210} + 50x_{211} + 50x_{212} + 50x_{213} + 50x_{214} + 50x_{215} +$
$50x_{216} + 50x_{217} + 50x_{218} + 50x_{219} + 50x_{220} + 50x_{221} + 50x_{222}+50x_{223} +50x_{224} +$
$50x_{225} + 50x_{226} + 50x_{227} + 50x_{228} + 50x_{229} + 50x_{230} + 50x_{231} + 50x_{232} + 50x_{233} +$
$50x_{234} + d_{11}^{-}$

Water Jetty projects

$$d_{12}^{+} = 5{,}100 + 87x_1 + 87x_2 + 87x_3 + 87x_4 + 87x_5 + 87x_6 + 87x_7 + 87x_8 + 87x_9 + 87x_{10} + 87x_{11}$$
$$+87x_{12} + 87x_{13} + 87x_{14} + 87x_{15} + 87x_{16} + 87x_{17} + 87x_{18} + 87x_{19} + 87x_{20} + 87x_{21}$$
$$+87x_{22} + 87x_{23} + 87x_{24} + 87x_{25} + 87x_{26} + 87x_{27} + 87x_{28} + 87x_{29} + 87x_{30} + 87x_{31}$$
$$+87x_{32} + 87x_{33} + 87x_{34} + 87x_{35} + 87x_{36} + 87x_{37} + 87x_{38} + 87x_{39} + 87x_{40} + 87x_{41}$$
$$+87x_{42} + 87x_{43} + 87x_{44} + 87x_{45} + 87x_{46} + 87x_{47} + 87x_{48} + 87x_{49} + 87x_{50} + 87x_{51}$$
$$+87x_{52} + 87x_{53} + 87x_{54} + 87x_{55} + 87x_{56} + 87x_{57} + 87x_{58} + 87x_{59} + 87x_{60} + 87x_{61}$$

$$+87x_{62} + 87x_{63} + 87x_{64} + 87x_{65} + 87x_{66} + 87x_{67} + 87x_{68} + 87x_{69} + 87x_{70} + 87x_{71}$$
$$+87x_{72} + 87x_{73} + 87x_{74} + 87x_{75} + 87x_{76} + 87x_{77} + 87x_{78} + 87x_{79} + 87x_{80} + 87x_{81}$$
$$+87x_{82} + 87x_{83} + 87x_{84} + 87x_{85} + 87x_{86} + 87x_{87} + 87x_{88} + 87x_{89} + 87x_{90} + 87x_{91}$$
$$+87x_{92} + 87x_{93} + 87x_{94} + 87x_{95} + 87x_{96} + 87x_{97} + 87x_{98} + 87x_{99} + 87x_{100} + 87x_{101}$$
$$+87x_{102} + d_{12}^{-}$$

4.2.5.5 Priority 4: Minimize duration for selected projects (months).

[Minimize $d_{13}^{+} + d_{14}^{+} + d_{15}^{+} + d_{16}^{+}$]

Solar-powered water projects

$$d_{13}^{-} = 1{,}890 + 15x_1 + 15x_2 + 15x_3 + 15x_4 + 15x_5 + 15x_6 + 15x_7 + 15x_8 + 15x_9 + 15x_{10} + 15x_{11} + 15x_{12}$$
$$+15x_{13} + 15x_{14} + 15x_{15} + 15x_{16} + 15x_{17} + 15x_{18} + 15x_{19} + 15x_{20} + 15x_{21} + 15x_{22} + 15x_{23}$$
$$+15x_{24} + 15x_{25} + 15x_{26} + 15x_{27} + 15x_{28} + 15x_{29} + 15x_{30} + 15x_{31} + 15x_{32} + 15x_{33} + 15x_{34}$$
$$+15x_{35} + 15x_{36} + 15x_{37} + 15x_{38} + 15x_{39} + 15x_{40} + 15x_{41} + 15x_{42} + 15x_{43} + 15x_{44} + 15x_{45}$$
$$+15x_{46} + 15x_{47} + 15x_{48} + 15x_{49} + 15x_{50} + 15x_{51} + 15x_{52} + 15x_{53} + 15x_{54} + 15x_{55} + 15x_{56}$$
$$+15x_{57} + 15x_{58} + 15x_{59} + 15x_{60} + 15x_{61} + 15x_{62} + 15x_{63} + 15x_{64} + 15x_{65} + 15x_{66} + 15x_{67}$$
$$+15x_{68} + 15x_{68} + 15x_{70} + 15x_{71} + 15x_{72} + 15x_{73} + 15x_{74} + 15x_{75} + 15x_{76} + 15x_{77} + 15x_{78}$$
$$+15x_{79} + 15x_{80} + 15x_{81} + 15x_{82} + 15x_{83} + 15x_{84} + 15x_{85} + 15x_{86} + 15x_{87} + 15x_{88} + 15x_{89}$$
$$+15x_{90} + 15x_{91} + 15x_{92} + 15x_{93} + 15x_{94} + 15x_{95} + 15x_{96} + 15x_{97} + 15x_{98} + 15x_{99} + 15x_{100}$$
$$+15x_{101} + 15x_{102} + 15x_{103} + 15x_{104} + 15x_{105} + 15x_{106} + 15x_{107} + 15x_{108} + 15x_{109} + 15x_{110}$$
$$+15x_{111} + 15x_{112} + 15x_{113} + 15x_{114} + 15x_{115} + 15x_{116} + 15x_{117} + 15x_{118} + 15x_{119} + 15x_{120}$$
$$+15x_{121} + 15x_{122} + 15x_{123} + 15x_{124} + 15x_{125} + 15x_{126} + d_{13}^{+}$$

Road projects

$$d_{14}^{-} = 37{,}329 + 18x_1 + 18x_2 + 18x_3 + 18x_4 + 18x_5 + 18x_6 + 18x_7 + 18x_8 + 18x_9 + 18x_{10} + 18x_{11}$$
$$+18x_{12} + 18x_{13} + 18x_{14} + 18x_{15} + 18x_{16} + 18x_{17} + 18x_{18} + 18x_{19} + 12x_{20} + 18x_{21}$$
$$+18x_{22} + 18x_{23} + 18x_{24} + 12x_{25} + 12x_{26} + 12x_{27} + 18x_{28} + 18x_{29} + 12x_{30} + 12x_{31}$$
$$+12x_{32} + 12x_{33} + 18x_{34} + 18x_{35} + 18x_{36} + 18x_{37} + 18x_{38} + 18x_{39} + 18x_{40} + 18x_{41}$$
$$+18x_{42} + 18x_{43} + 18x_{44} + 18x_{45} + 18x_{46} + 18x_{47} + 18x_{48} + 18x_{49} + 18x_{50} + 18x_{51}$$
$$+18x_{52} + 18x_{53} + 18x_{54} + 18x_{55} + 18x_{56} + 18x_{57} + 18x_{58} + 18x_{59} + 18x_{60} + 18x_{61}$$
$$+18x_{62} + 18x_{63} + 18x_{64} + 18x_{65} + 18x_{66} + 18x_{67} + 18x_{68} + 18x_{68} + 18x_{70} + 18x_{71}$$
$$+18x_{72} + 18x_{73} + 18x_{74} + 18x_{75} + 18x_{76} + 18x_{77} + 18x_{78} + 18x_{79} + 18x_{80} + 18x_{81}$$
$$+18x_{82} + 18x_{83} + 18x_{84} + 18x_{85} + 18x_{86} + 18x_{87} + 18x_{88} + 18x_{89} + 18x_{90} + 18x_{91}$$

$+18x_{92} + 18x_{93} + 18x_{94} + 18x_{95} + 18x_{96} + 18x_{97} + 18x_{98} + 18x_{99} + 18x_{100} + 18x_{101}$
$+18x_{102} + 18x_{103} + 18x_{104} + 18x_{105} + 18x_{106} + 18x_{107} + 18x_{108} + 18x_{109} + 18x_{110}$
$+18x_{111} + 18x_{112} + 18x_{113} + 18x_{114} + 18x_{115} + 18x_{116} + 18x_{117} + 18x_{118} + 18x_{119}$
$+18x_{120} + 18x_{121} + 18x_{122} + 18x_{123} + 18x_{124} + 18x_{125} + 18x_{126} + 18x_{127} + 18x_{128}$
$+18x_{129} + 18x_{130} + 18x_{131} + 18x_{132} + 18x_{133} + 18x_{134} + 18x_{135} + 18x_{136} + 18x_{137}$
$+18x_{138} + 18x_{139} + 18x_{140} + 18x_{141} + 18x_{142} + 18x_{143} + 18x_{144} + 18x_{145} + 18x_{146}$
$+18x_{147} + 18x_{148} + 18x_{149} + 18x_{150} + 18x_{151} + 18x_{152} + 18x_{153} + 18x_{154} + 18x_{155}$
$+18x_{156} + 18x_{157} + 18x_{158} + 18x_{159} + 18x_{160} + 18x_{161} + 18x_{162} + 18x_{163} + 18x_{164}$
$+18x_{165} + 18x_{166} + 18x_{167} + 18x_{168} + 18x_{169} + 18x_{170} + 18x_{171} + 18x_{172} + 18x_{173}$
$+18x_{174} + 18x_{175} + 18x_{176} + 18x_{177} + 18x_{178} + 18x_{179} + 18x_{180} + 18x_{181} + 18x_{182}$
$+18x_{183} + 18x_{184} + 18x_{185} + 18x_{186} + 18x_{187} + 18x_{188} + 18x_{189} + 18x_{190} + 18x_{191}$
$+18x_{192} + 18x_{193} + 18x_{194} + 18x_{195} + 18x_{196} + 18x_{197} + d_{14}^{+}$

Electrification projects
$d_{15}^{-} = 1{,}404 + 6x_1 + 6x_2 + 6x_3 + 6x_4 + 6x_5 + 6x_6 + 6x_7 + 6x_8 + 6x_9 + 6x_{10} + 6x_{11} +$
$6x_{12} + 6x_{13} + 6x_{14} + 6x_{15} + 6x_{16} + 6x_{17} + 6x_{18} + 6x_{19} + 6x_{20} + 6x_{21} + 6x_{22} + 6x_{23} +$
$6x_{24} + 6x_{25} + 6x_{26} + 6x_{27} + 6x_{28} + 6x_{29} + 6x_{30} + 6x_{31} + 6x_{32} + 6x_{33} + 6x_{34} + 6x_{35} +$
$6x_{36} + 6x_{37} + 6x_{38} + 6x_{39} + 6x_{40} + 6x_{41} + 6x_{42} + 6x_{43} + 6x_{44} + 6x_{45} + 6x_{46} + 6x_{47} +$
$6x_{48} + 6x_{49} + 6x_{50} + 6x_{51} + 6x_{52} + 6x_{53} + 6x_{54} + 6x_{55} + 6x_{56} + 6x_{57} + 6x_{58} + 6x_{59} +$
$6x_{60} + 6x_{61} + 6x_{62} + 6x_{63} + 6x_{64} + 6x_{65} + 6x_{66} + 6x_{67} + 6x_{68} + 6x_{69} + 6x_{70} + 6x_{71} +$
$6x_{72} + 6x_{73} + 6x_{74} + 6x_{75} + 6x_{76} + 6x_{77} + 6x_{78} + 6x_{79} + 6x_{80} + 6x_{81} + 6x_{82} +$
$6x_{83} + 6x_{84} + 6x_{85} +$
$6x_{86} + 6x_{87} + 6x_{88} + 6x_{89} + 6x_{90} + 6x_{91} + 6x_{92} + 6x_{93} + 6x_{94} + 6x_{95} + 6x_{96} + 6x_{97} +$
$6x_{98} + 6x_{99} + 6x_{100} + 6x_{101} + 6x_{012} + 6x_{103} + 6x_{104} + 6x_{105} + 6x_{106} + 6x_{107} + 6x_{108} +$
$6x_{109} + 6x_{110} + 6x_{111} + 6x_{112} + 6x_{113} + 6x_{114} + 6x_{115} + 6x_{116} + 6x_{117} + 6x_{228} +$
$6x_{119} + 6x_{120} + 6x_{121} + 6x_{122} + 6x_{123} + 6x_{124} + 6x_{125} + 6x_{126} + 6x_{127} + 6x_{128} +$
$6x_{129} + 6x_{130} + 6x_{131} + 6x_{132} + 6x_{133} + 6x_{134} + 6x_{135} + 6x_{136} + 6x_{137} + 6x_{138} +$
$6x_{139} + 6x_{140} + 6x_{141} + 6x_{142} + 6x_{143} + 6x_{144} + 6x_{145} + 6x_{146} + 6x_{147} + 6x_{148} +$
$6x_{149} + 6x_{150} + 6x_{151} + 6x_{152} + 6x_{153} + 6x_{154} + 6x_{155} + 6x_{156} + 6x_{157} + 6x_{158} +$
$6x_{159} + 6x_{160} + 6x_{161} + 6x_{162} + 6x_{163} + 6x_{164} + 6x_{165} + 6x_{166} + 6x_{167} + 6x_{168} +$
$6x_{169} + 6x_{170} + 6x_{171} + 6x_{171} + 6x_{172} + 6x_{173} + 6x_{174} + 6x_{175} + 6x_{176} + 6x_{177} +$
$6x_{178} + 6x_{179} + 6x_{180} + 6x_{181} + 6x_{182} + 6x_{183} + 6x_{184} + 6x_{185} + 6x_{186} + 6x_{187} +$
$6x_{188} + 6x_{189} + 6x_{190} + 6x_{191} + 6x_{192} + 6x_{193} + 6x_{194} + 6x_{195} + 6x_{196} + 6x_{197} +$
$6x_{198} + 6x_{199} + 6x_{200} + 6x_{201} + 6x_{202} + 6x_{203} + 6x_{204} + 6x_{205} + 6x_{206} + 6x_{207} +$
$6x_{208} + 6x_{209} + 6x_{210} + 6x_{211} + 6x_{212} + 6x_{213} + 6x_{214} + 6x_{215} + 6x_{216} + 6x_{217} +$
$6x_{218} + 6x_{219} + 6x_{220} + 6x_{221} + 6x_{222} + 6x_{223} + 6x_{224} + 6x_{225} + 6x_{226} + 6x_{227} +$
$6x_{228} + 6x_{229} + 6x_{230} + 6x_{231} + 6x_{232} + 6x_{233} + 6x_{234} + d_{15}^{+}$

Water Jetty projects
$d_{16}^{-} = 1{,}224 + 12x_1 + 12x_2 + 12x_3 + 12x_4 + 12x_5 + 12x_6 + 12x_7 + 12x_8 + 12x_9$
$+ 12x_{10} + 12x_{11}$
$+12x_{12} + 12x_{13} + 12x_{14} + 12x_{15} + 12x_{16} + 12x_{17} + 12x_{18} + 12x_{19} + 12x_{20} + 12x_{21}$
$+12x_{22} + 12x_{23} + 12x_{24} + 12x_{25} + 12x_{26} + 12x_{27} + 12x_{28} + 12x_{29} + 12x_{30} + 12x_{31}$
$+12x_{32} + 12x_{33} + 12x_{34} + 12x_{35} + 12x_{36} + 12x_{37} + 12x_{38} + 12x_{39} + 12x_{40} + 12x_{41}$
$+12x_{42} + 12x_{43} + 12x_{44} + 12x_{45} + 12x_{46} + 12x_{47} + 12x_{48} + 12x_{49} + 12x_{50} + 12x_{51}$
$+12x_{52} + 12x_{53} + 12x_{54} + 12x_{55} + 12x_{56} + 12x_{57} + 12x_{58} + 12x_{59} + 12x_{60} + 12x_{61}$
$+12x_{62} + 12x_{63} + 12x_{64} + 12x_{65} + 12x_{66} + 12x_{67} + 12x_{68} + 12x_{69} + 12x_{70} + 12x_{71}$
$+12x_{72} + 12x_{73} + 12x_{74} + 12x_{75} + 12x_{76} + 12x_{77} + 12x_{78} + 12x_{79} + 12x_{80} + 12x_{81}$
$+12x_{82} + 12x_{83} + 12x_{84} + 12x_{85} + 12x_{86} + 12x_{87} + 12x_{88} + 12x_{89} + 12x_{90} + 12x_{91}$

$$+12x_{92} + 12x_{93} + 12x_{94} + 12x_{95} + 12x_{96} + 12x_{97} + 12x_{98} + 12x_{99} + 12x_{100} + 12x_{101} + 12x_{102} + d_{16}^{+}$$

4.3 Genetic Algorithm Process or Procedure

The GA is the solution algorithm for the optimization model in this research, and it consists of selection, crossover, and mutation processes. Following the processes, the best chromosome is selected as the best optimal solution for the project portfolio selection problem (PPSP). The following is a synopsis of the genetic algorithm:

Step 1 Initialization process: Generate or input the GA parameters, i.e., the population size *pop _size* initial chromosomes will randomly generate, the crossover probability P_c, the mutation probability P_m, and the generations counting starting from 0.

Step 2 Fitness counting: To calculate fitness of the chromosomes through the objective function values.

Step 3 Selection process: Binary Tournament Selection adopted because it does not require any global population knowledge or a quantifiable measure of quality.

Step 4 Crossover operation: Two-point crossover point adopted. The two-point crossover point will be set between any points in the chromosome.

Step 5 Mutation operation: To generate a random variable between [0,1] to perform bit mutation operation.

Step 6 Termination condition: Repeat the steps from 1 to 5 under different GA parameters to generate maximum iteration Iter-max.

Step 7 Greatest result: The greatest chromosome is reported as the final optimal solution for PPSP.

4.4 GA Parameter Setting

Table 4.7: Genetic Algorithm Parameter Setting

Parameter Name	Model A	Model B	Model C	Model D
Algorithm	GA	GA	GA	GA
Population	200	200	200	200

Selection	Binary Tournament	Binary Tournament	Binary Tournament	Binary Tournament
Crossover Probability	0.6	0.6	0.6	0.8
Mutation Probability	0.025	0.025	0.025	0.025
Crossover Function	Two-Point	Two-Point	Two-Point	Two-Point
Mutation Function	Uniform	Uniform	Uniform	Uniform
Project Cost	₦2.9billion	₦45billion	₦13billion	₦133billion

Meanwhile, the model formulation was performed with personal computer Lenovo, Windows 10 Pro, Intel ® Core (TM)i5-3320M CPU @ 2.60GHz, 8.00 GB.

4.5 Chapter Summary

This chapter showed how the integrated model called AHP-GP-GA was implemented using projects like School, Housing, Jetty including walkways, Health Care Centres, Solar-powered Water Scheme, Road Infrastructure, Civic Centre/Community utilities and Electrification executed by a government agency to facilitate rapid and sustainable development to their region through projects to offer solutions to the socio-economic activities.

The AHP model developed matrix criteria, and a pairwise comparison of criteria including the sub-criteria with their priorities and final weight for the project alternatives. The AHP has also shown project selection criteria attributes.

The multi-objective GP model that combined weighted and pre-emptive models was formulated and the pre-emptive priority was determined from community needs as follows: select projects for social benefits, minimize the cost for projects, maximize number of jobs created, and minimize the time required to complete projects. The GA process and parameter setting for each model were developed for PPS.

CHAPTER FIVE: RESULTS AND DISCUSSION

5.1 Introduction

This chapter presents the results of the previous chapter of the model application of the hybrid method. Those results were showed or presented in bit string or integer number (0 or 1).

The model application chapter has shown the results of the AHP, which was used for the formulation of the multi-objective GP model.

Furthermore, the GP, AHP-GP and AHP-GP-GA results were presented in tables for comparison, while the other results on AHP-GP-GA for year 2, 3 and 4 were presented. The plot functions or graphs of the model were presented and explained.

The chapter also presents the total cash flow to the communities where projects were selected. Meanwhile, the chapter also discusses the research results accordingly.

5.2 The AHP Model

The AHP model results shown in section 4.2.1 are discussed below.

The study employed Spice Logic Software for the AHP modelling. Table 4.1 presented the project selection criteria including the scores scale. Tables 4.2, 4.3, 4.4 and 4.5 presented the sub-criteria matrix with each pairwise comparison including their relative priorities scores which indicated some project criteria that have high priorities scores that will improve the development of the communities like economic growth for the communities (0.445), political impact (0.345), community acceptance (0.532), place of the project (0.321), finish period of the project selected (0.321), project threat (0.321), structure with company mission or goals (0.450), and employment record of project manager (0.450). Table 4.6 presented the final weight of the alternative projects as being: School (0.037), Housing (0.032), Water Jetty (0.018), Health Centre (0.146), Solar Power Water Scheme (0.329), Road Infrastructure (0.183), Civic Centre (0.072) and (0.182) that showed that the Solar Power Water Scheme project with the highest weight was most needed for the communities. Figure 4.1 showed the attributes of project selection criteria as job creation, economic development, work experience, technical support of project managers, completion time and political impact. The AHP model highlighted some similar sub-criteria and project criteria attributes that are of significance to project selection criteria. The similar criteria are economic development, work experience of project manager, completion time of the project selected, and the political impact.

Meanwhile, the high priorities project criteria are the most important that need to be considered in solving the public project portfolio selection problems. Those project criteria which have been included in the public PPSP will improve the life of citizens of those selected communities, the nation's infrastructures level, and generally enhance the growth of nations in many ways, as the case may be. The model also recommended the project with the highest weight among the project alternatives in table 4.6, which was the solar power water scheme that needed to be given highest priority and the most attention for the communities.

Furthermore, the significance of these results is that practitioners will know the project criteria that have to be considered when dealing with public project selection problems, assisting everyone on the project team in comprehending the requirements and expectations for optimal results, and understanding many different criteria for defining and measuring success is beneficial. To ensure that other stakeholders are satisfied, project managers provide periodic reports on the project's progress, such as cost, time frame and project scope, and confirm that the project team has accomplished results that meet the project's objectives, ensuring that a project team has adequate personnel to finish the task and comprehensive documentation on the project. For the academia, it improves knowledge on public project selection criteria, creating a road map and set of contemporary public project selection criteria.

5.3 Results and Discussion for Year One

5.3.1 Comparison of optimization solutions between the hybrid AHP-GP-GA, AHP-GP and GP model from section 4.2.2

The table below compares the optimization solutions between the proposed AHP-GP-GA, AHP-GA and GP models.

Table 5.1: Optimization Solutions for GP, AHP-GP and AHP-GP-GA

Town	School	Water Jetty	Housing	GP Solution (Value)	AHP-GP Solution (Value)	AHP-GP-GA Solution (Value)	No. of Jobs	Remarks		
								GP	AHP-GP	AHP-GP-GA
1.	Classrooms block ($6x_1$)	Water Jetty (X_1)	Housing unit ($3X_1$)	0	1	1	14,87 &100	NS	S	S
2.	Classrooms block ($6x_2$)	Water Jetty (X_2)	Housing unit ($3X_2$)	1	1	1	14,87 &100	S	S	S
3.	Classrooms block ($6x_3$)	Water Jetty (X_3)	Housing unit ($3X_3$)	1	1	1	14,87 &100	S	S	S

4.	Classrooms block ($6x_4$)	Water Jetty (X_4)	Housing unit ($3X_4$)	0	1	1	14,87 &100	NS	S	S
5.	Classrooms block ($6x_5$)	Water Jetty (X_5)	Housing unit ($3X_5$)	0	1	1	14,87 &100	NS	S	S
6.	Classrooms block ($6x_6$)	Water Jetty (X_6)	Housing unit ($3X_6$)	1	1	1	14,87 &100	S	S	S
7.	Classrooms block ($6x_7$)	Water Jetty (X_7)	Housing unit ($3X_7$)	1	1	0	14,87 &100	S	S	NS
8.	Classrooms block ($6x_8$)	Water Jetty (X_8)	Housing unit ($3X_8$)	0	1	1	14,87 &100	NS	S	S
9.	Classrooms block ($6x_9$)	Water Jetty (X_9)	Housing unit ($3X_9$)	0	1	1	14,87 &100	NS	S	S
10.	Classrooms block ($6x_{10}$)	Water Jetty (X_{10})	Housing unit ($3X_{10}$)	0	1	0	14,87 &100	NS	S	NS
11.	Classrooms block ($6x_{11}$)	Water Jetty (X_{11})	Housing unit ($3X_{11}$)	1	1	0	14,87 &100	S	S	NS
12.	Classrooms block ($6x_{12}$)	Water Jetty (X_{12})	Housing unit ($3X_{12}$)	0	1	1	14,87 &100	NS	S	S
13.	Classrooms block ($6x_{13}$)	Water Jetty (X_{13})	Housing unit ($3X_{13}$)	0	1	1	14,87 &100	NS	S	S
14.	Classrooms block ($6x_{14}$)	Water Jetty (X_{14})	Housing unit ($3X_{14}$)	0	1	1	14,87 &100	NS	S	S
15.	Classrooms block ($6x_{15}$)	Water Jetty (X_{15})	Housing unit ($3X_{15}$)	0	1	1	14,87 &100	NS	S	S
16.	Classrooms block ($6x_{16}$)	Water Jetty (X_{16})	Housing unit ($3X_{16}$)	0	1	0	14,87 &100	NS	S	NS
17.	Classrooms block ($6x_{17}$)	Water Jetty (X_{17})	Housing unit ($3X_{17}$)	0	1	1	14,87 &100	NS	S	S
18.	Classrooms block ($6x_{18}$)	Water Jetty (X_{18})	Housing unit ($3X_{18}$)	0	0	1	14,87 &100	NS	NS	S
19.	Classrooms block ($6x_{19}$)	Water Jetty (X_{19})	Housing unit ($3X_{19}$)	0	1	1	14,87 &100	NS	S	S
20.	Classrooms block ($6x_{20}$)	Water Jetty (X20)	Housing unit ($3X_{20}$)	0	1	1	14,87 &100	NS	S	S
21.	Classrooms block ($6x_{21}$)	Water Jetty (X_{21})	Housing unit ($3X_{21}$)	0	1	1	14,87 &100	NS	S	S
22.	Classrooms block ($6x_{22}$)	Water Jetty (X_{22})	Housing unit ($3X_{22}$)	0	0	1	14,87 &100	NS	NS	S

23.	Classrooms block ($6x_{23}$)	Water Jetty (X_{23})	Housing unit ($3X_{23}$)	1	1	1	14,87 &100	S	S	S
24.	Classrooms block ($6x_{24}$)	Water Jetty (X_{24})	Housing unit ($3X_{24}$)	0	1	1	14,87 &100	NS	S	S
25.	Classrooms block ($6x_{25}$)	Water Jetty (X_{25})	Housing unit ($3X_{25}$)	0	1	1	14,87 &100	NS	S	S
26.	Classrooms block ($6x_{26}$)	Water Jetty (X_{26})	Housing unit ($3X_{26}$)	0	1	1	14,87 &100	NS	S	S
27.	Classrooms block ($6x_{27}$)	Water Jetty (X_{27})	Housing unit ($3X_{27}$)	0	1	1	14,87 &100	NS	S	S
28.	Classrooms block ($6x_{28}$)	Water Jetty (X28)	Housing unit ($3X_{28}$)	0	1	1	14,87 &100	NS	S	S
29.	Classrooms block ($6x_{29}$)	Water Jetty (X_{29})	Housing unit ($3X_{129}$)	0	1	1	14,87 &100	NS	S	S
30.	Classrooms block ($6x_{30}$)	Water Jetty (X_{30})	Housing unit ($3X_{30}$)	0	1	0	14,87 &100	NS	S	NS
31.	Classrooms block ($6x_{31}$)	Water Jetty (X_{31})	Housing unit ($3X_{31}$)	0	1	1	14,87 &100	NS	S	S
32.	Classrooms block ($6x_{32}$)	Water Jetty (X_{32})	Housing unit ($3X_{32}$)	0	1	1	14,87 &100	NS	S	S
33.	Classrooms block ($6x_{33}$)	Water Jetty (X_{33})	Housing unit ($3X_{33}$)	0	1	1	14,87 &100	NS	S	S
34.	Classrooms block ($6x_{34}$)	Water Jetty (X_{34})	Housing unit ($3X_{34}$)	0	1	1	14,87 &100	NS	S	S
35.	Classrooms block ($6x_{35}$)	Water Jetty (X_{35})	Housing unit ($3X_{35}$)	0	1	1	14,87 &100	NS	S	S
36.	Classrooms block ($6x_{36}$)	Water Jetty (X_{36})	Housing unit ($3X_{36}$)	0	1	1	14,87 &100	NS	S	S
37.	Classrooms block ($6x_{37}$)	Water Jetty (X_{37})	Housing unit ($3X_{37}$)	0	1	1	14,87 &100	NS	S	S
38.	Classrooms block ($6x_{38}$)	Water Jetty (X_{38})	Housing unit ($3X_{38}$)	0	1	1	14,87 &100	NS	S	S
39.	Classrooms block ($6x_{39}$)	Water Jetty (X_{39})	Housing unit ($3X_{39}$)	0	1	1	14,87 &100	NS	S	S
40.	Classrooms block ($6x_{40}$)	Water Jetty (X_{40})	Housing unit ($3X_{40}$)	0	1	1	14,87 &100	NS	S	S
41.	Classrooms block ($6x_{41}$)	Water Jetty (X_{41})	Housing unit ($3X_{41}$)	0	1	0	14,87 &100	NS	S	NS

42.	Classrooms block ($6x_{42}$)	Water Jetty (X_{42})	Housing unit ($3X_{42}$)	0	1	1	14,87 &100	NS	S	S
43.	Classrooms block ($6x_{43}$)	Water Jetty (X_{43})	Housing unit ($3X_{43}$)	0	0	1	14,87 &100	NS	NS	S
44.	Classrooms block ($6x_{44}$)	Water Jetty (X_{44})	Housing unit ($3X_{44}$)	0	1	1	14,87 &100	NS	S	S
45.	Classrooms block ($6x_{45}$)	Water Jetty (X_{45})	Housing unit ($3X_{45}$)	0	1	1	14,87 &100	NS	S	S
46.	Classrooms block ($6x_{46}$)	Water Jetty (X_{46})	Housing unit ($3X_{46}$)	0	0	1	14,87 &100	NS	NS	S
47.	Classrooms block ($6x_{47}$)	Water Jetty (X_{47})	Housing unit ($3X_{47}$)	0	1	1	14,87 &100	NS	S	S
48.	Classrooms block ($6x_{48}$)	Water Jetty (X_{48})	Housing unit ($3X_{48}$)	0	1	1	14,87 &100	NS	S	S
49.	Classrooms block ($6x_{49}$)	Water Jetty (X_{49})	Housing unit ($3X_{49}$)	0	1	1	14,87 &100	NS	S	S
50.	Classrooms block ($6x_{50}$)	Water Jetty (X_{50})	Housing unit ($3X_{50}$)	0	1	1	14,87 &100	NS	S	S
51.	Classrooms block ($6x_{51}$)	Water Jetty (X_{51})	Housing unit ($3X_{51}$)	0	1	1	14,87 &100	NS	S	S
52.	Classrooms block ($6x_{52}$)	Water Jetty (X_{52})	Housing unit ($3X_{52}$)	0	1	1	14,87 &100	NS	S	S
53.	Classrooms block ($6x_{53}$)	Water Jetty (X_{53})	Housing unit ($3X_{53}$)	1	1	1	14,87 &100	S	S	S
54.	Classrooms block ($6x_{54}$)	Water Jetty (X_{54})	Housing unit ($3X_{54}$)	0	1	1	14,87 &100	NS	S	S
55.	Classrooms block ($6x_{55}$)	Water Jetty (X_{55})	Housing unit ($3X_{55}$)	0	1	1	14,87 &100	NS	S	S
56.	Classrooms block ($6x_{56}$)	Water Jetty (X_{56})	Housing unit ($3X_{56}$)	0	1	1	14,87 &100	NS	S	S
57.	Classrooms block ($3x_{57}$)	Water Jetty (X_{57})	Housing unit ($3X_{57}$)	1	1	1	14,87 &100	S	S	S
58.	Classrooms block ($6x_{58}$)	Water Jetty (X_{58})	Housing unit ($3X_{58}$)	0	0	1	14,87 &100	NS	NS	S
59.	Classrooms block ($3x_{59}$)	Water Jetty (X_{59})	Housing unit ($3X_{59}$)	1	1	1	14,87 &100	S	S	S
60.	Classrooms block (x_{60})	Water Jetty (X_{60})	Housing unit ($3X_{60}$)	1	1	1	14,87 &100	S	S	S

61.	Classrooms block ($6x_{61}$)	Water Jetty (X_{61})	Housing unit ($3X_{61}$)	1	1	0	14,87 &100	S	S	NS
62.	Classrooms block ($6x_{62}$)	Water Jetty (X_{62})	Housing unit ($3X_{62}$)	0	1	1	14,87 &100	NS	S	S
63.	Classrooms block ($6x_{63}$)	Water Jetty (X_{63})	Housing unit ($3X_{63}$)	1	1	1	14,87 &100	S	S	S
64.	Classrooms block ($6x_{64}$)	Water Jetty (X_{64})	Housing unit ($3X_{64}$)	0	1	1	14,87 &100	NS	S	S
65.	Classrooms block ($6x_{65}$)	Water Jetty (X_{65})	Housing unit ($3X_{65}$)	0	1	1	14,87 &100	NS	S	S
66.	Classrooms block ($6x_{66}$)	Water Jetty (X_{66})	Housing unit ($3X_{66}$)	1	1	1	14,87 &100	S	S	S
67.	Classrooms block ($6x_{67}$)	Water Jetty (X_{67})	Housing unit ($3X_{67}$)	0	1	1	14,87 &100	NS	S	S
68.	Classrooms block ($6x_{68}$)	Water Jetty (X_{68})	Housing unit ($3X_{68}$)	0	1	1	14,87 &100	NS	S	S
69.	Classrooms block ($6x_{69}$)	Water Jetty (X_{69})	Housing unit ($3X_{69}$)	0	1	1	14,87 &100	NS	S	S
70.	Classrooms block ($6x_{70}$)	Water Jetty (X_{70})	Housing unit ($3X_{70}$)	0	0	1	14,87 &100	NS	NS	S
71.	Classrooms block ($6x_{71}$)	Water Jetty (X_{71})	Housing unit ($3X_{71}$)	0	1	1	14,87 &100	NS	S	S
72.	Classrooms block ($6x_{72}$)	Water Jetty (X_{72})	Housing unit ($3X_{72}$)	0	1	1	14,87 &100	NS	S	S
73.	Classrooms block ($6x_{73}$)	Water Jetty (X_{73})	Housing unit ($3X_{73}$)	0	1	1	14,87 &100	NS	S	S
74.	Classrooms block ($3x_{74}$)	Water Jetty (X_{74})	Housing unit ($3X_{74}$)	0	0	1	14,87 &100	NS	NS	S
75.	Classrooms block ($6x_{75}$)	Water Jetty (X_{75})	Housing unit ($3X_{75}$)	0	1	1	14,87 &100	NS	S	S
76.	Classrooms block ($3x_{76}$)	Water Jetty (X_{76})	Housing unit ($3X_{76}$)	0	1	1	14,87 &100	NS	S	S
77.	Classrooms block ($6x_{77}$)	Water Jetty (X_{77})	Housing unit ($3X_{77}$)	1	1	1	14,87 &100	S	S	S
78.		Water Jetty (X_{78})	Housing unit ($3X_{78}$)	0	0	1	14,87 &100	NS	NS	S
79.		Water Jetty (X_{79})	Housing unit ($3X_{79}$)	1	1	1	14,87 &100	S	S	S

80.		Water Jetty (X_{80})	Housing unit ($3X_{80}$)	1	1	1	14,87 &100	S	S	S
81.		Water Jetty (X_{81})	Housing unit ($3X_{81}$)	0	1	1	14,87 &100	NS	S	S
82.		Water Jetty (X_{82})	Housing unit ($3X_{82}$)	0	1	1	14,87 &100	NS	S	S
83.		Water Jetty (X_{83})	Housing unit ($3X_{83}$)	0	1	1	14,87 &100	NS	S	S
84.		Water Jetty (X_{84})	Housing unit ($3X_{84}$)	0	1	1	14,87 &100	NS	S	S
85.		Water Jetty (X_{85})	Housing unit ($3X_{85}$)	0	1	1	14,87 &100	NS	S	S
86.		Water Jetty (X_{86})	Housing unit ($3X_{86}$)	0	1	1	14,87 &100	NS	S	S
87.		Water Jetty (X_{87})	Housing unit ($3X_{87}$)	1	1	1	14,87 &100	S	S	S
88.			Housing unit ($3X_{88}$)	1	1	1	14,87 &100	S	S	S
89.			Housing unit ($3X_{89}$)	1	1	1	14,87 &100	S	S	S
90.			Housing unit ($3X_{90}$)	1	1	1	14,87 &100	S	S	S
91.			Housing unit ($3X_{91}$)	1	1	1	14,87 &100	S	S	S
92.			Housing unit ($3X_{92}$)	1	1	1	14,87 &100	S	S	S
93.			Housing unit ($3X_{93}$)	1	1	1	14,87 &100	S	S	S
94.			Housing unit ($3X_{94}$)	1	1	1	14,87 &100	S	S	S
95.			Housing unit ($3X_{95}$)	1	1	1	14,87 &100	S	S	S
96.			Housing unit ($3X_{96}$)	1	1	1	14,87 &100	S	S	S
97.			Housing unit ($3X_{97}$)	1	1	1	14,87 &100	S	S	S
98.			Housing unit ($3X_{98}$)	1	1	1	14,87 &100	S	S	S

99.			Housing unit ($3X_{99}$)	1	1	1	14,87 &100	S	S	S
100.			Housing unit ($3X_{100}$)	1	1	1	14,87 &100	S	S	S
Total	**454**	**87**	**300**				**980, 6960 & 9300**			

NB: NS = NOT SELECTED; N = SELECTED

5.3.2 Discussion of optimization solutions of hybrid AHP-GP-GA, AHP-GP, and GP model for year one

The hybrid method AHP-GP-GA was solved through the use of the MATLAB software package, while both the AHP-GP and GP were solved separately using the LINGO 18.0 software package. The optimization results of integrated AHP-GP-GA in Table 5.1 show that projects with solution values of (1) were appropriate for selection, whilst projects with solution values of (0) were not appropriate or qualified for selection. The projects appraised for numerous towns included a school, a wooden jetty, and houses. In school projects, 70 out of 77 projects, or 412 classrooms out of 454 classes, were chosen, resulting in 980 jobs for the towns' natives. There were 80 wooden jetty projects chosen from 87 projects that provided 6960 jobs. In housing scheme initiatives, 93 out of 100 plans were chosen, resulting in 279 housing units out of 300 units, creating 93 000 jobs for the communities. The overall cost savings from projects that were not chosen was ₦207 million.

Table 7 juxtaposes the optimization outcomes of AHP-GP-GA, AHP-GP and GP to highlight the competency of the hybrid technique (AHP-GP-GA) for project portfolio selection. In comparison to the AHP-GP and GP models, the AHP-GP-GA model selected more school, wooden jetty, and housing projects, which resulted in more classrooms and jobs, as well as increased business activity in the host communities. The integrated AHP-GP-GA approach provided 70 optimal solutions, which made the approach robust and flexible for decision making problems to select projects from a variety of options where projects reflect community needs. When the best possible result is obtained, the algorithm will be terminated. The solutions established the viability of the method. Therefore, the significance of the AHP-GP-GA integrated model for practitioners and academia was to enhance the decisions to choose the right, or suitable projects for public developments, saving costs, to handle and select more complex projects in large-scale real-life situations used for project planning and operations, and improved knowledge on hybrid methods for PPSP. The novel approach connects both academia and industry in the area of Public PPSP to improve knowledge, and develop a society suited to citizen's needs, which in turn adds to nation building.

5.4 Results and Discussion for Year Two

5.4.1 Optimization solutions from the hybrid (AHP-GP-GA) model in section 4.2.3

Table 5.2: Optimization Solutions for AHP-GP-GA for Year Two

Town	School	Solar-Powered Water Project	Community Utilities & Civic Center	Road	AHP-GP-GA Solution (Value)	No. of Jobs	Remark AHP-GP-GA
1.	Construction of Mega Caring Heart Primary School Blocks (X1)	Construction of Solar-Powered Water Project (X1)	Construction of Skill Acquisition Centre(X1)	Construction of 1km Road (X1)	1	14,87, 14 & 50	S
2.	Construction and Equipping of Science Laboratory (X2)	Construction of Solar-Powered Water Project (X2)	Construction of Modern Civic Centre (X2)	Construction of 1 Km Road (X2)	1	14,87, 14 & 50	S
3.	Construction and Equipping of Science Laboratory (X3)	Construction of Solar-Powered Water Project (X3)	Construction of Civic Community Centre (X3)	Construction of Road (X3)	1	14,87, 14 & 50	S
4.	Construction of Science Laboratory (X4)	Construction of Solar-Powered Water Project (X4)	Construction of Ultra-Modern Town Hall (X4)	Construction of 2km Road (X4)	1	14,87, 14 & 50	S
5.	Construction and Equipping of Science Laboratory (X5)	Construction of Solar-Powered Water Project (X5)	Construction of Skill Acquisition Centre (X5)	Construction of Closed Road (X5)	1	14,87, 14 & 50	S
6.	Construction and Equipping of Science Laboratory (X6)	Construction of Solar-Powered Water Project (X6)	Construction of Community Centre (X6)	Construction of Road (X6)	1	14,87, 14 & 50	S
7.	Construction and Equipping of Science Laboratory (X7)	Construction of Solar-Powered Water Project (X7)	Construction of Multi-Purpose Town Hall (X7)	Construction of Road (X7)	1	14,87, 14 & 50	S
8.	Construction of 24 Classrooms Block (24x8)	Construction of Solar-Powered Water Project (X8)	Construction of Public Toilet Block (X8)	Construction of Road (X8)	1	14,87, 14 & 50	S

9.	Construction of 6 Wooden Classroom Block (6x9)	Construction of Solar-Powered Water Project (X9)	Construction of Wooden Civic Centre (X9)	Construction of Flexible Pavement (X9)	1	14,87, 14 & 50	S
10.	Construction of Science Laboratories (X10)	Construction of Solar-Powered Water Project (X10)	Construction of Public Toilet Block (X10)	Construction of Road (X10)	1	14,87, 14 & 50	S
11.	Construction and Equipping of Science Laboratory (X11)	Construction of Solar-Powered Water Project (X11)	Construction of Modern Town Hall/Civic Centre (X11)	Construction of Flexible Pavement (X11)	1	14,87, 14 & 50	S
12.	Construction and Equipping of Science Lab (X12)	Construction of Solar-Powered Water Project (X12)	Construction of Modern Town Hall/Civic Community Centre (X12)	Construction of 2km Road (X12)	0	14,87, 14 & 50	NS
13.	Construction and Equipping of Science Laboratory (X13)	Construction of Solar-Powered Water Project (X13)	Construction of Town Hall (X13)	Construction of Road (1km) (X13)	1	14,87, 14 & 50	S
14.	Construction of 12 Classroom Blocks (12x14)	Construction of Solar-Powered Water Project (X14)	Construction of Civic Community Centre (X14)	Construction of Road. (X14)	1	14,87, 14 & 50	S
15.	Construction & Equipping of Science Laboratories (X15)	Construction of Solar-Powered Water Project (X15)	Construction of Civic Community Centre (X15)	Remedial Work of Road (X15)	1	14,87, 14 & 50	S
16.	Construction of Science Laboratory (X16)	Construction of Solar-Powered Water Project (X16)	Completion of Civic Centre (X16)	Construction of Internal Roads (X16)	1	14,87, 14 & 50	S
17.	Construction of Science Laboratory (X17)	Construction of Solar-Powered Water Project (X17)	Construction of Civic Centre (X17)	Construction of Road (X17)	1	14,87, 14 & 50	S
18.	Construction and Equipping of Science Lab (X18)	Construction of Solar-Powered Water Project (X18)	Construction of Civic Community Centre (X18)	Construction of High School Street (X18)	1	14,87, 14 & 50	S
19.	Construction & Equipping of Science Laboratories. (X19)	Construction of Solar-Powered Water Project (X19)	Construction of Civic Community Centre (X19)	Construction of 1km Flexible Pavement (X19)	1	14,87, 14 & 50	S
20.	Construction of 6 Wooden Classroom Blocks (6x20)	Construction of Solar-Powered	Construction of Civic Community Centre (X20)	Construction of Internal Road (X20)	1	14,87, 14 & 50	S

		Water Project (X20)					
21.	Construction and Equipping of Science Lab (X21)	Construction of Solar-Powered Water Project (X21)	Construction of Civic Centre (X21)	Construction of Internal Road Network (X21)	1	14,87, 14 & 50	S
22.	Construction and Equipping of Science Laboratory (X22)	Construction of Solar-Powered Water Project (X22)	Rehabilitation of 33kv Overhead Line Network (X22)	Construction of a 2km Road with Drains and Asphalt of Seaside Beach Road (X22)	1	14,87, 14 & 50	S
23.	Construction and Equipping of Science Laboratory. (X23)	Construction of Solar-Powered Water Project (X23)	Construction of Multi-Purpose Civic Centre (X23)	Construction of Palace Road. (X23)	1	14,87, 14 & 50	S
24.	Construction and Equipping of Science Laboratory. (X24)	Construction of Solar-Powered Water Project (X24)	Construction of Town Hall (X24)	Remedial Works on Road (X24)	1	14,87, 14 & 50	S
25.	Construction of 12 Classroom Blocks (Composite) (12x25)	Construction of Solar-Powered Water Project (X25)	Construction of Lock-Up Shops (X25)	Remedial Works on Road (X25)	1	14,87, 14 & 50	S
26.	Construction of 12 Classroom Blocks (12x26)	Construction of Solar-Powered Water Project (X26)	Construction of Modern Civic Centre (X26)	Contract for Remedial Works on Road (X26)	1	14,87, 14 & 50	S
27.	Construction and Equipment of Modern Library (X27)	Construction of Solar-Powered Water Project (X27)	Construction and Equipping of Modern Civic Centre (X27)	Construction of Township Internal Road (X27)	1	14,87, 14 & 50	S
28.	Construction of 12 classroom blocks (12x28)	Construction of Solar-Powered Water Project (X28)	Construction of Modern Civic Centre (X28)	Construction of Road (X28)	1	14,87, 14 & 50	S
29.	Renovation of 3 classroom blocks (Wooden) (3x29)	Construction of Solar-Powered Water Project (X29)	Construction of Modern Town Hall (X29)	Construction of Road. (X29)	1	14,87, 14 & 50	S
30.	Renovation of 6 classroom blocks (Wooden) (6x30)	Construction of Solar-Powered Water Project (X30)	Construction of Ultra-Modern Town Hall (X30)	Remedial Works of Road (X30)	1	14,87, 14 & 50	S
31.	Renovation of 6 classroom blocks (Wooden) (6x31)	Construction of Solar-Powered Water Project (X31)	Construction of Skill Acquisition Centre(X31)	Construction of Road. (X31)	1	14,87, 14 & 50	S

32.	Renovation of 6 classroom blocks (Wooden) (6x32)	Construction of Solar-Powered Water Project (X32)	Construction of Community Centre (X32)	Construction of 1km Flexible Pavement. (X32)	1	14,87, 14 & 50	S
33.	Renovation of 6 classroom blocks (Wooden) (6X33)	Construction of Solar-Powered Water Project (X33)	Construction of Multi-Purpose Town Hall (X33)	Remedial Work of Road (X33)	1	14,87, 14 & 50	S
34.	Renovation of 6 classroom blocks (Wooden) (6X34)	Construction of Solar-Powered Water Project (X34)	Construction of Wooden Civic Centre (X34)	Construction of State Office Road. (X34)	1	14,87, 14 & 50	S
35.	Renovation of 6 classroom blocks (Sandcrete) (6X35)	Construction of Solar-Powered Water Project (X35)	Construction of Modern Town Hall (X35)	Construction of Road (X35)	1	14,87, 14 & 50	S
36.	Renovation of 6 classroom blocks (Sandcrete) (6X36)	Construction of Solar-Powered Water Project (X36)	Construction of Modern Town Hall (X36)	Construction of Internal Road (X36)	1	14,87, 14 & 50	S
37.	Renovation of 6 classroom blocks (Sandcrete) (6X37)	Construction of Solar-Powered Water Project (X37)	Construction of Town Hall (X37)	Construction of New Site Internal Road. (X37)	1	14,87, 14 & 50	S
38.	Renovation of 6 classroom blocks (Sandcrete) (6X38)	Construction of Solar-Powered Water Project (X38)	Construction of Modern Town Hall (X38)	Construction of Housing Estate Internal Road (X38)	1	14,87, 14 & 50	S
39.	Renovation of 4 classroom blocks (Sandcrete) (6X39)	Construction of Solar-Powered Water Project (X39)	Completion of Civic Centre (X39)	Construction of Flexible Pavement (X39)	1	14,87, 14 & 50	S
40.	Renovation of 4 classroom blocks (Sandcrete) (4X40)	Construction of Solar-Powered Water Project (X40)	Construction of Civic Centre (X40)	Construction of Township Road (X40)	1	14,87, 14 & 50	S
41.	Renovation of 6 classroom blocks (Wooden) (6X41)	Construction of Solar-Powered Water Project (X41)	Construction of Modern Town Hall (X41)	Construction of Flexible Pavement (X41)	1	14,87, 14 & 50	S
42.	Model School 12 classroom block (12X42)	Construction of Solar Powered Water Project (X42)	Construction of Civic Centre (X42)	Construction of Road (X42)	1	14,87, 14 & 50	S
43.	Model School 12 classroom block (12X43)	Construction of Solar-Powered Water Project (X43)	Construction of Multi-purpose Civic Centre (X43)	Construction of 1 km Flexible Pavement (X43)	1	14,87, 14 & 50	S

44.	Model School 22 classroom block (22X44)	Construction of Solar-Powered Water Project (X44)	Construction of Town Hall (X44)	Construction of Internal Road (X44)	1	14,87, 14 & 50	S
45.	Model School 22 classroom block (22X45)	Construction of Solar-Powered Water Project (X45)	Construction of Lock-up Shops (X45)	Construction of Road (X45)	1	14,87, 14 & 50	S
46.	Model School 12 classroom block (12X46)	Construction of Solar-Powered Water Project (X46)	Construction of Modern Civic Centre (X46)	Construction of Internal Road. (X46)	0	14,87, 14 & 50	NS
47.	Model School 24 classroom block (24X47)	Construction of Solar-Powered Water Project (X47)	Construction and Equipping of Modern Civic Centre (X47)	Emergency Repairs of Failed Portions of Road (X47)	1	14,87, 14 & 50	S
48.	Model School 12 classroom block (12X48)	Construction of Solar-Powered Water Project (X48)	Construction of Modern Civic Centre (X48)	Construction of Internal Roads. (X48)	1	14,87, 14 & 50	S
49.	Model School 12 classroom block (12X49)	Construction of Solar-Powered Water Project (X49)	Construction of Modern Civic Centre (X49)	Construction of Zone 2, Road (X49)	1	14,87, 14 & 50	S
50.	Construction of a 3-classroom block (3X50)	Construction of Solar-Powered Water Project (X50)	Construction of Skill Acquisition Centre (X50)	Construction of Flexible Pavement (X50)	1	14,87, 14 & 50	S
51.	Construction of 6 classroom blocks (wooden) (6X51)	Construction of Solar-Powered Water Project(X51)	Construction of Lock-up Shops (X51)	Construction of Internal Road (X51)	1	14,87, 14 & 50	S
52.	Construction of 6 classroom blocks (wooden) (6X52)	Construction of Solar-Powered Water Project (X52)	Construction of Wooden Civic Centre (X52)	Construction of Road (X52)	1	14,87, 14 & 50	S
53.	Construction of 6 classroom blocks (wooden) (6X53)	Construction of Solar-Powered Water Project (X53)	Construction of Town Hall (X53)	Construction of Road (X53)	1	14,87, 14 & 50	S
54.	Construction of 12 classroom blocks (12X54)	Construction of Solar-Powered Water Project (X54)	Construction of Town Hall (X54)	Construction of Road Project (X54)	1	14,87, 14 & 50	S
55.	Construction of 3 classroom blocks (3X55)	Construction of Solar-Powered Water Project (X55)	Completion of Civic Centre (X55)	Remedial Works on Road (X55)	1	14,87, 14 & 50	S

56.	Construction of 3 classroom blocks (3X56)	Construction of Solar-Powered Water Project (X56)	Construction of Civic Centre (X56)	Construction of Road (X56)	1	14,87, 14 & 50	S
57.	Construction & equipping of science laboratory (X57)	Construction of Solar-Powered Water Project (X57)	Construction of Civic Centre (X57)	Construction of Internal Roads (X57)	1	14,87, 14 & 50	S
58.	Construction of 6 classroom blocks (composite) (6X58)	Construction of Solar-Powered Water Project (X58)	Construction of Ultra-Modern Town Hall (X58)	Construction of Flexible Pavement (X58)	1	14,87, 14 & 50	S
59.	Construction of 3 classroom blocks (3X59)	Construction of Solar-Powered Water Project (X59)	Construction of Modern Civic Centre (X59)	Construction of Road. (X59)	1	14,87, 14 & 50	S
60.	Completion of 6 classroom blocks (6X60)	Construction of Solar-Powered Water Project (X60)	Construction of Modern Civic Centre (X60)	Construction of Flexible Pavement Road (X60)	1	14,87, 14 & 50	S
61.	Construction of 6 wooden classroom blocks (6X61)	Construction of Solar-Powered Water Project (X61)	Construction of Modern Town Hall (X61)	Construction of 1km Road (X61)	1	14,87, 14 & 50	S
62.	Construction of 6 classroom blocks (6X62)	Construction of Solar-Powered Water Project (X62)	Construction of Modern Town Hall (X62)	Construction of Flexible Pavement (X62)	1	14,87, 14 & 50	S
63.	Construction of a 3-classroom block (3X63)	Construction of Solar-Powered Water Project (X63)	Construction of Modern Town Hall (X63)	Construction of Road (X63)	1	14,87, 14 & 50	S
64.	Construction and equipping of science laboratory (X64)	Construction of Solar-Powered Water Project (X64)	Construction of Modern Town Hall (X64)	Construction of Road. (X64)	0	14,87, 14 & 50	NS
65.	Construction and equipping of science laboratory (X65)	Construction of Solar-Powered Water Project (X64)	Construction of Community Centre (X65)	Construction of Flexible Pavement Road (X65)	1	14,87, 14 & 50	S
66.	Construction and equipment of technical college (X66)	Construction of Solar-Powered Water Project (X66)	Construction and Equipping of Modern Civic Centre (X66)	Construction of 2km Road (X66)	1	14,87, 14 & 50	S
67.	Construction of science laboratory (X67)	Construction of Solar-Powered Water Project (X67)	Construction of Multi-Purpose Town Hall (X67)	Construction of Road (X67)	1	14,87, 14 & 50	S

68.	Construction and equipping of science lab (X68)	Construction of Solar-Powered Water Project (X68)	Construction of Multi-purpose Civic Centre (X68)	Construction of Road (X68)	1	14,87, 14 & 50	S
69.	Construction of 12 classroom blocks (composite) (12X69)	Construction of Solar-Powered Water Project (X69)	Construction of Modern Town Hall (X69)	Construction of Township Road (X69)	0	14,87, 14 & 50	NS
70.	Construction of 22 classroom blocks (22X70)	Construction of Solar-Powered Water Project (X70)	Construction of Wooden Civic Centre (X70)	Construction of 1.5km Flexible Pavement (X70)	0	14,87, 14 & 50	NS
71.	Construction and equipment of modern library (X71)	Construction of Solar-Powered Water Project (X71)	Construction of Modern Town Hall (X71)	Construction of Internal Roads. (X71)	1	14,87, 14 & 50	S
72.		Construction of Solar-Powered Water Project (X72)		Emergency Repairs of Failed Portions of Road (X72)	1	14,87, 14 & 50	S
73.		Construction of Solar-Powered Water Project (X73)		Remedial Work on Road. (X73)	1	14,87, 14 & 50	S
74.				Remedial Work on Road (X74)	1	14,87, 14 & 50	S
75.				Construction of New High Court Road (X75)	1	14,87, 14 & 50	S
76.				Construction of Flexible Pavement Road (X76)	1	14,87, 14 & 50	S
77.				Emergency Repair of Road (X77)	1	14,87, 14 & 50	S
78.				Remedial Work on Internal Roads (X78)	1	14,87, 14 & 50	S
79.				Construction of Housing Estate Internal Road (X79)	1	14,87, 14 & 50	S
80.				Construction of Road (X80)	0	14,87, 14 & 50	NS
81.				Construction of Road (X81)	1	14,87, 14 & 50	S

82.				Construction of Road and Bridge (X82)	1	14,87, 14 & 50	S
83.				Construction of 2km Road (X83)	1	14,87, 14 & 50	S
84.				Construction of Road (X84)	1	14,87, 14 & 50	S
85.				Construction of 2km Rigid Pavement Road (X85)	1	14,87, 14 & 50	S
86.				Construction of Internal Road (X86)	1	14,87, 14 & 50	S
87.				Remedial Work of Road (X87)	1	14,87, 14 & 50	S
88.				Construction of Internal Road (X88)	0	14,87, 14 & 50	NS
89.				Construction of 1km Flexible Pavement. (X89)	1	14,87, 14 & 50	S
90.				Construction of Concrete Pavement with Culvert and Drains (X90)	1	14,87, 14 & 50	S
91.				Construction of Internal Road (Lot I) (X91)	1	14,87, 14 & 50	S
92.				Construction of Internal Road (Lot 2) (X92)	0	14,87, 14 & 50	NS
93.				Construction of Internal Road (Lot 3) (X93)	1	14,87, 14 & 50	S
94.				Construction of Internal Road (Lot 4) (X94)	0	14,87, 14 & 50	NS
95.				Construction of Internal Road (Lot 5) (X95)	1	14,87, 14 & 50	S
96.				Construction of Internal Road (X96)	1	14,87, 14 & 50	S
97.				Construction of Road Phase 1 (X97)	1	14,87, 14 & 50	S

98.				Construction of 2km Rigid Pavement Road (X98)	1	14,87, 14 & 50	S
99.				Construction of Internal Road (X99)	0	14,87, 14 & 50	NS
100.				Construction of Flexible Pavement Road (X100)	1	14,87, 14 & 50	S
101.				Construction of 7.5km Road with Rigid Pavement (X101)	1	14,87, 14 & 50	S
102.				Construction of 7.5km Road with Rigid Pavement (X102)	1	14,87, 14 & 50	S
103.				Construction of 7.5km Road with Rigid Pavement (X103)	1	14,87, 14 & 50	S
104.				Construction of 7.5km Road with Rigid Pavement (X104)	1	14,87, 14 & 50	S
105.				Construction of 7.5km Road with Rigid Pavement (X105)	1	14,87, 14 & 50	S
106.				Construction of 7.5km Road with Rigid Pavement (X106)	1	14,87, 14 & 50	S
107.				Construction of 7.5km Road with Rigid Pavement (X107)	1	14,87, 14 & 50	S
108.				Construction of 3km Road (X108)	1	14,87, 14 & 50	S
109.				Construction of 2.5km Road with Drains (X109)	1	14,87, 14 & 50	S
110.				Construction of Access Road (X110)	0	14,87, 14 & 50	NS
111.				Construction of Road (X111)	1	14,87, 14 & 50	S

112.				Construction of 2km Road (X112)	1	14,87, 14 & 50	S
113.				Construction of Road (X113)	1	14,87, 14 & 50	S
114.				Construction of Road (X114)	0	14,87, 14 & 50	NS
Total	**416**	**73**	**71**	**114**		**924, 5916, 924 & 5100**	

NB: NS = NOT SELECTED; N = SELECTED

5.4.2 Discussion of optimization solutions of hybrid AHP-GP-GA for year two

The hybrid method AHP-GP-GA was solved through the use of the MATLAB software package. The optimization solutions of hybrid AHP-GP-GA in Table 5.2 present projects with solution values of (1) that were appropriate for selection while projects with value of (0) were not appropriate or qualified for selection. The school, solar-powered water projects, community utilities and road projects were considered for various communities in the region. The integrated model selected 66 out of 71 school projects and converted 368 classrooms out of 416 classrooms, 68 out of 73 solar-powered water projects, 66 out of 71 community utilities projects, and 102 out of 114 road construction projects to create a total number of 12,864 jobs for the people of the host communities. The projects not selected represented a total saving cost of ₦3.954 billion. The integrated AHP-GP-GA approach provided 200 optimal solutions, which made the approach robust and flexible for decision making problems to select projects from a variety of options where the projects reflect community needs.

5.5 Results and Discussion for Year Three

5.5.1 Optimization solutions from the hybrid (AHP-GP-GA) model in section 4.2.4

Table 5.3: Optimization Solutions for AHP-GP-GA for Year Three

Town	Model Health Care	School	Housing	AHP-GP-GA Solution (Value)	No. of Jobs	Remark
						AHP-GP-GA
1.	Construction of Comprehensive Health Care Centre (X1)	Completion of 6 Classroom Blocks (Wooden) (6X1)	Construction of 3-Bedroom Housing unit (3X1)	1	40,14 &100	S
2.	Construction of Mega Caring	Construction and Equipping of	Construction of 3-Bedroom	1	40,14 &100	S

	Heart Centre (X2)	Science Laboratory (X2)	Housing unit (3X2)			
3.	Construction and Equipping of Mother and Child Hospital (X3)	Construction of 3 Classroom Blocks. (3X3)	Construction of 3-Bedroom Housing unit (3X3)	1	40,14 &100	S
4.	Reconstruction of Health Care Centre (X4)	Construction and Equipping of Science Laboratory. (X4)	Construction of Office Complex (X4)	1	40,14 &100	S
5.	Construction of Wooden Comprehensive Health Care Centre (X5)	Construction of 3 Classroom Blocks. (3x5)	Construction of 3-Bedroom Housing unit (3X5)	1	40,14 &100	S
6.	Construction of Comprehensive Health Care Centre (X6)	Construction of 3 Classroom Blocks (3x6)	Construction of Swimming Platform (X6)	1	40,14 &100	S
7.	Construction of Wooden Comprehensive Health Care Centre (X7)	Construction of 3 Classroom Blocks (3x7)	Construction of Swimming Platform(X7)	1	40,14 &100	S
8.	Construction of Comprehensive Health Care Centre (X8)	Construction of 6 Classroom Blocks (6x8)	Construction of 3-Bedroom Housing unit (3X8)	1	40,14 &100	S
9.	Construction of Comprehensive Health Care Centre (X9)	Construction of 6 Classroom Blocks (6x9)	Construction of Staff Quarters (X9)	1	40,14 &100	S
10.	Construction of Comprehensive Health Care Centre (X10)	Construction of 12 Classroom Blocks. (12X10)	Construction of Public Toilet Block (X10)	1	40,14 &100	S
11.	Construction of Comprehensive Health Care Centre (X11)	Construction of Science Laboratory (X11)	Renovation of Magistrates' Quarters (X11)	1	40,14 &100	S
12.	Construction of Comprehensive Health Care Centre (Wooden) (X12)	Construction and Equipping of Science Laboratory (X12)	Construction of 3-Bedroom Housing unit (3X12)	1	40,14 &100	S
13.	Construction of Wooden Comprehensive Health Care Centre (X13)	Construction of 3 Classroom Blocks (3X13).	Construction of Public Toilet Block (X13)	1	40,14 &100	S
14.	Construction of Wooden Comprehensive Health Care Centre (X14)	Construction of Carpentry Workshop (X14)	Construction of 3-Bedroom Housing unit (3X14)	1	40,14 &100	S
15.	Construction of Mortuary Building (X15)	Construction of 3 Classroom Blocks. (3X15)	Construction of 3-Bedroom	1	40,14 &100	S

			Housing unit (3X15)			
16.	Construction of Health Care Centre (X16)	Construction of 3 Classroom Blocks with Staff Room (3X16)	Construction of 3-Bedroom Housing unit (3X16)	1	40,14 &100	S
17.	Construction of Comprehensive Health Care Centre (X17)	Construction of Office Complex (X17)	Construction of 3-Bedroom Housing unit (3X18)	1	40,14 &100	S
18.	Construction of Comprehensive Health Centre (X18)	Construction of 6 Classroom Blocks (6X18)	Construction of 3-Bedroom Housing unit (3X18)	1	40,14 &100	S
19.	Construction of Comprehensive Health Care Centre (X19)	Construction of 6 (Wooden) Classroom Blocks (6X19)	Construction of 3-Bedroom Housing unit (3X19)	1	40,14 &100	S
20.	Construction of Comprehensive Health Care Centre (X20)	Construction of 6 Classroom Blocks (6X20)	Construction of 3-bedroom Housing unit (3X20)	1	40,14 &100	S
21.	Construction of Community Health Centre (X21)	Construction of 6 Classroom Blocks (Wooden) (6X21)	Construction of 3-Bedroom Housing unit (3X21)	1	40,14 &100	S
22.	Construction of Comprehensive Health Care Centre (X22)	Re-habitation of Damaged School Buildings (3X22)	Construction of 3-Bedroom Housing unit (3X22)	1	40,14 &100	S
23.	Construction and Equipping of Mother and Child Hospital (X23)	Completion of 6 Classroom Blocks (6X23)	Construction of 3-Bedroom Housing unit (3X23)	1	40,14 &100	S
24.	Construction of Comprehensive Health Care Centre (X24)	Construction of Laboratory Block (X24)	Construction of 3-Bedroom Housing unit (3X24)	1	40,14 &100	S
25.	Construction of Comprehensive Health Care Centre (X25)	Construction of Office Complex (X25)	Construction of Regional Technology Village and Industrial Park (X25)	1	40,14 &100	S
26.	Construction and Equipping of Modern Health Care Centre (X26)	Construction of 3 Classroom Blocks (3X26)	Construction of 3-Bedroom Housing unit (3X26)	1	40,14 &100	S
27.	Construction and Equipping of Basic Health Care Centre (X27)	Construction and Equipping of Science Laboratory (X27)	Construction of Students Hostel (X27)	1	40,14 &100	S
28.	Construction of Comprehensive Health Care Centre (X28)	Construction of Science Laboratories (3X28)	Construction of Students Hostel (X27)	1	40,14 &100	S

29.	Construction of Comprehensive Health Care Centre (X29)	Construction of 12 Classroom Blocks and Staff Quarters (12X29)	Construction of 3-Bedroom Housing unit (3X29)	1	40,14 &100	S
30.	Renovation of General Hospital (X30)	Construction of 12 Classroom Block (12X30)	Construction of 3-Bedroom Housing unit (3X30)	1	40,14 &100	S
31.	Renovation of General Hospital (X31)	Completion of 6 Classroom Blocks (6X31)	Construction of 3-Bedroom Housing unit (3X31)	1	40,14 &100	S
32.	Construction of Comprehensive Health Care Centre (32)	Construction of Model 3 Classroom Blocks (3X32)	Construction of 3-Bedroom Housing unit (3X32)	1	40,14 &100	S
33.	Construction of Mega Caring Health Care Centre (X33)	Construction of 3 Classroom Blocks (3X33)	Construction of 3-Bedroom Housing unit (3X33)	1	40,14 &100	S
34.	Construction and Equipping of Mother and Child Hospital (X34)	Construction of 6 Classroom Block (Composite) (6X34)	Construction of 3-Bedroom Housing unit (3X34)	1	40,14 &100	S
35.	Construction of Comprehensive Health Care Centre (X35)	Construction of 6 Wooden Classroom Block (6X35)	Construction of 3-Bedroom Housing unit (3X35)	1	40,14 &100	S
36.	Construction of Comprehensive Health Care Centre (X36)	Construction of 3 Science Laboratories (3X36)	Construction of 3-Bedroom Housing unit (3X36)	1	40,14 &100	S
37.	Construction of Comprehensive Health Care Centre (X37)	Construction and Equipping of Science Laboratory (X37)	Construction of 3-Bedroom Housing unit (3X37)	1	40,14 &100	S
38.	Construction of Mortuary Building (X38)	Construction of 6 Model Classroom Block (6X38)	Construction of 3-Bedroom Housing unit (3X38)	0	40,14 &100	NS
39.	Construction of Comprehensive Health Care Centre (39)	Completion of 6 Classroom Block (6X39)	Construction of 3-Bedroom Housing unit (3X39)	1	40,14 &100	S
40.	Construction and Equipping of Mother and Child Hospital (X40)	Construction of 3 Classroom Blocks (3X40)	Construction of 3-Bedroom Housing unit (3X40)	1	40,14 &100	S
41.	Construction of Comprehensive Health Care Centre. (X41)	Construction of 6 Classroom Blocks (6X41)	Construction of 3-Bedroom Housing unit (3X41)	1	40,14 &100	S
42.	Construction and Equipping of Modern Health Care Centre. (X42)	Construction of a Dormitory Block & 2 Classrooms (3X42)	Construction of 3-Bedroom Housing unit (3X42)	1	40,14 &100	S

43.	Construction and Equipping of Basic Health Care Centre. (X43)	Construction of 3 Classroom Blocks (3X43)	Construction of 3-Bedroom Housing unit (3X43)	1	40,14 &100	S
44.	Construction of Comprehensive Health Care Centre (X44)	Construction of 3 Classroom Blocks (3X44)	Construction of 3-Bedroom Housing unit (3X44)	1	40,14 &100	S
45.	Construction of Comprehensive Health Care Centre. (X45)	Completion of 6 Classroom Blocks (6X45)	Construction of 3-Bedroom Housing unit (3X45)	1	40,14 &100	S
46.	Supply and Installation of Medical Equipment at General Hospital. (X46)	Construction of 6 Wooden Classroom blocks (6X46)	Construction of 3-Bedroom Housing unit (3X46)	1	40,14 &100	S
47.	Construction of Mother and Child Hospital (X47)	Construction and Equipping of Science Laboratory (X47)	Construction of 3-Bedroom Housing unit (3X47)	1	40,14 &100	S
48.	Construction of Model Health Care Centre (X48)	Completion of a Classroom Building (Woodwork) (X48)	Construction of 3-Bedroom Housing unit (3X48)	1	40,14 &100	S
49.	Construction of Modern Basic Health Centre (X49)	Construction of 3 Classroom Blocks (3X49)	Construction of 3-Bedroom Housing unit (3X49)	1	40,14 &100	S
50.	Construction of a Health Care Centre (X 50)	Construction of Science Laboratories (3X50)	Construction of 3-Bedroom Housing unit (3X50)	1	40,14 &100	S
51.	Construction of a Health Care Centre (X51)	Construction of 3 Classroom Blocks (3X51)	Construction of 3-Bedroom Housing unit (3X51)	1	40,14 &100	S
52.	Construction of a Health Care Centre (X52)	Construction of 6 Classroom Blocks (6X52)	Construction of 3-Bedroom Housing unit (3X52)	1	40,14 &100	S
53.	Construction of a Health Care Centre (X53)	Construction of 6 Classroom Block (6X53)	Construction of 3-Bedroom Housing unit (3X53)	1	40,14 &100	S
54.	Construction of Heath Care Centre (X54)	Construction and Equipping of Science Laboratory (X54)	Construction of 3-Bedroom Housing unit (3X54)	1	40,14 &100	S
55.	Construction of Health Care Centre (X55)	Construction of 6 Model classroom Blocks (6X55)	Construction of 3-Bedroom Housing unit (3X55)	1	40,14 &100	S
56.	Construction of Health Care Centre (X56)	Construction of 3 Classroom Blocks (3X56)	Construction of 3-Bedroom Housing unit (3X56)	1	40,14 &100	S

57.	Construction of Health Care Centre (X57)	Construction of 6 Model classroom Blocks (6X57)	Construction of 3-Bedroom Housing unit (3X57)	1	40,14 &100	S
58.	Construction of Health Care Centre (X58)	Construction of 3 Model Classroom Block (3X58)	Construction of 3-Bedroom Housing unit (3X58)	1	40,14 &100	S
59.	Construction of Health Care Centre (X59)	Completion of 6 Classroom Blocks (6X59)	Construction of 3-Bedroom Housing unit (3X59)	1	40,14 &100	S
60.		Construction of 3 Classroom Blocks (3X60)	Construction of 3-Bedroom Housing unit (3X60)	1	40,14 &100	S
61.		Construction of 6 Classroom Blocks (6X61)	Construction of 3-Bedroom Housing unit (3X61)	1	40,14 &100	S
62.		Construction of 12 High School Classrooms (12X62)	Construction of 3-Bedroom Housing unit (3X62)	1	40,14 &100	S
63.		Construction of 22 Classroom Blocks (22X63)	Construction of 3-Bedroom Housing unit (3X63)	1	40,14 &100	S
64.		Construction of 3 Classroom Blocks (3X64)	Construction of 3-Bedroom Housing unit (3X64)	1	40,14 &100	S
65.		Construction of 3 Classroom Blocks (3X65)	Construction of 3-Bedroom Housing unit (3X65)	1	40,14 &100	S
66.		Construction of 6 Classroom Blocks (wooden) (6X66)	Construction of 3-Bedroom Housing unit (3X66)	0	40,14 &100	NS
67.		Construction & Equipping of Science Laboratories (X67)	Construction of 3-Bedroom Housing unit (3X67)	1	40,14 &100	S
68.		Construction of 6 Classroom Blocks (wooden) (6X68)	Construction of 3-Bedroom Housing unit (3X68)	0	40,14 &100	NS
69.		Construction of 6 Classroom Blocks (wooden) (X69)	Construction of 3-Bedroom Housing unit (3X69)	1	40,14 &100	S
70.		Construction of Science Laboratories (3X70)	Construction of 3-Bedroom Housing unit (3X70)	1	40,14 &100	S

71.		Construction of 6 Classroom Blocks (wooden) (6X71)	Construction of 3-Bedroom Housing unit (3X71)	1	40,14 &100	S
72.		Completion of 6 Classroom Blocks (wooden) (6X72)	Construction of 3-Bedroom Housing unit (3X72)	1	40,14 &100	S
73.		Construction of 3 Classroom Blocks (3X73)	Construction of 3-Bedroom Housing units (3X73)	1	40,14 &100	S
74.		Construction of 3 Classroom Blocks (3X74)	Construction of 3-Bedroom Housing unit (3X74)	1	40,14 &100	S
75.		Construction of Science Laboratory (X75)	Construction of 3-Bedroom Housing unit (3X75)	1	40,14 &100	S
76.		Construction and Equipping of Science Laboratories (X76)	Construction of 3-Bedroom Housing unit (3X76)	1	40,14 &100	S
77.		Construction of 6 Classroom Blocks (wooden) (6X77)	Construction of 3-Bedroom Housing unit (3X77)	1	40,14 &100	S
78.		Construction of 6 Classroom Blocks (composite) (6X78)	Construction of 3-Bedroom Housing unit (3X78)	1	40,14 &100	S
79.		Construction of 6 Classroom Blocks (wooden) (6X79)	Construction of 3-Bedroom Housing unit (3X79)	1	40,14 &100	S
80.		Construction of 3 Classroom Blocks (3X80)	Student Hostel (X80)	1	40,14 &100	S
81.		Construction of 12 Classroom Blocks (12X81)		1	40,14 &100	S
82.		Construction of 3 Classroom Blocks (3X82)		0	40,14 &100	NS
83.		Construction of 6 Classroom Blocks (wooden) (6X83)		1	40,14 &100	S
84.		Construction of 6 Classroom Blocks (wooden) (6X84)		1	40,14 &100	S
85.		Construction of 6 Classroom Blocks (wooden) (6X85)		1	40,14 &100	S
86.		Construction of 12 Classroom Blocks (12X86)		1	40,14 &100	S

87.		Construction of 3 Classroom Blocks (3X87)		1	40,14 &100	S
88.		Construction of 3 Classroom Blocks (3X88)		1	40,14 &100	S
89.		Construction & Equipping of Science Laboratories (X89)		0	40,14 &100	NS
90.		Construction of 6 Classroom Blocks (composite) (6X90)		1	40,14 &100	S
91.		Construction of 3 Classroom Blocks (3X91)		1	40,14 &100	S
92.		Completion of 6 Classroom Blocks (6X92)		1	40,14 &100	S
93.		Construction of 6 Classroom Blocks (wooden) (6X93)		1	40,14 &100	S
94.		Construction of 6 Classroom Blocks (6X94)		1	40,14 &100	S
95.		Construction of 3 classroom blocks (3X95)		0	40,14 &100	NS
96.		Construction and Equipping of Science Laboratory (X96)		1	40,14 &100	S
97.		Construction and Equipping of Science Laboratory (X97)		1	40,14 &100	S
98.		Construction and Equipping of Technical College (22X98)		1	40,14 &100	S
99.		Construction and Equipping of Science Laboratory (X99)		1	40,14 &100	S
100.		Construction and Equipping of Science Laboratory (X100)		1	40,14 &100	S
101.		Construction of 12 Classroom Blocks (composite) (12X101)		1	40,14 &100	S
102.		Construction of 22 Classroom Blocks (22X102)		1	40,14 &100	S

103.		Construction and Equipping of Modern Library (X103)		1	40,14 &100	S
Total	**59**	**489**	**218**		**2320, 1358 & 7700**	

NB: NS = NOT SELECTED; N = SELECTED

5.5.2 Discussion of optimization solutions of hybrid AHP-GP-GA for year three

The hybrid method AHP-GP-GA was solved with the MATLAB software package. The optimization results of integrated AHP-GP-GA in Table 5.3 shows that projects with solution values of (1) were appropriate for selection while projects with a value of (0) were not appropriate or qualified for selection. Health Centre, school, and housing including hostel projects were being considered for various communities. The integrated model selected 58 out of 59 health centre projects, 97 out of 103 school projects, transformed 467 classrooms into 489 classrooms, and 77 out of 80 housing and hostel projects that resulted in a total of 11,378 employment opportunities for the residents of the host communities. The total cost for the projects that were not selected was 239 million. The integrated AHP-GP-GA approach provided 97 optimal solutions, which made the approach robust and flexible for decision making problems to select projects from a variety of options where the projects reflected community needs.

5.6 Results and Discussion for Year Four

5.6.1 Optimization solutions from the hybrid (AHP-GP-GA) model in section 4.2.5

The table below shows the optimization solutions of the proposed AHP-GP-GA.

Table 5.4: Optimization Solutions for AHP-GP-GA for Year Four

Town	Solar-Powered Water Project	Road	Electricity	Water Jetty & Walkways	AHP-GP-GA Solution (Value)	No. of Jobs	Remark
							AHP/GP-GA
1.	Construction of solar-powered water project (X1)	Construction of 1km Road (X1)	Installation of solar-powered Street light project (X1)	Construction of Walkway (X1)	1	87, 50, 50 &87	S
2.	Construction of solar-powered	Construction of 1 km Road (X2)	Installation of Solar-powered Street light	Construction of a 1.5km Foot	1	87, 50, 50 &87	S

	water project (X2)		project (X2)	Bridge (X2)			
3.	Construction of solar-powered water project (X3)	Construction of road (X3)	Installation of Solar-powered Street light project (X3)	Construction of 1.5km Foot Bridge (X3)	1	87, 50, 50 &87	S
4.	Construction of solar-powered water project (X4)	Construction of Road (X4)	Installation of Solar-powered Street light project (X4)	Construction of Concrete Jetty and Walkway (X4)	1	87 ,50, 50 &87	S
5.	Construction of solar-powered water project (X5)	Construction of 2km road (X5)	Installation of Solar-powered Street light project (X5)	Construction of Landing Jetty (X5)	1	87, 50, 50 &87	S
6.	Construction of solar-powered water project (X6)	Construction of Road (X6)	Installation of Solar-powered Street light project (X6)	Construction of Concrete Jetty and Walkway (X6)	1	87, 50, 50 &87	S
7.	Construction of solar-powered water project (X7)	Construction of Sawmill (X7)	Installation of Solar-powered Street light project (X7)	Construction of Concrete Landing Jetty (X7)	1	87, 50, 50 &87	S
8.	Construction of solar-powered water project (X8)	Construction of Celestial Road (X8)	Installation of Solar-powered Street light project (X8)	Construction of Concrete Landing Jetty (X8)	1	87, 50, 50 &87	S
9.	Construction of solar-powered water project (X9)	Construction of Road, phase 1 (X9)	Installation of Solar-powered Street light project (X9)	Construction of Concrete Landing Jetty (X9)	1	87, 50, 50 &87	S
10.	Construction of solar-powered water project (X10)	Construction of flexible Pavement Road (X10)	Installation of Solar powered street light project (X10)	Construction of Concrete Landing Jetty and Walkway (X10)	1	87, 50, 50 &87	S
11.	Construction of solar-powered water project (X11)	Construction of Road (X11)	Electrification (X11)	Construction of Landing Jetty and Walkway (X11)	1	87, 50, 50 &87	S
12.	Construction of solar-powered	Construction of flexible	Installation of 1 no. 300kva,	Construction of Jetty and	1	87, 50, 50	S

	water project (X12)	Pavement Road (X12)	11/0.415kv Transformer (X12)	Walkway (X12)		&87	
13.	Construction of solar-powered water project (X13)	Construction of 2km Road (X13)	Electrification project (X13)	Construction of Walkway (X13)	0	87, 50, 50 &87	NS
14.	Construction of Solar-Powered Water Project (X14)	Construction of Road (X14)	Installation of 1 no. 300kva, 11/0.415kv Transformer (X14)	Construction of Concrete Jetty and Walkway (X14)	1	87, 50, 50 &87	S
15.	Construction of Solar-Powered Water Project (X15)	Construction of Road (X15)	Installation of 1 no. 500kva, 11/0.415kv Transformer (X15)	Construction of Concrete Jetty and Walkway (X15)	1	87, 50, 50 &87	S
16.	Construction of Solar-Powered Water Project (X16)	Remedial Work of Road Construction of the road (X16)	Installation of 1 no. 300kva, 11/0.415kv Transformer (X16)	Construction of Concrete Jetty and Walkway (X16)	1	87, 50, 50 &87	S
17.	Construction of Solar-Powered Water Project (X17)	Construction of internal Roads (X17)	Installation of 1 no. 300kva, 11/0.415kv transformer (X17)	Construction of Concrete Jetty and Walkway (X17)	1	87, 50, 50 &87	S
18.	Construction of Solar-Powered Water Project (X18)	Construction of Road (X18)	Installation of 1 no. 300kva, 11/0.415kv Transformer (X18)	Construction of Concrete Jetty and Walkway (X18)	1	87, 50, 50 &87	S
19.	Construction of Solar-Powered Water Project (X19)	Construction of Road (X19)	Installation of 500kva, 11/0.415kv Transformer (X19)	Construction of Concrete Jetty and Walkway (X19)	1	87, 50, 50 &87	S
20.	Construction of Solar-Powered Water Project (X20)	Construction of 1km flexible pavement Construction of road (X20)	Installation of 300kva, 11/0.415kv Transformer (X20)	Construction of Concrete Jetty and Walkway (X20)	1	87, 50, 50 &87	S
21.	Construction of Solar-Powered Water Project (X21)	Construction of internal road (X21)	Installation of 1 no. 300kva, 11/0.415kv Transformer (X21)	Construction of Concrete Jetty and Walkway (X21)	1	87, 50, 50 &87	S
22.	Construction of Solar-Powered	Construction of internal	Electrification Project (X22)	Construction of Concrete	1	87, 50, 50	S

	Water Project (X22)	road network (X22)		Jetty and Walkway (X22)		&87	
23.	Construction of Solar-Powered Water Project (X23)	Construction of 2km road with drains and asphalt (X23)	Installation of 1no. 500kva, 11/0.415kv transformer (X23)	Construction of Concrete Jetty and Walkway (X23)	1	87, 50, 50 &87	S
24.	Construction of Solar-Powered Water Project (X24)	Construction of road (X24)	Installation of 1 no. 300kva, 11/0.415kv transformer (X24)	Construction of Concrete Jetty and Walkway (X24)	1	87, 50, 50 &87	S
25.	Construction of Solar Powered Water Project (X25)	Remedial Works of Road Construction of the road (X25)	Installation of 1 no. 300kva, 11/0.415kv Transformer (X25)	Construction of Concrete Jetty and Walkway (X25)	1	87, 50, 50 &87	S
26.	Construction of Solar-Powered Water Project (X26)	Remedial Works of Road Construction (X26)	Installation of 1 no. 300kva, 11/0.415kv Transformer (X26)	Construction of Concrete Jetty and Walkway (X26)	1	87, 50, 50 &87	S
27.	Construction of Solar-Powered Water Project (X27)	Remedial Works of Road Construction of the road (X27)	Installation of 1 no. 300kva, 11/0.415kv Transformer (X27)	Construction of Concrete Jetty and Walkway (X27)	1	87, 50, 50 &87	S
28.	Construction of Solar-Powered Water Project (X28)	Construction of Internal Road (X28)	Installation of Solar-Powered Street Lights (X28)	Construction of Concrete Jetty and Walkway (X28)	0	87, 50, 50 &87	NS
29.	Construction of Solar-Powered Water Project (X29)	Construction of Road (X29)	Improvement of Electricity Supply (X29)	Construction of Concrete Jetty and Walkway (X29)	1	87, 50, 50 &87	S
30.	Construction of Solar-Powered Water Project (X30)	Construction of Road (X30)	Installation of 1 no. 500kva, 11/0.415kv Transformer (X30)	Construction of Concrete Jetty and Walkway (X30)	1	87, 50, 50 &87	S
31.	Construction of Solar-Powered Water Project (X31)	Remedial works of Road Construction of the road (X31)	Electrification (X31)	Construction of Concrete Jetty and Walkway (X31)	1	87,50, 50 &87	S
32.	Construction of Solar-Powered	Construction of Road (X32)	Installation of 1 no. 300kva,	Construction of Concrete	1	87, 50, 50	S

	Water Project (X32)		11/0.415kv Transformer (X32)	Jetty and Walkway (X32)		&87	
33.	Construction of Solar-Powered Water Project (X33)	Construction of 1km Flexible Pavement Construction of road (X33)	Installation of 1 no. 500kva, 11/0.415kv Transformer (X33)	Construction of Concrete Jetty and Walkway (X33)	1	87, 50, 50 &87	S
34.	Construction of Solar-Powered Water Project (X34)	Remedial Work of Road Construction of road (X34)	Electrification (X34)	Construction of Concrete Jetty and Walkway (X34)	1	87, 50, 50 &87	S
35.	Construction of Solar-Powered Water Project (X35)	Construction of Road (X35)	Installation of 1 no. 300kva, 11/0.415kv transformer (X35)	Construction of Concrete Jetty and Walkway (X35)	1	87, 50, 50 &87	S
36.	Contract for Solar-Powered Water Project (X36)	Construction of Road (X36)	Installation of 1 no. 300kva, 11/0.415kv Transformer (X36)	Construction of Concrete Jetty and Walkway (X36)	1	87, 50, 50 &87	S
37.	Construction of Solar-Powered Water Project (X37)	Construction of Internal Road (X37)	Installation of Solar-Powered Street Lights (X37)	Construction of Concrete Jetty and Walkway (X37)	1	87, 50, 50 &87	S
38.	Construction of Solar-Powered Water Project (X38)	Construction of Internal Road (X38)	Installation of 1 no. 500kva, 11/0.415kv Transformer (X38)	Construction of Concrete Jetty and Walkway (X38)	1	87, 50, 50 &87	S
39.	Construction of Solar-Powered Water Project (X39)	Construction of the Internal Road (X39)	Installation of 1 no 300kva, 11/0.415kv Transformer (X39)	Construction of Concrete Jetty and Walkway (X39)	0	87, 50, 50 &87	NS
40.	Construction of Solar-Powered Water Project (X40)	Construction of flexible pavement Construction of road (X40)	Installation of Solar-Powered Street Lights (X40)	Construction of Concrete Jetty and Walkway (X40)	1	87, 50, 50 &87	S
41.	Construction of Solar-Powered Water Project (X41)	Construction of Township Road Construction of the road (X41)	Installation of Solar-Powered Street Lights (X41)	Construction of Concrete Jetty and Walkway (X41)	1	87, 50, 50 &87	S
42.	Construction of Solar-Powered	Construction of flexible pavement	Rural Electrifica-	Construction of Concrete	1	87, 50, 50	S

	Water Project (X42)	Construction of road (X42)	tion project (X42)	Jetty and Walkway (X42)		&87	
43.	Construction of Solar-Powered Water Project (X43)	Construction of Road (X43)	Installation of 1 no. 500kva, 11/0.415kv Transformer (X43)	Construction of Concrete Jetty and Walkway (X43)	1	87, 50, 50 &87	S
44.	Construction of Solar-Powered Water Project (X44)	Construction of 1km flexible pavement Construction of road (X44)	Electrification project (X43)	Construction of Concrete Jetty and Walkway (X44)	1	87, 50, 50 &87	S
45.	Construction of Solar-Powered Water Project (X45)	Construction of Internal Road (X45)	Installation of 1 no. 300kva, 11/0.415kv Transformer (X45)	Construction of Concrete Jetty and Walkway (X45)	1	87, 50, 50 &87	S
46.	Construction of Solar-Powered Water Project (X46)	Construction of Road (X46)	Installation of 1 no. 500kva, 11/0.415kv Transformer (X46)	Construction of Concrete Jetty and Walkway (X46)	1	87, 50, 50 &87	S
47.	Construction of Solar-Powered Water Project (X47)	Construction of Internal Road (X47)	Electrification Project. (X47)	Construction of Concrete Jetty and Walkway (X47)	0	87, 50, 50 &87	NS
48.	Construction of Solar-Powered Water Project (X48)	Repairs of failed portions of road Construction of the road (X48)	Installation of solar-powered streetlights (X48)	Construction of Concrete Jetty and Walkway (X48)	1	87, 50, 50 &87	S
49.	Construction of Solar-Powered Water Project (X49)	Construction of Internal Roads (X49)	Installation of solar-Powered Street Lights (X49)	Construction of Concrete Jetty and Walkway (X49)	1	87, 50, 50 &87	S
50.	Construction of Solar-Powered Water Project (X50)	Construction of Road (X50)	Installation of Solar-Powered Street Lights (X50)	Construction of Concrete Jetty and Walkway (X50)	1	87, 50, 50 &87	S
51.	Construction of Solar-Powered Water Project (X51)	Construction of flexible pavement Construction of road (X51)	Installation of Solar-powered street lights (X51)	Construction of Concrete Jetty and Walkway (X51)	1	87, 50, 50 &87	S

52.	Construction of Solar-Powered Water Project (X52)	Construction of Internal road (X52)	Installation of Solar-Powered Street Lights (X52)	Construction of Concrete Jetty and Walkway (X52)	1	87, 50, 50 &87	S
53.	Construction of Solar-Powered Water Project (X53)	Construction of Road (X53)	Installation of 1 no. 300kva, 11/0.415kv Transformer (X53)	Construction of Concrete Jetty and Walkway (X53)	1	87, 50, 50 &87	S
54.	Construction of Solar-Powered Water Project (X54)	Construction of Road (X54)	Installation of 300kva, 11/0.415kv Transformer (X54)	Construction of Concrete Jetty and Walkway (X54)	1	87, 50, 50 &87	S
55.	Construction of Solar-Powered Water Project (X55)	Construction of Road (X55)	Electrification (X55)	Construction of Concrete Jetty and Walkway (X55)	1	87, 50, 50 &87	S
56.	Construction of Solar-Powered Water Project (X56)	Remedial Works of Road Construction of the road (X56)	Installation of 1 no. 500kva, 11/0.415kv Transformer (X56)	Construction of Concrete Jetty and Walkway (X56)	1	87, 50, 50 &87	S
57.	Construction of Solar-Powered Water Project (X57)	Construction of Road (X57)	Installation of 1 no. 500kva, 11/0.415kv Transformer (X57)	Construction of Concrete Jetty and Walkway (X57)	1	87, 50, 50 &87	S
58.	Construction of Solar-Powered Water Project (X58)	Construction of Internal Roads Construction of the road (X58)	Electrification Project (X58)	Construction of Concrete Jetty and Walkway (X58)	1	87, 50, 50 &87	S
59.	Construction of Solar-Powered Water Project (X59)	Construction of Flexible Pavement Construction of road (X59)	Installation of 1 no. 500kva, 11/0.415kv Transformer (X59)	Construction of Concrete Jetty and Walkway (X59)	1	87, 50, 50 &87	S
60.	Construction of Solar-Powered Water Project (X60)	Construction of Road (X60)	Installation of 1 no. 300kva, 11/0.415kv Transformer (X60)	Construction of Concrete Jetty and Walkway (X60)	1	87, 50, 50 &87	S
61.	Construction of Solar-Powered Water Project (X61)	Construction of Road (X61)	Installation of Solar-Powered Street Light Electrification (X61)	Construction of Concrete Jetty and Walkway (X61)	1	87, 50, 50 &87	S

62.	Construction of Solar-Powered Water Project (X62)	Construction of 1km Road (X62)	Installation of 300kva, 11/0.415kv Transformer (X62)	Construction of Concrete Jetty and Walkway (X62)	1	87, 50, 50 &87	S
63.	Construction of Solar-Powered Water Project (X63)	Construction of Road (X63)	Electrification (X63)	Construction of Concrete Jetty and Walkway (X63)	1	87, 50, 50 &87	S
64.	Construction of Solar-Powered Water Project ((X64)	Construction of Flexible Pavement (X64)	Installation of 2300kva 0.33/0.415 kv Transformers (X64)	Construction of Concrete Jetty and Walkway (X64)	1	87, 50, 50 &87	S
65.	Construction of Solar-Powered Water Project (X65)	Construction of Road (X65)	Electrification (X65)	Construction of Concrete Jetty and Walkway (X65)	1	87, 50, 50 &87	S
66.	Construction of Solar-Powered Water Project (X66)	Construction of Road (X66)	Installation of 2 300kva 0.33/0.415 kv Transformers(X66)	Construction of Concrete Jetty and Walkway (X66)	0	87, 50, 50 &87	NS
67.	Construction of Solar-Powered Water Project (X67)	Construction of Flexible Pavement (X67)	Installation of Solar-Powered Street Lights (X67)	Construction of Concrete Jetty and Walkway (X67)	1	87, 50, 50 &87	S
68.	Construction of Solar-Powered Water Project (X68)	Construction of 2km Road (X68)	Installation of Solar-Powered Street Lights (X68)	Construction of Concrete Jetty and Walkway (X68)	1	87, 50, 50 &87	S
69.	Construction of Solar-Powered Water Project (X69)	Construction of Road (X69)	Electrifica-tion project. (X69)	Construction of Concrete Jetty and Walkway (X69)	1	87, 50, 50 &87	S
70.	Construction of Solar-Powered Water Project (X70)	Construction of road with bridge (X70)	Installation of Solar-Powered Street Lights (X70)	Construction of Concrete Jetty and Walkway (X70)	1	87, 50, 50 &87	S
71.	Construction of Solar-Powered Water	Construction of road & bridge (X71)	Installation of 1 no. 500kva, 11/0.415kv	Construction of Concrete Jetty and	1	87, 50, 50 &87	S

	Project (X71)		transformer (X71)	Walkway (X71)			
72.	Construction of solar-powered water project (X72)	Repairs of failed road (X72)	Installation of 1 no. 300kva, 11/0.415kv transformer (X72)	Constructio n of Concrete Jetty and Walkway (X72)	1	87, 50, 50 &87	S
73.	Construction of solar-powered water project (X73)	Construction of township road (X73)	Installation of 1 no. 300kva, 11/0.415kv transformer (X73)	Constructio n of Concrete Jetty and Walkway (X73)	1	87, 50, 50 &87	S
74.	Construction of solar powered water project (X74)	Construction of 1.5km flexible pavement (X74)	Installation of 1 no. 300kva, 11/0.415kv transformer (X74)	Constructio n of Concrete Jetty and Walkway (X74)	1	87, 50, 50 &87	S
75.	Construction of solar powered water project (X75)	Construction of road (X75)	Installation of solar-powered street lights (X75)	Constructio n of Concrete Jetty and Walkway (X75)	1	87, 50, 50 &87	S
76.	Construction of solar-powered water project (X76)	Construction of internal roads (X76)	Installation of 1 no. 300kva, 11/0.415kv transformer (X76)	Constructio n of Concrete Jetty and Walkway (X76)	1	87, 50, 50 &87	S
77.	Construction of solar-powered water project (X77)	Repairs of failed portions of road (X77)	Installation of 1 no. 300kva, 11/0.415kv transformer (X77)	Constructio n of Concrete Jetty and Walkway (X77)	1	87, 50, 50 &87	S
78.	Construction of solar-powered water project (X78)	Remedial works of road (X78)	Installation of solar-powered street lights (X78)	Constructio n of Concrete Jetty and Walkway (X78)	1	87, 50, 50 &87	S
79.	Construction of solar-powered water project (X79)	Remedial works of road (X79)	Installation of 1 no. 300kva, 11/0.415kv transformer (X79)	Constructio n of Concrete Jetty and Walkway (X79)	0	87, 50, 50 &87	NS
80.	Water scheme: borehole drilling (X80)	Construction of road (X80)	Installation of solar-powered street lights (X80)	Constructio n of Concrete Jetty and Walkway (X80)	1	87, 50, 50 &87	S
81.	Water scheme: Rig platform tank (X81)	Construction of flexible pavement (X81)	Electrifica-tion (X81)	Constructio n of Concrete Jetty and	1	87, 50, 50 &87	S

				Walkway (X81)			
82.	Water scheme: Tank erection (X82)	Construction of road (X82)	Electrifica-tion (X82)	Constructio n of Concrete Jetty and Walkway (X82)	1	87, 50, 50 &87	S
83.	Water scheme: Tank & tank erection (X83)	Repair of secretariat road (X83)	Electrifica-tion (X83)	Constructio n of Concrete Jetty and Walkway (X83)	1	87, 50, 50 &87	S
84.	Water scheme Rig/platform tank (X84)	Remedial works of internal roads (X84)	Rural electrificati on project. (X84)	Constructio n of Concrete Jetty and Walkway (X84)	1	87, 50, 50 &87	S
85.	Construction of sola-r powered water project (X85)	Construction of internal road (X85)	Electrifica-tion (X85)	Constructio n of Concrete Jetty and Walkway (X85)	1	87, 50, 50 &87	S
86.	Construction of solar-powered water project (X86)	Construction of road (X86)	Installation of 1 no. 300kva, 11/0.415kv transformer (X86)	Constructio n of Concrete Jetty and Walkway (X86)	1	87, 50, 50 &87	S
87.	Water scheme: tank & tank erection (X87)	Construction of road (X87)	Installation of solar-powered street lights (X87)	Constructio n of Concrete Jetty and Walkway (X87)	1	87, 50, 50 &87	S
88.	Water scheme: generator house, service quarters, reticulation (X88)	Construction of road (X88)	Installation of 1 no. 300kva, 11/0.415kv transformer (X88)	Constructio n of Concrete Jetty and Walkway (X88)	1	87, 50, 50 &87	S
89.	Construction of solar-powered water project (X89)	Construction of road (X89)	Installation of solar-powered street lights (X89)	Constructio n of Concrete Jetty and Walkway (X89)	1	87, 50, 50 &87	S
90.	Construction of solar-powered water project (X90)	Construction of 2km road (X90)	Installation of solar-powered street lights (X90)	Constructio n of Concrete Jetty and Walkway (X90)	1	87, 50, 50 &87	S

91.	Construction of solar-powered water project (X91)	Construction of Road (X91)	Electrifica-tion (gen. Set) (X91)	Constructio n of Concrete Jetty and Walkway (X91)	1	87, 50, 50 &87	S
92.	Construction of solar-powered water project (X92)	Construction of 2km rigid pavement (X92)	Installation of solar-powered street lights (X92)	Constructio n of Concrete Jetty and Walkway (X92)	1	87, 50, 50 &87	S
93.	Construction of solar-powered water project (X93)	Construction of internal road (X93)	Installation of 1 no. 300kva, 11/0.415kv transformer (X93)	Constructio n of Concrete Jetty and Walkway (X93)	1	87, 50, 50 &87	S
94.	Construction of solar-powered water project (X94)	Remedial work of road (X94)	Installation of 1 no. 500kva, 11/0.415kv transformer (X94)	Constructio n of Concrete Jetty and Walkway (X94)	1	87, 50, 50 &87	S
95.	Construction of solar-powered water project (X95)	Construction of internal road (X95)	Installation of 1 no. 300kva, 11/0.415kv transformer (X95)	Constructio n of Concrete Jetty and Walkway (X95)	0	87, 50, 50 &87	NS
96.	Construction of solar-powered water project (X96)	Construction of internal road (X96)	Electrificati on (X96)	Constructio n of Concrete Jetty and Walkway (X96)	1	87, 50, 50 &87	S
97.	Construction of solar-powered water project (X97)	Construction of internal road (X97)	Installation of solar-powered street lights (X97)	Constructio n of Concrete Jetty and Walkway (X97)	1	87, 50, 50 &87	S
98.	Construction of solar-powered water project (X98)	Construction of internal road (X98)	Installation of 1 no. 300kva, 11/0.415kv transformer (X98)	Constructio n of Concrete Jetty and Walkway (X98)	1	87, 50, 50 &87	S
99.	Construction of solar-powered water project (X99)	Construction of internal road (X99)	Installation of 1 no. 300kva, 11/0.415kv transformer (X99)	Constructio n of Concrete Jetty and Walkway (X99)	1	87, 50, 50 &87	S
100.	Construction of solar-powered water project (X100)	Construction of internal road (X100)	Installation of 500kva, 11/0.415kv transformer (X100)	Constructio n of Concrete Jetty and Walkway (X100)	1	87, 50, 50 &87	S

101.	Construction of solar-powered water project (X101)	Construction of internal road (X101)	Installation of 1 no. 500kva, 11/0.415kv transformer (X101)	Constructio n of Concrete Jetty and Walkway (X101)	1	87, 50, 50 &87	S
102.	Construction of solar-powered water project (X102)	Construction of internal road (X102)	Installation of solar-powered street lights (X102)	Constructio n of Concrete Jetty and Walkway (X102)	1	87, 50, 50 &87	S
103.	Construction of solar-powered water project (X103)	Construction of internal road (X103)	Installation of 1 no. 300kva, 11/0.415kv transformer (X103)		1	87, 50, 50 &87	S
104.	Construction of solar-powered water project (X104)	Construction of internal road (X104)	Installation of 1 no. 300kva, 11/0.415kv transformer (X104)		1	87, 50, 50 &87	S
105.	Construction of solar-powered water project (X105)	Construction of internal road (X105)	Installation of 1 no. 300kva, 11/0.415kv transformer (X105)		1	87, 50, 50 &87	S
106.	Construction of solar-powered water project (X106)	Construction of internal road (X106)	Installation of solar-powered street lights (X106)		1	87, 50, 50 &87	S
107.	Water scheme: service quarters, Gen. House & reticulation (X107)	Construction of flexible pavement (X107)	Installation of 1 no. 300kva, 11/0.415kv transformer (X107)		1	87, 50, 50 &87	S
108.	Water scheme: tank erection (108)	Construction of internal road (X108)	Constructio n of 1 x 1.5mva 33/11kv injection substation (X108)		1	87, 50, 50 &87	S
109.	Water scheme: Gen. House & reticulations (X109)	Construction of 7.5km road with rigid pavement (X109)	Installation of solar-powered street lights (X109)		0	87, 50, 50 &87	NS
110.	Water scheme: generator	Construction of 7.5km road with rigid	Installation of 1 no. 500kva,		0	87, 50, 50	NS

	house & service quarters (X110)	pavement (X110)	11/0.415kv transformer (X110)			&87	
111.	Water scheme: Gen. House service quarters & reticulations (X111)	Construction of 7.5km road with rigid pavement (X111)	Installation of 1 no. 300kva, 11/0.415kv transformer (X111)		1	87, 50, 50 &87	S
112.	Water scheme: Generator house, service quarters & reticulation (X112)	Construction of 7.5km road with rigid pavement (X112)	Installation of 1 no. 500kva, 11/0.415kv transformer (X112)		1	87, 50, 50 &87	S
113.	Water scheme: borehole drilling (X113)	Construction of 7.5km road with rigid pavement (X113)	Installation of 1 no. 500kva, 11/0.415kv transformer (X113)		1	87, 50, 50 &87	S
114.	Water project: Overhead tank, water distribution and public water stand (X114)	Construction of 7.5km road with rigid pavement (X114)	Installation of 1 no. 300kva, 11/0.415kv transformer (X114)		0	87, 50, 50 &87	NS
115.	Construction of solar-powered water project (X115)	Construction of 7.5km road with rigid pavement (X115)	Installation of solar-powered street lights (X115)		1	87, 50, 50 &87	S
116.	Construction of solar-powered water project (X116)	Construction of 3km road (X116)	Installation of 1 no. 300kva, 11/0.415kv transformer (X116)		1	87, 50, 50 &87	S
117.	Construction of solar-powered water project (X117)	Construction of 2.5km road (X117)	Installation of 1 no. 500kva, 11/0.415kv transformer (X117)		1	87, 50, 50 &87	S
118.	Water scheme: Gen. House, service quarters & reticulations (X118)	Construction of road (X118)	Electrifica-tion (gen-set) (X118)		1	87, 50, 50 &87	S

119.	Construction of solar-powered water project (X119)	Construction of road (X119)	Installation of solar-powered street lights (X119)		1	87, 50, 50 &87	
120.	Construction of solar-powered water project (X120)	Construction of 2km road (X120)	Electrification project (X120)		1	87, 50, 50 &87	S
121.	Construction of solar-powered water project (X121)	Construction of road (X121)	Installation of 1 no. 300kva, 11/0.415kv transformer (X121)		1	87, 50, 50 &87	S
122.	Construction of solar-powered water project (X122)	Construction of road (X122)	Installation of 1 no. 500kva, 11/0.415kv transformer (X122)		1	87, 50, 50 &87	S
123.	Construction of solar-powered water project (X123)	Construction of road (X123)	Installation of solar-powered street lights (X123)		1	87, 50, 50 &87	S
124.	Construction of solar-powered water project (X124)	Repairs of failed portions of road (X124)	Installation of 1 no. 300kva, 11/0.415kv transformer (X124)		1	87, 50, 50 &87	S
125.	Construction of solar-powered water project (X125)	Repairs of failed portions of road (X125)	Installation of solar-powered street lights (X125)		1	87, 50, 50 &87	S
126.	Construction of solar-powered water project (X126)	Repairs of failed portions of road (X126)	Installation of 1 no. 300kva, 11/0.415kv transformer (X126)		1	87, 50, 50 &87	S
127.		Repairs of failed portions of road (X127)	Installation of 2 500kva, 33/0.415kv transformers (X127)		0	87, 50, 50 &87	NS
128.		Repairs of failed portions of road (X128)	Installation of 3 300kva, 33/0.415kv transformers (X128)		0	87, 50, 50 &87	NS

129.		Repairs of failed portions of road (X129)	Installation of 300kva, 11/0.415kv transformer (X129)		1	87, 50, 50 &87	S
130.		Repairs of failed portions of road (X130)	Installation of solar-powered street lights (X130)		1	87, 50, 50 &87	S
131.		Repairs of failed portions of road (X131)	Installation of 1 no. 300kva, 11/0.415kv transformer (X131)		0	87, 50, 50 &87	NS
132.		Repairs of failed portions of road (X132)	Installation of 1 no. 300kva, 11/0.415kv transformer (X132)		1	87, 50, 50 &87	S
133.		Repairs of failed portions of road (X133)	Installation of 1 no. 300kva, 11/0.415kv transformer (X133)		1	87, 50, 50 &87	S
134.		Repairs of failed portions of road (X134)	Installation of 1 no. 300kva, 11/0.415kv transformer (X134)		1	87, 50, 50 &87	S
135.		Repairs of failed portions of road (X135)	Installation of 1 no. 500kva, 11/0.415kv transformer (X135)		1	87, 50, 50 &87	S
136.		Repairs of failed portions of road 2 (X136)	Installation of 1 no. 300kva, 11/0.415kv transformer (X136)		1	87, 50, 50 &87	S
137.		Repairs of failed portions of road (X137)	Installation of 1 no. 500kva, 11/0.415kv transformer (X137)		1	87, 50, 50 &87	S
138.		Repairs of failed portions of road (X138)	Installation of 1 no. 500kva, 11/0.415kv transformer (X138)		0	87, 50, 50 &87	NS
139.		Remedial works on	Installation of 1 no.		0	87, 50,	NS

		failed portions of road (X139)	500kva, 11/0.415kv transformer (X139)			50 &87	
140.		Remedial works on failed portions of road (X140)	Installation of 1 no. 300kva, 11/0.415kv transformer (X140)		1	87, 50, 50 &87	S
141.		Remedial works on failed portions of road (X141)	Installation of 300kva, 11/0.415kv transformer (X141)		1	87, 50, 50 &87	S
142.		Remedial works on failed portions of road (X142)	Installation of 1 no. 300kva, 11/0.415kv transformer (X142)		1	87, 50, 50 &87	S
143.		Remedial works on failed portions of road (X143)	Installation of solar-powered street lights (X143)		1	87, 50, 50 &87	S
144.		Remedial works on failed portions of road (X144)	Installation of 1 no. 300kva, 11/0.415kv transformer (X144)		0	87, 50, 50 &87	NS
145.		Remedial works on failed portions of road (X145)	Constructio n of 1.5mva 33/11kv injection substation (X145)		1	87, 50, 50 &87	S
146.		Remedial works on failed portions of Road (X146)	Installation of solar-powered street lights (X146)		0	87, 50, 50 &87	NS
147.		Remedial works on failed portions of road (X147)	Installation of 1 no. 500kva, 11/0.415kv transformer (X147)		1	87, 50, 50 &87	S
148.		Remedial works on failed portions of road (X148)	Installation of 1 no. 300kva, 11/0.415kv transformer (X148)		1	87, 50, 50 &87	S
149.		Remedial works on failed	Installation of 500kva, 11/0.415kv		1	87, 50, 50 &87	S

		portions of road (X149)	transformer (X149)				
150.		Remedial works on failed portions of road (X150)	Installation of 1 no. 500kva, 11/0.415kv transformer (X150)		1	87, 50, 50 &87	S
151.		Remedial works on failed portions of road (X151)	Installation of 1 no. 300kva, 11/0.415kv transformer (X151)		1	87, 50, 50 &87	S
152.		Remedial works on failed portions of road (X152)	Installation of solar-powered street lights (X152)		1	87, 50, 50 &87	S
153.		Remedial works on failed portions of road (X153)	Installation of 1 no. 300kva, 11/0.415kv transformer (X153)		1	87, 50, 50 &87	S
154.		Remedial works on failed portions of road (X154)	Installation of 1 no. 500kva, 11/0.415kv transformer (X154)		1	87, 50, 50 &87	S
155.		Remedial works on failed portions of road (X155)	Electrificati on (gen-set) (X155)		1	87, 50, 50 &87	S
156.		Remedial works on failed portions of road (X156)	Installation of solar-powered street lights (X156)		1	87, 50, 50 &87	S
157.		Remedial works on failed portions of road (X157)	Electrificati on project (X157)		1	87, 50, 50 &87	S
158.		Remedial works on failed portions of road (X158)	Installation of 1 no. 300kva, 11/0.415kv transformer (X158)		1	87, 50, 50 &87	
159.		Remedial works on failed portions of road (X159)	Installation of 1 no. 500kva, 11/0.415kv transformer (X159)		1	87, 50, 50 &87	S
160.		Remedial works on	Installation of solar-		1	87, 50,	S

		failed portions of road (X160)	powered street lights (X160)			50 &87	
161.		Remedial works on failed portions of road (X161)	Installation of 1 no. 300kva, 11/0.415kv transformer (X161)		1	87, 50, 50 &87	S
162.		Remedial works on failed portions of road (X162)	Installation of solar-powered street lights (X162)		1	87, 50, 50 &87	S
163.		Remedial works on failed portions of road (X163)	Installation of 1 no. 300kva, 11/0.415kv transformer (X163)		1	87, 50, 50 &87	S
164.		Remedial works on failed portions of road (X164)	Installation of 2 no. 500kva, 11/0.415kv transformer (X164)		1	87, 50, 50 &87	S
165.		Remedial works on failed portions of road (X165)	Installation of 3 no. 300kva, 11/0.415kv transformer (X165)		1	87, 50, 50 &87	S
166.		Construction of road (X166)	Installation of 1 no. 300kva, 11/0.415kv transformer (X166)		1	87, 50, 50 &87	S
167.		Construction of road (X167)	Installation of 1 no. 500kva, 11/0.415kv transformer (X167)		1	87, 50, 50 &87	S
168.		Construction of road (X168)	Installation of 300kva, 11/0.415kv transformer (X168)		1	87, 50, 50 &87	S
169.		Construction of road (X169)	Installation of 300kva, 11/0.415kv transformer (X169)		1	87, 50, 50 &87	S
170.		Construction of road (X170)	Installation of 300kva, 11/0.415kv transformer (X170)		1	87, 50, 50 &87	S

171.		Construction of road (X171)	Installation of 1 no. 300kva, 11/0.415kv transformer (X171)		1	87, 50, 50 &87	S
172.		Construction of road (X172)	Installation of 1 no. 500kva, 11/0.415kv transformer (X172)		1	87, 50, 50 &87	S
173.		Construction of road (X173)	Installation of 1 no. 300kva, 11/0.415kv transformer (X173)		1	87, 50, 50 &87	S
174.		Construction of road (X174)	Installation of solar-powered street lights (X174)		1	87, 50, 50 &87	
175.		Construction of road (X175)	Electrification (completion) (X175)		1	87, 50, 50 &87	S
176.		Construction of road (X176)	Installation of 1 no. 300kva, 11/0.415kv transformer (X176)		0	87, 50, 50 &87	NS
177.		Construction of road (X177)	Installation of 1 no. 300kva, 11/0.415kv transformer (X177)		1	87, 50, 50 &87	S
178.		Construction of road (X178)	Construction of 132kv transmission line & 132kv/33kv substation (X178)		1	87, 50, 50 &87	S
179.		Construction of road (X179)	Electrification (X179)		1	87, 50, 50 &87	S
180.		Construction of road (X180)	Electrifica-tion (X180)		1	87, 50, 50 &87	S
181.		Construction of road (X181)	Installation of 1 300kva, 11/0.415kv		1	87, 50, 50 &87	S

			transformer (X181)				
182.		Construction of road (X182)	Installation of 1 no. 300kva, 11/0.415kv transformer (X182)		1	87, 50, 50 &87	S
183.		Construction of road (X183)	Installation of 1 no. 300kva, 11/0.415kv transformer (X183)		0	87,50, 50 &87	NS
184.		Construction of road (X184)	Installation of 300kva, 11/0.415kv transformer (X184)		1	87, 50, 50 &87	S
185.		Construction of road (X185)	Electrifica-tion (X185)		1	87, 50, 50 &87	S
186.		Remedial works on failed portions of road (X186)	Installation of 1 no. 300kva, 11/0.415kv transformer (X186)		1	87, 50, 50 &87	S
187.		Remedial works on failed portions of road (X187)	Installation of 1 no. 500kva, 11/0.415kv transformer (X187)		1	87, 50, 50 &87	S
188.		Remedial works on failed portions of road (X188)	Installation of 1 no. 300kva, 11/0.415kv transformer (X188)		0	87, 50, 50 &87	NS
189.		Remedial works on failed portions of road (X189)	Installation of 1 no. 500kva, 11/0.415kv transformer (X189)		1	87, 50, 50 &87	S
190.		Remedial works on failed portions of Road (X190)	Installation of 1 no. 500kva, 11/0.415kv transformer (X190)		1	87, 50, 50 &87	S
191.		Remedial works on failed portions of road (X191)	Rural electrifica-tion (X191)		1	87, 50, 50 &87	S
192.		Remedial works on	Electrificati on (X192)		1	87, 50,	S

		failed portions of road (X192)				50 &87	
193.		Remedial works on failed portions of road (X193)	Electrifica-tion project/ rehabilitati on of township distribution network (X193)		1	87, 50, 50 &87	S
194.		Remedial works on failed portions of road (X194)	Installation of 1 no. 300kva, 11/0.415kv transformer (X194)		1	87, 50, 50 &87	S
195.		Remedial works on failed portions of road (X195)	Installation of 1 no. 500kva, 11/0.415kv transformer (X195)		1	87, 50, 50 &87	S
196.		Remedial works on failed portions of road (X196)	Installation of 1 no. 300kva, 11/0.415kv transformer (X196)		0	87, 50, 50 &87	NS
197.		Remedial works on failed portions of road (X197)	Installation of 1 no. 300kva, 11/0.415kv transformer (X197)		1	87, 50, 50 &87	S
198.			Installation of 1 no. 300kva, 11/0.415kv transformer (X198)		1	87, 50, 50 &87	S
199.			Installation of 1 no. 300kva, 11/0.415kv transformer (X199)		1	87, 50, 50 &87	S
200.			Installation of 1 no. 300kva, 11/0.415kv transformer (X200)		1	87, 50, 50 &87	S
201.			Installation of 1 no. 300kva, 11/0.415kv transformer (X201)		1	87, 50, 50 &87	S

202.			Installation of 1 no. 500kva, 11/0.415kv transformer (X202)		1	87, 50, 50 &87	S
203.			Installation of 1 no. 500kva, 11/0.415kv transformer (X203)		0	87, 50, 50 &87	NS
204.			Installation of 1 no. 300kva, 11/0.415kv transformer (X204)		1	87, 50, 50 &87	S
205.			Installation of 1 no. 300kva, 11/0.415kv transformer (X205)		1	87, 50, 50 &87	S
206.			Installation of 1 no. 300kva, 11/0.415kv transformer (X206)		1	87, 50, 50 &87	S
207.			Installation of 1 no. 300kva, 11/0.415kv transformer (X207)		0	87, 50, 50 &87	NS
208.			Installation of 1 no. 500kva, 11/0.415kv transformer (X208)		1	87, 50, 50 &87	S
209.			Installation of 1 no. 500kva, 11/0.415kv transformer (X209)		1	87, 50, 50 &87	S
210.			Installation of 1 no. 500kva, 11/0.415kv transformer (X210)		0	87, 50, 50 &87	NS
211.			Installation of 1 no. 500kva, 11/0.415kv transformer (X211)		0	87, 50, 50 &87	NS

212.			Installation of 1 no. 300kva, 11/0.415kv transformer (X212)		0	87, 50, 50 &87	NS
213.			Electrification project. (X213)		1	87, 50, 50 &87	S
214.			Installation of 1 no. 300kva, 11/0.415kv transformer (X214)		0	87, 50, 50 &87	NS
215.			Installation of 1 no. 300kva, 11/0.415kv transformer (X215)		1	87, 50, 50 &87	S
216.			Installation of solar-powered street lights (X216)		1	87, 50, 50 &87	S
217.			Solar-powered electrification project (X217)		1	87, 50, 50 &87	S
218.			Installation of 1 no. 300kva, 11/0.415kv transformer (X218)		1	87, 50, 50 &87	S
219.			Installation of 1 no. 300kva, 11/0.415kv transformer (X219)		1	87, 50, 50 &87	S
220.			Installation of 1 no. 300kva, 11/0.415kv transformer (X220)		0	87, 50, 50 &87	NS
221.			Installation of 1 no. 500kva, 11/0.415kv transformer (X221)		0	87,50, 50 &87	NS
222.			Electrification project (X222)		1	87,50, 50 &87	S

223.			Installation of solar-powered street lights (X223)		1	87,50, 50 &87	S
224.			Installation of 1 no. 500kva, 11/0.415kv transformer (X224)		1	87,50, 50 &87	S
225.			Installation of 1 no. 300kva, 11/0.415kv transformer (X225)		0	87,50, 50 &87	NS
226.			Installation of solar-powered street lights (X226)		1	87,50, 50 &87	S
227.			Installation of 1 no. 300kva, 11/0.415kv transformer (X227)		1	87,50, 50 &87	S
228.			Installation of 1 no. 300kva, 11/0.415kv transformer (X228)		1	87,50, 50 &87	S
229.			Installation of 1 no. 300kva, 11/0.415kv transformer (X229)		1	87,50, 50 &87	S
230.			Installation of 1 no. 300kva, 11/0.415kv transformer (X230)		0	87,50, 50 &87	NS
231.			Installation of solar-powered street lights (X231)		0	87, 50, 50 &87	NS
232.			Installation of solar-powered street lights (X232)		1	87, 50, 50 &87	S
233.			Installation of solar-powered		1	87, 50, 50 &87	S

			streetlights (X233)				
234.			Installation of solar-powered streetlights (X234)		1	87, 50, 50 &87	S
Total	**126**	**197**	**234**	**102**		**10092, 8800,10100 & 8265**	

NB: NS = NOT SELECTED; N = SELECTED

5.6.2 Discussion of Optimization solutions of hybrid AHP-GP-GA for year four

The hybrid method AHP-GP-GA was solved through the use of the MATLAB software package. Table 5.4 exhibits the optimization results of hybrid AHP-GP-GA projects with solution values of (1) that were appropriate for selection, whereas projects with a value of (0) were not appropriate or eligible for selection. Solar-powered water projects, road building, electrification, and water jetty construction, including walkways, were among the projects being explored for a number of towns. 116 out of 126 solar-powered water projects were selected, creating 10 092 jobs for the communities' inhabitants. 176 road construction projects were selected out of 197, totalling 8800 jobs. In electrification initiatives, 202 out of 234 energy projects were selected, producing 10 100 jobs for the communities; 95 out of 102 water jetty projects with walkways were selected, resulting in the creation of 8265 employment opportunities. The overall cost savings from projects that were not selected was $9.574 billion. The integrated AHP-GP-GA approach provided 200 optimal solutions, which made the approach robust and flexible in terms of decision-making problems and made it possible to select projects from a variety of options where the selected project reflected community needs.

5.7 Plot Function Graphs

5.7.1 AHP-GP-GA Model Graphs for Years One, Two, Three and Four

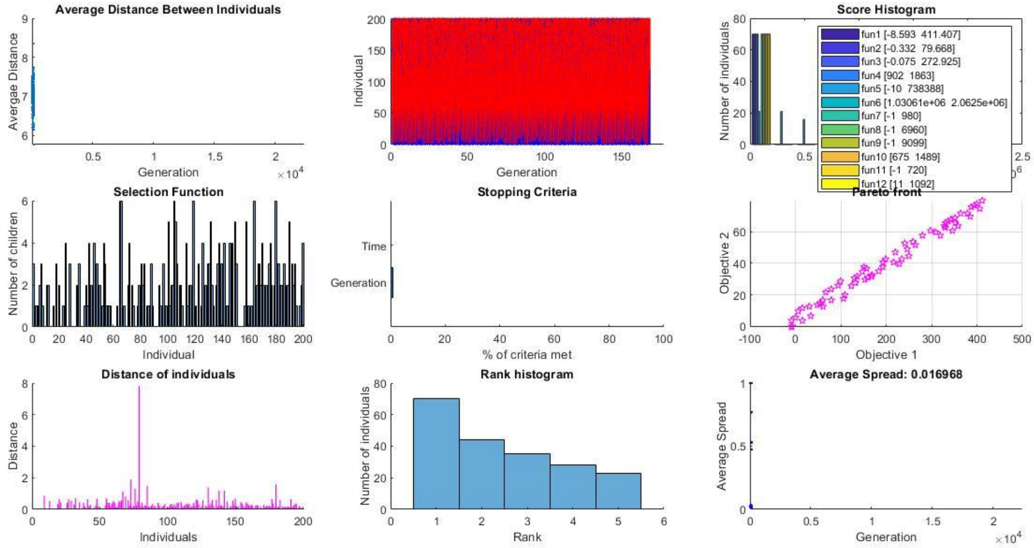

Figure 5.1: Illustrating plot of the Average distance between individuals, Maximum iteration or Generation number, Score histogram, Tournament selection function, Pareto front, Distance of individuals, and Average spread of the solution points for Year One.

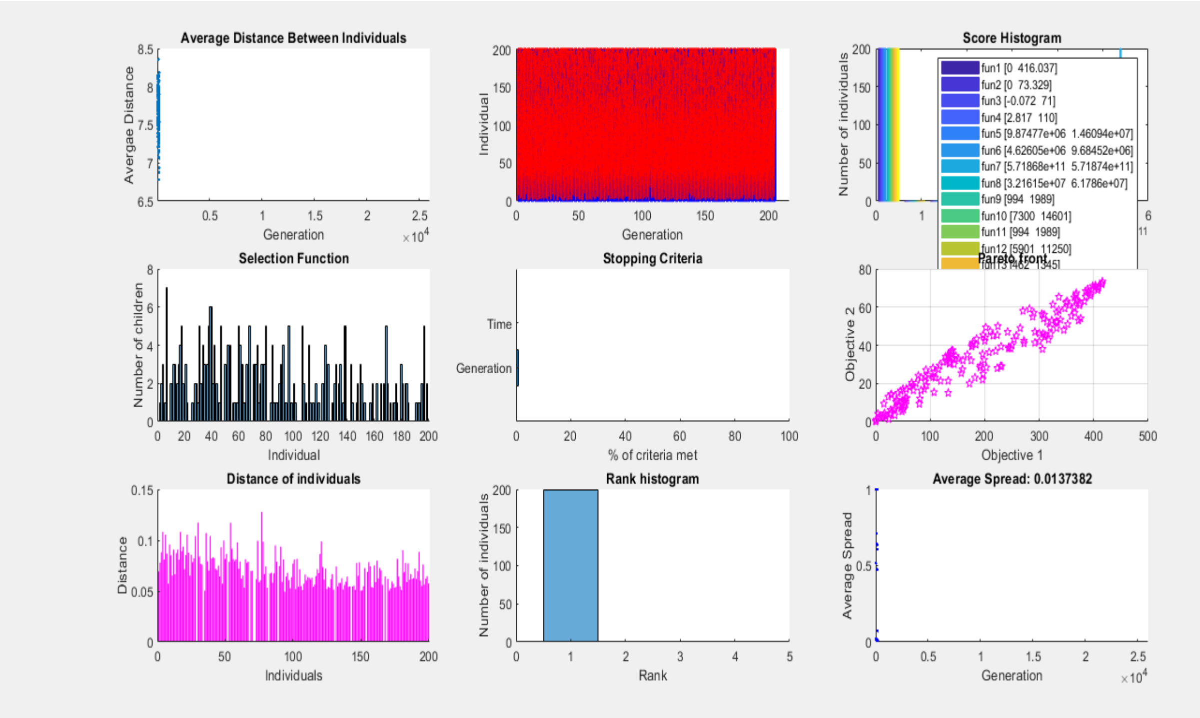

Figure 5.2: Illustrating plot of the Average distance between individuals, Maximum iteration or Generation number, Score histogram, Tournament selection function, Pareto front, Distance of individuals, and Average spread of the solution points for Year Two.

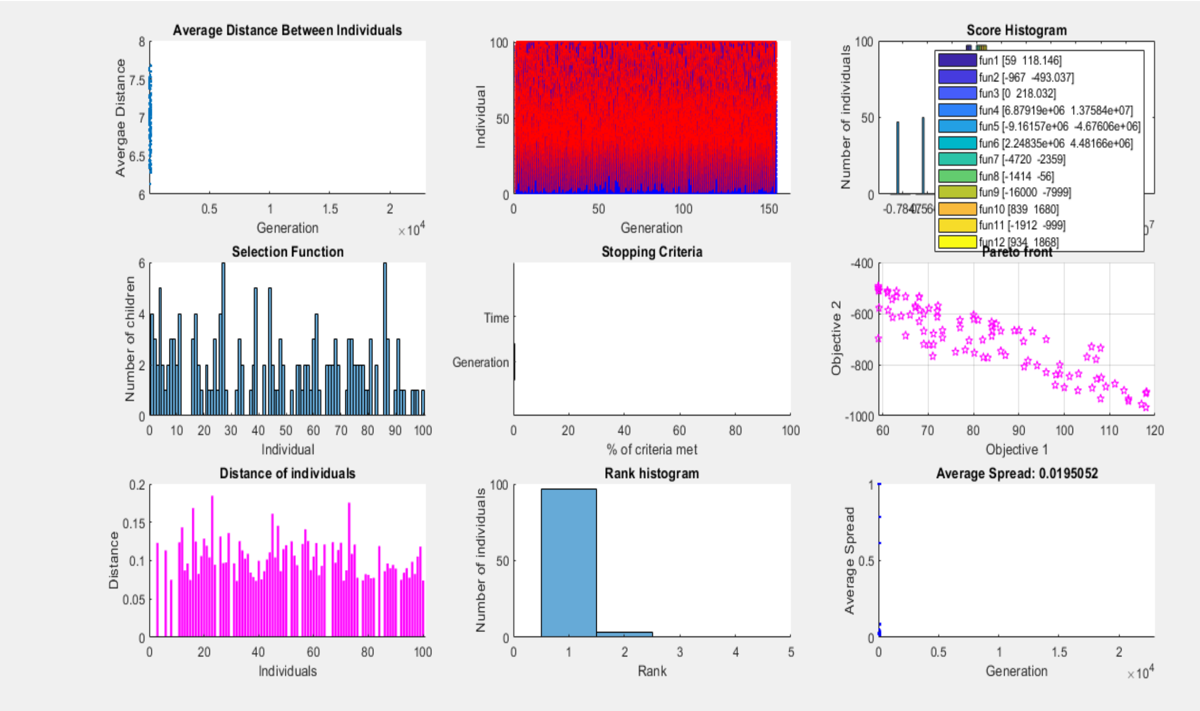

Figure 5.3: Illustrating plot of the Average distance between individuals, Maximum iteration or Generation number, Score histogram, Tournament selection function, Pareto front, Distance of individuals, and Average spread of the solution points for Year Three.

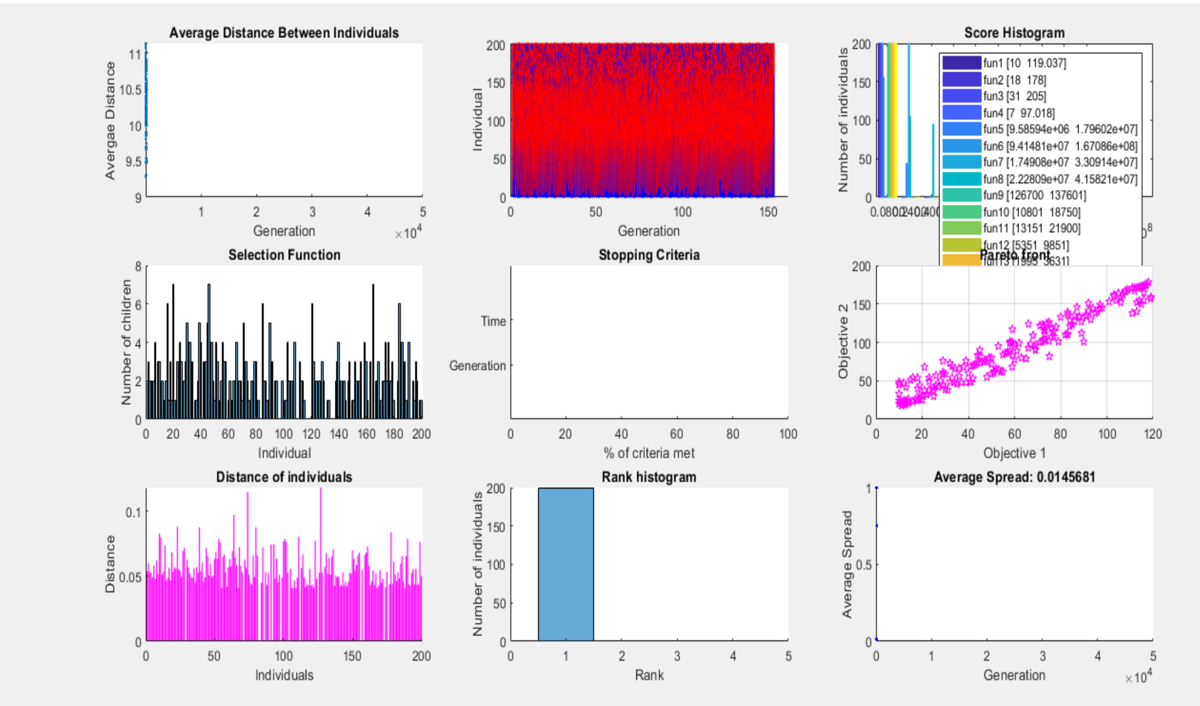

Figure 5.4: Illustrating plot of the Average distance between individuals, Maximum iteration or Generation number, Score histogram, Tournament selection function, Pareto front, Distance of individuals, and Average spread of the solution points for Year Four

5.7.2 Discussion of Plot Function Graphs

Figure 5.1 shows the plotting of the Average distance between individuals, Maximum iteration or Generation number, Score histogram, Tournament selection function, Pareto front, Distance between individuals, and Average spread of the solution points. The average distance between the solutions is fairly constant. The changes are not observable because of the scale, but it is worth noting that the values range from 6.2 to 7.8, which shows there is variance. The average Pareto distance between individuals is 0.0373, the maximum iteration number is 169, and the average spread is 0.0170, with the speed of each run of GA between 0 and 1. The Score histogram exhibits the 12 objective function values at the end of the algorithm operation and the range of objective function values into which the population's scores fall. The selection function is normally distributed, and the number of children, or offspring generated by each changes from 1 to 6, which means that the highest is 6 and the lowest is 1. The distance plot shows that there are variable distances between the variables. It is almost uniform along the individuals but at 75, a high distance is observed. The maximum distance of each individual in the last generation is 8. In the rank histogram, there is a lot of variability in the ranking, but about 25% of the solutions are ranked as the best solution, 75 individuals are ranked as 1, 40 are ranked as 2, etc. In the Pareto front graph, the red points in a straight line indicate Pareto-optimal choices of project selection and represent the true Pareto front. It allows the stakeholders, or decision-makers to make efficient choices in project selection problems. The generated graphs show the robustness and efficiency of the developed approach.

Figure 5.2 shows the plotting of the Average distance between individuals, Maximum iteration or Generation number, Score histogram, Tournament selection function, Pareto front, Distance between individuals and Average spread of the solution points. The average distance between the solutions is fairly constant because of the calibration of the x-axis. The change is not observable because of the scale, but it's noteworthy that the values range from 6.5 to 8.25, which shows there is variance. The average Pareto distance between individuals is 0.0157, the maximum iteration number is 206, and the average spread is 0.0137, with the speed of each run of GA between 0 and 1. The Score histogram showed the objective function values at the end of the algorithm operation. The selection function is normally distributed, and the number of children, or offspring generated by each individual change from 1 to 7, i.e., the highest is 7, and the lowest is 1. The selection function shows there is little variability in the number of children generated by each parent. In the distance of individuals, the minimal distance ranges from 0.075 to 0.15. This shows that there is variability in the distance generated, which is an ideal case for GA optimisation. The maximum distance of each individual in the last generation is 0.13. In the Pareto front graph, the red points in a straight line indicate Pareto-optimal choices of project selection and represent the true Pareto front. It helps the stakeholders make decision makers make the best choices in the project selection problem. Figure 5.3 shows or presents the plotting of the Average distance between individuals, Maximum iteration or Generation number, Score histogram, Tournament selection function, Pareto front, Distance between individuals, and Average spread of the solution points. The average Pareto distance between individuals is 0.0245, the maximum iteration number is 154, and the average spread is 0.0195, with the speed of each run of GA between 0 and 1.

The score histogram shows the objective function values at the end of the algorithm operation. It helps to show the variation of scores for each solution. The rank histogram helps to show the ranking of results. The majority of the population is ranked as 1 (good results) while a few are ranked as 2, which indicates means solutions that did not perform well. It can be said that the histogram is skewed to the left. The selection function shows the number of children each individual generates. The selection function is normally distributed, and the number of children, or offspring generated by each individual changes from 1 to 6. The high randomness shows that selection is not uniform, which is the desired case. The maximum distance of each individual in the last generation is 0.18. The manifestation was that there was variation in the average distance between the individuals that were being generated. The average distance, as seen in the bar chart, is far from a Gaussian Distribution (normal distribution). In the Pareto front graph, the red points in a straight line indicate Pareto-optimal choices of project selection and represent the true Pareto front. It allows the stakeholders, or decision-makers to make effective choices in project selection problems.

Figure 5.4 shows the plotting of the Average distance between individuals, Maximum iteration or Generation number, Score histogram, Tournament selection function, Pareto front, Distance of individuals, and Average spread of the solution points. The average distance among the solutions here is fairly constant, and the change is not observable because of the scale, but it's noteworthy that the values range from 9.25 to 11, which shows there is variance. The average Pareto distance between individuals is 0.0133, the maximum iteration number is 154, and the average spread is 0.0146, with the speed of each run of GA between 0 and 1. The Score histogram showed the objective function values at the end of the algorithm operation. The selection function is normally distributed, and the number of children, or offspring generated by each individual change from 1 to 7, meaning that the highest is 7 and the lowest is 1. The gaps indicated that there were individuals who did not generate offspring. The maximum distance of each individual in the last generation is 0.13. The rank histogram shows that all the solutions were ranked as 1, which means all the solutions are preferred. In the Pareto front graph, the red points in a straight line indicate Pareto-optimal choices of project selection and represents the true Pareto front. It allows the stakeholders, or decision-makers to make effective choices in project selection problems. The generated graphs show the robustness and efficiency of the developed approach.

5.8 Quantification of Jobs Selected

5.8.1 Cash Flow to Communities

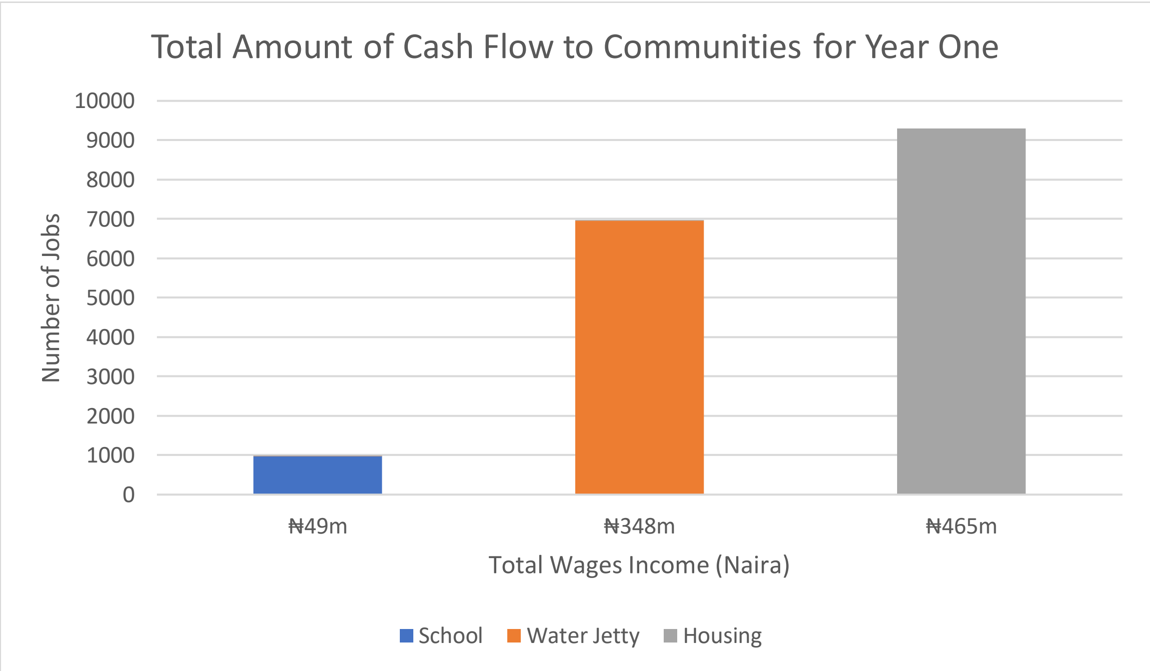

Figure 5.5: Total Cash Flow to Communities

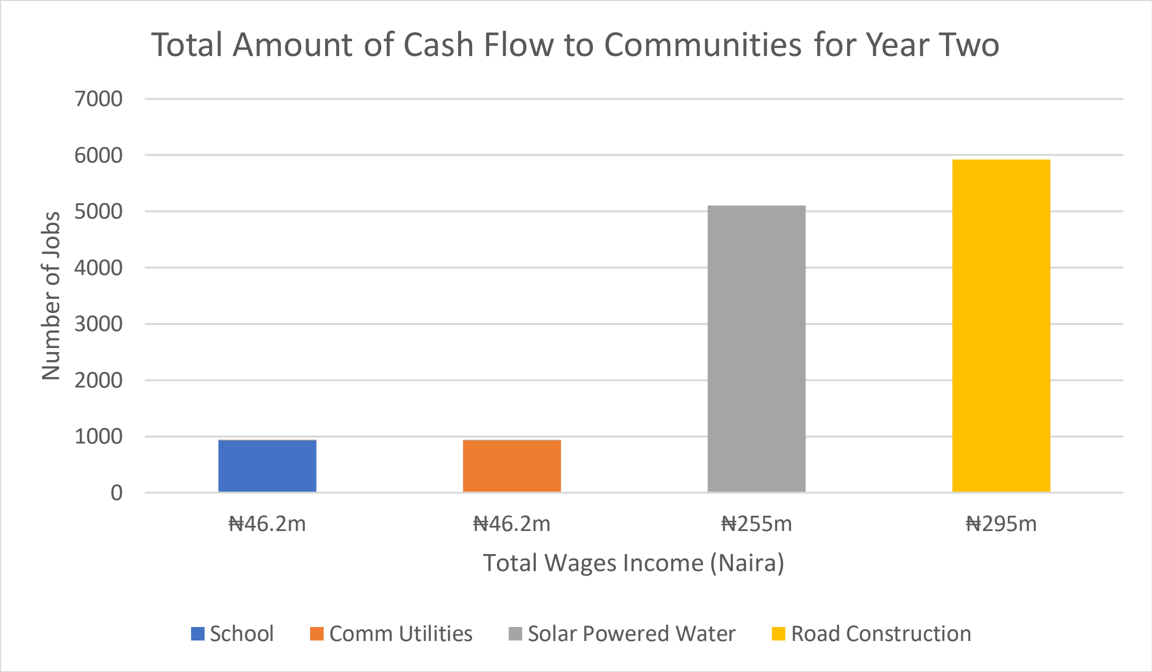

Figure 5.6: Total Cash Flow to Communities

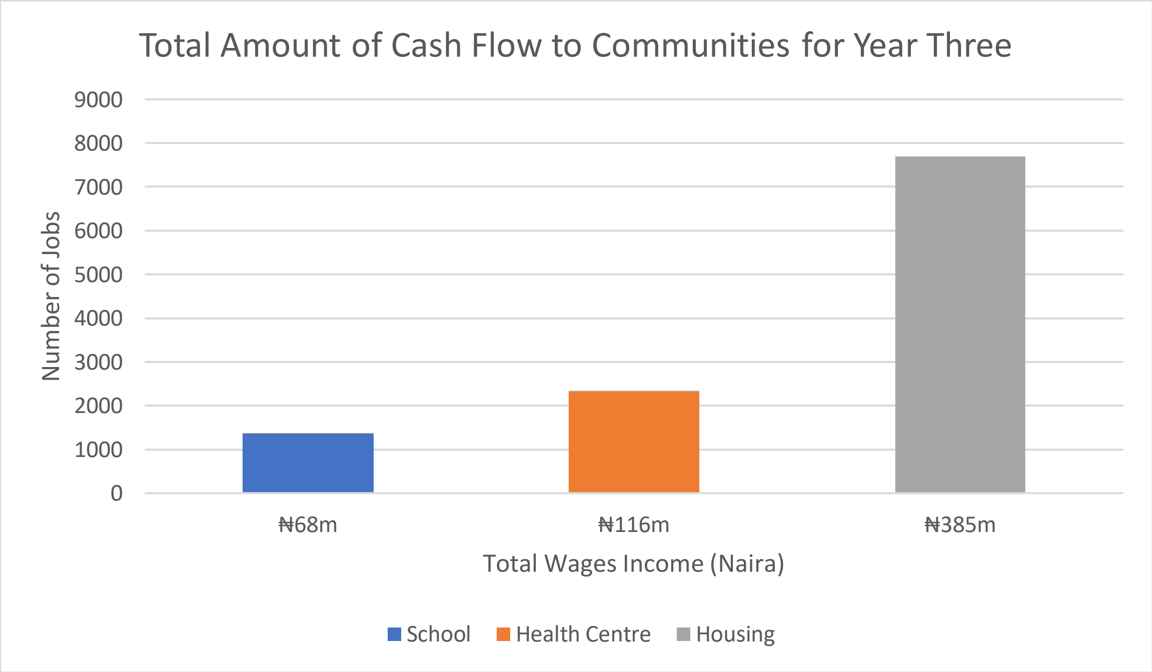

Figure 5.7: Total Cash Flow to Communities

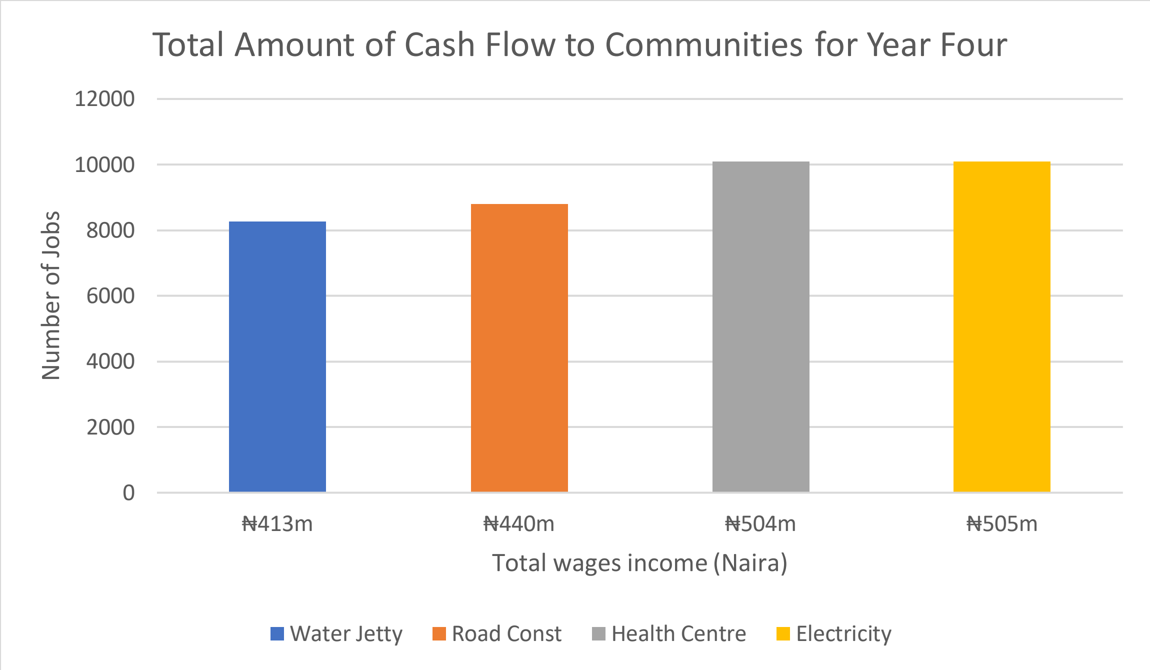

Figure 5.8: Total Cash Flow to Communities

5.8.2 Discussion of Cash Flow to Communities

Figure 5.5 presents the total cash flow to communities where school, water jetty and housing projects were selected. The average wages of jobs created was ₦50,000.00 monthly. The total wages income for 980 jobs for school projects generated is ₦49million, for 6960 jobs for water jetty projects ₦348million is generated, and for 9300 jobs for housing projects ₦465million is generated. If school, water jetty and housing projects were selected together in a community, it would generate 201 jobs with average wages income of ₦10million. Figure 5.6 presents the total cash flow to communities from the school, solar-powered water projects, community utility and civic centre projects and road construction projects where those projects were selected. The average wages of jobs created was ₦50,000.00 monthly. A total number of 924 jobs was generated for school projects translating into an amount of ₦46.2 million in wages income to the communities; likewise, 924 jobs for community utility and civic centre projects represents ₦46.2 million wages in income, 5100 jobs generated in roads construction represents ₦255 million wages in income, and 5916 jobs created in solar-powered water projects represents ₦295.8 million in wages income. If a community had school, solar-powered water, community utility and civic centre projects and road construction projects selected together, it would generate 165 jobs with ₦8.250 million in wages income.

Figure 5.7 presents the total cash flow to communities from health care centre, school and housing projects where those projects were selected. The average wages of jobs created was ₦50,000.00 monthly. A total number of 1358 jobs were generated for school projects amounting to ₦67.9 million in wages income to the communities, 2320 jobs generated in health centre amounted to ₦116 million in wages income, and 7700 jobs created in housing projects amounted to ₦385 million in wages income. If a community had health centre, school, and housing projects selected together, it would generate 154 jobs with ₦7.7 million in wages income.

Figure 5.8 presents the total cash flow to communities where solar-powered water, road construction, electricity and water jetty projects were selected. The average wages of jobs created was ₦50,000.00 monthly. The total wages income generated for 8265 jobs for water jetty projects is ₦413.250 million, 8800 jobs for road construction projects generated ₦440million, 10 092 jobs for solar powered water generated ₦504.6 million and 10 100 jobs for electricity projects generated ₦505 million respectively. If solar-powered water, road construction, electricity and water jetty projects were selected together in a community, it would generate 274 jobs with average wages income of ₦13.7 million. All these projects invariably improved the social life of citizens of those communities including their economy.

5.9 Chapter Summary

This chapter analysed and interpreted the results of PPSP using exact method, integrated exact methods and also hybrid exact and meta-heuristics methods as illustrated in Tables 5.1, 5.2, 5.3 and 5.4. It discussed the results of the AHP model in Tables 4.2, 4.3, 4.4 and 4.5 and presented the attributes of project selection criteria in Figure 4.1. The results in table 4.6 were used as part of the mathematical model formulation in tables 4.2.2, 4.2.3, 4.2.4 and 4.2.5 and were used to solve the PPSP.

The solutions of GP, AHP-GP and AHP-GP-GA were discussed in Table 5.1 including the efficiency of the models used to justify the proposed integrated method. This addressed the objectives of the study by integrated (AHP-GP-GA) to institute correlation and correct the biased or human perception of each model and also applied the developed model in a selected community with a set of projects. Tables 5.2, 5.3 and 5.4 discussed the results of the proposed model for sets of projects in several/different years to justify the integration of GA with other models.

The chapter also discussed the plot function or graph in Figures 5.1, 5.2, 5.3 and 5.4 of the program results to show the optimal results, accuracy and efficiency of the model. The last section presented how the jobs created were quantified to show the total cash flow to the host communities in Figures 5.5, 5.6, 5.7 and 5.8 respectively.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter discusses the research conclusion, underlines the research objectives and shows how each of the objectives was addressed. It supports the research methodology developed for PPSP. The integrated approach was motivated by problem statements such as the need for new optimization methods for NP-hard problems, the fact that exact methods are ineffective at finding optimal solutions to large-scale problems, are computationally expensive or even impossible in some cases, the efficacy of alternative optimization methods such as heuristics or meta-heuristics, and the real-world situation. The chapter also lists some contributions and recommendations that will improve the study of PPS in project management operations including the limitations of the study.

Further research that will contribute to the growth of project management operation using stochastic approaches for improvement and accuracy is discussed.

6.2 Research Conclusion

Project selection management is complicated for project-oriented businesses, especially when decision-makers are constrained by inadequate funds. One of the key interests is choosing an optimal subset that may effectively meet the company's goals while dedicating appropriate resources to the best subset for the project. Project Portfolio Selection Problem (PPSP) entails identifying a portfolio comprised of a set of project proposals chosen by a decision-maker based on one or more criteria (individual or group). In this research, study trends considered the social sustainability, project benefits, criteria for public project selection, and exact algorithms effective for a large-scale number of projects of project portfolio selection problem.

1.) The first objective of the research was to establish an integrated Analytic Hierarchy Process, Goal Programming and Genetic Algorithm (AHP-GP-GA) for PPSP. This objective was achieved and discussed in section 3.2 which stated the six-step sequence of the AHP approach and the priority structure. Section 3.3 formulated the general goal programming model based on the priority structure of the community needs, and section 3.4 stated the main steps of the GA optimization method, including the GA procedure adopted for the study.

2.) The second objective was to establish a relationship for the developed models and remove the bias of each model. The established relationship was presented in figure 1.1. The AHP method developed project criteria priorities and the final weights of the project alternatives and applied them to the developed GP mathematical formulation model, while the GA optimization-based approach solved the integrated AHP-GP objective functions. The limitation, or bias of each model was removed in sections 2.3, 2.4 and 2.6 to justify the developed approach. In section 2.3, the AHP was shown as a powerful tool for decision-making to handle multi-criteria decision making (MCDM) but has its limitations by not being able to find ideal solutions based on organizational goals and constraints conditions for multi-objective optimization to handle multiple, usually conflicting objectives measures, whereas GP overcame the AHP limitations. In section 2.4, it was shown that the goal programming (GP) model cannot handle large numbers of decision variables, in spite of the fact that it can solve the analytical structure of relatively large-scale multi-criteria decision-making problems that a decision maker can use to provide optimal solutions to multiple and conflicting objectives. But in a complex problem with many decision variables, which involve non-smooth and multimodal search spaces, or uncertainty conditions, GP is limited and cannot produce Pareto efficient solutions, but GA has proved to be effective in the multi-modal search spaces and capable of producing Pareto efficient solutions. In section 2.6, the GA is shown as a suitable optimization tool for solving complex problems with a large number of decision variables, which involve non-smooth and multimodal search spaces. However, a portfolio selection from many potential projects can't be handled effectively and efficiently by GA. However, to fill the gap of GA, an integrated model including meta-heuristic algorithms and multicriteria decision-making techniques is better for the selection of a portfolio from many potential projects.

3.) The third objective was to apply the model developed in a selected location/community with a set of large-size projects for optimal solutions. The objective was achieved through the integration of AHP-GP in sections 4.2.2, 4.2.3, 4.2.4 and 4.2.5 and was solved by GA as a solution algorithm for the optimization model that consisted of selection, crossover, and mutation processes as was presented in section 4.3 and discussed extensively in 6.2 and that achieved the overall aim of the study in a multi-objective optimization model for public PPS. The combined AHP-GP-GA model selected more projects compared to the AHP-GP and GP as single methods, that transformed into the construction of many classrooms and the establishment of many jobs and increased business activities for the host communities. The developed approach provided many optimal solutions, which made the approach robust and flexible and able to solve decision making problems and to select projects from a variety of options where the projects reflected community needs. The results established the viability of the method. The developed model was solved employing Logic Spice and MATLAB Software.

6.2.1 Practical and Theoretical Contributions of the Research

The stakeholders that will benefit from the research are project management practitioners like organization management, top executives, senior and junior supervisors, and personnel connected to the projects. It will benefit them in selecting optimal projects from various solution options to improve the lives of the citizens of the host communities, make infrastructural developments that add to nation building, save costs, and handle and select more complex projects in large-scale, real-life situations used for project planning and operations.

The researchers or academia will also benefit from the research by improving their knowledge and understanding of PPSP and it will contribute to the literature to enhance the existing methods of integrated approaches.

Much research has been conducted on project portfolio selection problems, as was demonstrated in prior studies. However, the following findings were drawn from this research:

1.) The developed model known as Analytic Hierarchy Process-Goal Programming-Genetic Algorithm (AHP-GP-GA) is novel in PPSP.

2.) The proposed hybrid method considers both the qualitative and quantitative factors.

3.) The integrated method presents project selection criteria that are more important in public PPSP.

4.) The integrated method reduces or even removes the bias in selecting projects and also provides many options of optimal solutions.

5.) The jobs generated from projects selected were quantified in terms of cash flow to the communities to improve their economies.

6.) The developed approach is robust and flexible to allow for decision making or for decision makers to select projects with various optimal results.

7.) The novel practical approach applied the goal programming method to 100 projects and also the integrated developed method to more than 200 projects.

8.) The hybrid method was added to the literature to enhance the existing methods since the AHP-GP-GA is novel to PPSP.

In summary, the established approach is a useful tool for practitioners to employ in dealing with complicated decision-making problems with a wide range of public project portfolio selection criteria, aims and objectives.

6.2.2 Challenges to Formulate the Developed Approach

Some of the challenges encountered in developing the AHP-GP-GA approach.

1.) The process to identified appropriate project selection criteria and the sub-criteria for public project portfolio selection problems.

2.) To determine the pre-emptive priority for the GP model

3.) In order to allow the population type from the Matlab software to use Bit String, to select projects for optimal solution in integer number (0 or 1), some formulated GP model was restructured along the goal constraint function that included the deviational variables to align with the relative importance weights of project alternatives, by inputting minus sign (-) to the mathematical models

4.) To determine a suitable GA parameter setting, several experiments was conducted.

6.3 Recommendations

The use of a hybrid method in a multi-objective optimization model for PPSP can provide top management, project managers and academia with insights into optimising the use of resources and derive optimum benefits for the organization. However, the successful processing and implementation of the developed approach requires careful consideration of the following recommendations.

1.) The application of the approach is based on the theory of public project portfolio selection and the execution of a framework of developed approaches as expressed in section 3.1 or figure 3.1. The department of the Project Management Office (PMO) with either a budget or financial department could perform this function in the organization to support management or decision makers.

2.) The developed approach does not have a limitation on the number of candidate projects, constraints or objectives. Meanwhile, in a real-life situation the number of objectives or constraints that the application can properly handle could be moderated for accuracy and effectiveness of the approach.

3.) Permission to use the necessary licence for the installation of the software needed for the optimization problem should be obtained.

4.) The practitioners should be familiar with the proposed framework for solving project selection problems.

5.) This practical approach should be made available to industry as a tool for use in their organizations.

6.4 Limitations of the Study

The following are the limitations of the study.

1.) The project selection criteria have four categories with 17 sub-criteria for priority ranking; the inclusion of more criteria might lead to a better decision-making framework.

2.) The study might not be applicable to developed countries as it is intended to be more effective in developing countries that need infrastructure development because developed countries do not need large-scale projects for selection and execution.

6.5 Future Research

The development of a multi-objective optimization model for the project portfolio selection problem should include many further improvements for the advancement of project management as follows:

1.) Integration of stochastic models for the Public Project Portfolio Selection Problem should be considered because stochastic techniques incorporate randomness and uncertainty into the decision-making process. These approaches use probabilistic models, simulation techniques, and stochastic optimization algorithms to reflect the inherent unpredictability and variability in real-world project portfolio selection situations.

2.) Development of more, or new project selection criteria in to be used in solving the Project Portfolio Selection Problem should be undertaken because a project portfolio is a cluster of project proposals selected by decision-makers based on one or more criteria. Meanwhile, PPSP relies on several criteria being considered by decision-makers.

3.) Consideration should be given to other evolutionary algorithms or computations like Genetic Programming, Evolution Strategies, Evolutionary Programming, Differential Evolution, Learning Classifier Systems, Particle Swarm Optimization, and Estimation of Distribution Algorithms with AHP and GP. Most evolutionary algorithms are stochastic search and optimization techniques created using the classical evolution theory that is applied on computers. The fundamental concept is that if only those individuals in a population that produce offspring and who meet certain criteria are selected and the other individuals in the population die, the population will have to convene to select those individuals who most closely satisfy the criteria for selection. For dealing with optimization problems, evolutionary algorithms employ mechanisms generated by the evolution of life, such as reproduction, mutation, recombination, natural selection, and survival of the fittest.

4.) Consideration should be given to the development of other meta-heuristics like Simulated Annealing Equation with Exact methods. Simulated annealing is a stochastic global exploration optimization technique and employs chance as part of the exploration process. It renders the technique suitable for nonlinear objective functions, where other local search techniques fail. It is useful for locating optimal global conditions when there are many local optimal conditions and simulated annealing employs the objective function of a problem with optimization.

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APPENDIX: PRIMARY DATA

Table A1: School Projects

Project	Project Description (x)	Town	Duration (Weeks)	Cost (₦ x10^6)	Estimated % completion
1.	Construction of 6 Classroom blocks (6x_1)	1	12	17	100
2.	Construction of 6 Classroom blocks (6x_2)	2	12	17	100
3.	Construction of 6 Classroom blocks (6x_3)	3	12	17	100
4.	Construction of 6 Classroom blocks (6x_4)	4	12	17	100
5.	Construction of 6 Classroom blocks (6x_5)	5	12	17	100
6.	Construction of 6 Classroom blocks (6x_6)	6	12	17	100
7.	Construction of 6 Classroom blocks (6x_7)	7	12	17	100
8.	Construction of 6 Classroom blocks (6x_8)	8	12	17	100
9.	Construction of 6 Classroom blocks (6x_9)	9	12	13	100
10.	Construction of 6 Classroom blocks (6x_{10})	10	12	13	100
11.	Construction of 6 Classroom blocks (6x_{11})	11	12	13	100
12.	Construction of 6 Classroom blocks (6x_{12})	12	12	17	100
13.	Construction of 3 Classroom blocks (6x_{13})	13	7	7	95
14.	Construction of 6 Classroom blocks (6x_{14})	14	12	17	95
15.	Construction of 6 Classroom blocks(6x_{15})	15	12	13	100
16.	Construction of 6 Classroom blocks (6x_{16})	16	12	13	100
17.	Construction of 16 classroom blocks (6x_{17})	17	12	13	100
18.	Construction of 6 Classrooms block (6x_{18})	18	12	17	100
19.	Construction of 6 Classroom blocks (6x_{19})	19	12	17	100
20.	Construction of a Classroom block (6x_{20})	20	7	3	100
21.	Construction of 6 Classroom blocks (6x_{21})	21	12	13	100
22.	Construction of 6 Classroom blocks (6x_{22})	22	12	13	100
23.	Construction of 6 Classroom blocks (6x_{23})	23	12	13	100
24.	Construction of 6 Classroom blocks (6x_{24})	24	12	13	100
25.	Construction of 6 Classroom blocks (6x_{25})	25	12	13	100
26.	Construction of 6 Classroom blocks (6x_{26})	26	12	13	100

27.	Reconstruction of 6 Classroom blocks ($6x_{27}$)	27	12	13	100
28.	Reconstruction of 6 Classroom blocks ($6x_{28}$)	28	12	13	100
29.	Reconstruction of 6 Classroom blocks ($6x_{29}$)	29	12	13	100
30.	Reconstruction of 6 Classroom blocks ($6x_{30}$)	30	12	13	100
31.	Reconstruction of 6 Classroom blocks ($6x_{31}$)	31	12	13	100
32.	Reconstruction of 6 Classroom blocks ($6x_{32}$)	32	12	13	100
33.	Reconstruction of 6 Classroom blocks ($6x_{33}$)	33	12	13	100
34.	Reconstruction of 6 Classroom blocks ($6x_{34}$)	34	12	13	100
35.	Reconstruction of 6 Classroom blocks ($6x_{35}$)	35	12	13	100
36.	Reconstruction of 6 Classroom blocks ($6x_{36}$)	36	12	13	100
37.	Reconstruction of 6 Classroom blocks ($6x_{37}$)	37	12	13	100
38.	Reconstruction of 6 Classroom blocks ($6x_{38}$)	38	12	13	100
39.	Reconstruction of 6 Classroom blocks ($6x_{39}$)	39	12	13	100
40.	Reconstruction of 6 Classroom blocks ($6x_{40}$)	40	12	13	100
41.	Reconstruction of 6 Classroom blocks ($6x_{41}$)	41	12	13	100
42.	Reconstruction of 6 Classroom blocks ($6x_{42}$)	42	12	13	100
43.	Renovation of 6 Classroom blocks ($6x_{43}$)	43	12	13	100
44.	Rehabilitation of 6 Classrooms school ($6x_{44}$)	44	12	13	100
45.	Construction of 6 classroom blocks ($6x_{45}$)	45	12	17	100
46.	Construction of 6 classroom blocks ($6x_{46}$)	46	12	17	100
47.	Construction of 6 classroom blocks ($6x_{47}$)	47	12	13	100
48.	Construction of 6 classroom blocks ($6x_{48}$)	48	12	13	100
49.	Construction of 6 classroom blocks ($6x_{49}$)	49	12	13	100
50.	Construction of 6 classroom blocks ($6x_{50}$)	50	12	13	100
51.	Construction of 3 classroom blocks ($3x_{51}$)	51	7	7	100
52.	Construction of 3 classroom blocks ($3x_{52}$)	52	7	7	100
53.	Construction of 6 classroom blocks ($6x_{53}$)	53	12	13	100
54.	Construction of 6 classroom blocks ($6x_{54}$)	54	12	13	100

55.	Construction of 6 classroom blocks ($6x_{55}$)	55	12	13	100
56.	Construction of 6 classroom blocks ($6x_{56}$)	56	12	13	100
57.	Construction of 6 classroom blocks ($6x_{57}$)	57	12	13	100
58.	Construction of 6 classroom blocks ($6x_{58}$)	58	12	13	100
59.	Construction of 3 classroom blocks ($3x_{59}$)	59	12	13	100
60.	Construction of laboratory block (x_{60})	60	7	7	100
61.	Construction of 6 classroom blocks ($6x_{61}$)	61	12	13	100
62.	Construction of 6 classroom blocks ($6x_{62}$)	62	12	13	100
63.	Construction of 6 classroom blocks ($6x_{63}$)	63	12	13	100
64.	Construction of 6 classroom block ($6x_{64}$)	64	12	13	100
65.	Construction of 6 classroom blocks ($6x_{65}$)	65	12	13	100
66.	Construction of 12 classroom blocks ($12x_{66}$)	66	17	34	100
67.	Construction of 12 classroom blocks ($12x_{67}$)	67	17	26	100
68.	Construction of 6 classroom blocks ($6x_{68}$)	68	12	13	100
69.	Construction of 6 classroom blocks ($6x_{69}$)	69	12	13	100
70.	Construction of 6 classroom blocks ($3x_{70}$)	70	12	7	100
71.	Construction of 6 classroom blocks ($6x_{71}$)	71	12	13	100
72.	Construction of 6 classroom blocks ($6x_{72}$)	72	12	13	100
73.	Construction of 6 classroom blocks ($6x_{73}$)	73	12	13	100
74.	Construction of 3 classroom blocks ($3x_{74}$)	74	7	7	100
75.	Construction of 6 classroom blocks ($6x_{75}$)	75	12	13	100
76.	Construction of 3 classroom blocks ($3x_{76}$)	76	7	7	100
77.	Construction of 6 classroom blocks ($6x_{77}$)	77	12	13	100
	Total cost			**1,039**	

Table A.2: Wooden Jetty

S/N	PROJECT DESCRIPTION (JETTY)	LOCATION	PROJECT COST (₦ x10^3)	DURATION (MONTHS)	% COMPLETION
1.	Wooden Jetty (X1)	1	7,913	9	100
2.	Wooden Jetty (X2)	2	4,372	9	100
3.	Wooden Jetty (X3)	3 `	4,372	9	100
4.	Wooden Jetty (X4)	4	6,257	9	100

5.	Wooden Jetty (X5)	5	6,257	9	100
6.	Wooden Jetty (X6)	6	4,372	9	100
7.	Wooden Jetty (X7)	7	4,372	9	100
8.	Wooden Jetty (X8)	8	6,257	9	100
9.	Wooden Jetty (X9)	9	6,257	9	100
10.	Wooden Jetty (X10)	10	6,041	9	100
11.	Wooden Jetty (X11)	11	4,156	9	100
12.	Wooden Jetty (X12)	12	6,041	9	100
13.	Wooden Jetty (X13)	13	7,083	9	100
14.	Wooden Jetty (X14)	14	6,537	9	100
15.	Wooden Jetty (X15)	15	6,537	9	100
16.	Wooden Jetty (X16)	16	6,257	9	100
17.	Wooden Jetty (X17)	17	8,230	9	100
18.	Wooden Jetty (X18)	18	18,108	9	100
19.	Wooden Jetty (X19)	19	7,125	9	100
20.	Wooden Jetty (X20)	20	6,340	9	100
21.	Wooden Jetty (X21)	21	6,340	9	100
22.	Wooden Jetty (X22)	22	18,324	9	100
23.	Wooden Jetty (X23)	23	4,987	9	100
24.	Wooden Jetty (X24)	24	6,340	9	100
25.	Wooden Jetty (X25)	25	7,688	9	100
26.	Wooden Jetty (X26)	26	7,477	9	100
27.	Wooden Jetty (X27)	27	6,936	9	100
28.	Wooden Jetty (X28)	28	7,135	9	100
29.	Wooden Jetty (X29)	29	6,257	9	100
30.	Wooden Jetty (X30)	30	6,257	9	100
31.	Wooden Jetty (X31)	31	6,041	9	100
32.	Wooden Jetty (X32)	32	6,257	9	100
33.	Wooden Jetty (X33)	33	12,683	9	100
34.	Wooden Jetty (X34)	34	13,098	9	100
35.	Wooden Jetty (X35)	35	9,391	9	100
36.	Wooden Jetty (X36)	36	7,911	9	100
37.	Wooden Jetty (X37)	37	7,082	9	100
38.	Wooden Jetty (X38)	38	9,272	9	100
39.	Wooden Jetty (X39)	39	8,526	9	100
40.	Wooden Jetty (X40)	40	8,526	9	100
41.	Wooden Jetty (X41)	41	9,193	9	100
42.	Wooden Jetty (X42)	42	8,893	9	100
43.	Wooden Jetty (X43)	43	24,144	9	100
44.	Wooden Jetty (X44)	44	14,741	9	100
45.	Wooden Jetty (X45)	45	14,570	9	100
46.	Wooden Jetty (X46)	46	18,324	9	100
47.	Wooden Jetty (X47)	47	7,298	9	100
48.	Wooden Jetty (X49)	48	15,513	9	100
49.	Wooden Jetty (X49)	49	9,279	9	100
50.	Wooden Jetty (X50)	50	10,084	9	100
51.	Wooden Jetty (X51)	51	14,703	9	100
52.	Wooden Jetty (X52)	52	12,288	9	100
53.	Wooden Jetty (X53)	53	5,184	9	100
54.	Wooden Jetty (X54)	54	6,257	9	100
55.	Wooden Jetty (X55)	55	7,683	9	100
56.	Wooden Jetty (X56)	56	12,893	9	100
57.	Wooden Jetty (X57)	57	4,446	9	100
58.	Wooden Jetty (X58)	58	27,233	9	100
59.	Wooden Jetty (X59)	59	4,245	9	100
60.	Wooden Jetty (X60)	60	3,735	9	100
61.	Wooden Jetty (X61)	61	4,123	9	100
62.	Wooden Jetty (X62)	62	6,128	9	100

63.	Wooden Jetty (X63)	63	4,672	9	100
64.	Wooden Jetty (X64)	64	6,281	9	100
65.	Wooden Jetty (X65)	65	7,789	9	100
66.	Wooden Jetty (X66)	66	5,092	9	100
67.	Wooden Jetty (X67)	67	8,320	9	100
68.	Wooden Jetty (X68)	68	6,281	9	100
69.	Wooden Jetty (X69)	69	6,281	9	100
70.	Wooden Jetty (X70)	70	17,186	9	100
71.	Wooden Jetty (X71)	71	7,484	9	100
72.	Wooden Jetty (X72)	72	15,908	9	100
73.	Wooden Jetty (X73)	73	13,308	9	100
74.	Wooden Jetty (X74)	74	24,636	9	100
75.	Wooden Jetty (X75)	75	15,283	9	100
76.	Wooden Jetty (X76)	76	7,323	9	100
77.	Wooden Jetty (X77)	77	5,108	9	100
78.	Wooden Jetty (X78)	78	17,300	9	100
79.	Wooden Jetty (X79)	79	4,644	9	100
80.	Wooden Jetty (X80)	80	4,649	9	100
81.	Wooden Jetty (X81)	81	5,920	9	100
82.	Wooden Jetty (X82)	82	7,247	9	100
83.	Wooden Jetty (X83)	83	15,302	9	100
84.	Wooden Jetty (X84)	84	8,925	9	100
85.	Wooden Jetty (X85)	85	7,660	9	100
86.	Wooden Jetty (X86)	86	6,939	9	100
87.	Wooden Jetty (X87)	87	4,741	9	100
TOTAL			**774,648**		

Table A.3: Housing Projects

S/N	PROJECT DESCRIPTION (HOUSING)	LOCATION	PROJECT COST (₦ x 10^3)	DURATION (MONTHS)	% COMPLETION
1.	Construction of 3-Bedroom Housing unit ($3X_1$)	1	8,606	12	100
2.	Construction of 3-Bedroom Housing unit ($3X_2$)	2	8,606	12	100
3.	Construction of 3-BedroomHousing unit ($3X_3$)	3	8,606	12	100
4.	Construction of 3-Bedroom Housing unit ($3X_4$)	4	8,606	12	100
5.	Construction of 3-Bedroom Housing unit ($3X_5$)	5	8,606	12	100
6.	Construction of 3-Bedroom Housing unit ($3X_6$)	6	8,606	12	100
7.	Construction of 3-Bedroom Housing unit ($3X_7$)	7	8,606	12	100
8.	Construction of 3-Bedroom Housing unit ($3X_8$)	8	8,606	12	100
9.	Construction of 3-Bedroom Housing unit ($3X_9$)	9	8,376	12	100
10.	Construction of 3-Bedroom Housing unit ($3X_{10}$)	10	8,376	12	100
11.	Construction of 3-Bedroom Housing unit ($3X_{11}$)	11	8,376	12	100
12.	Construction of 3-Bedroom Housing unit ($3X_{12}$)	12	8,376	12	100

13.	Construction of 3-Bedroom Housing unit ($3X_{13}$)	13	8,376	12	100
14.	Construction of 3-Bedroom Housing unit ($3X_{14}$)	14	8,376	12	100
15.	Construction of 3-Bedroom Housing unit ($3X_{15}$)	15	8,376	12	100
16.	Construction of 3-Bedroom Housing unit ($3X_{16}$)	16	8,376	12	100
17.	Construction of 3-Bedroom Housing unit ($3X_{16}$)	17	8,376	12	100
18.	Construction of 3-Bedroom Housing unit ($3X_{17}$)	18	8,376	12	100
19.	Construction of 3-Bedroom Housing unit ($3X_{18}$)	19	8,376	12	100
20.	Construction of 3-bedroom Housing unit ($3X_{20}$)	20	8,376	12	100
21.	Construction of 3-Bedroom Housing unit ($3X_{21}$)	21	8,376	12	100
22.	Construction of 3-Bedroom Housing unit ($3X_{22}$)	22	8,376	12	100
23.	Construction of 3-Bedroom Housing unit ($3X_{23}$)	23	8,146	12	100
24.	Construction of 3-Bedroom Housing unit ($3X_{24}$)	24	8,146	12	100
25.	Construction of 3-Bedroom Housing unit ($3X_{25}$)	25	8,146	12	100
26.	Construction of 3-Bedroom Housing unit ($3X_{26}$)	26	8,146	12	100
27.	Construction of 3-Bedroom Housing unit ($3X_{27}$)	27	12,882	12	100
28.	Construction of 3-Bedroom Housing unit ($3X_{28}$)	28	12,882	12	100
29.	Construction of 3-Bedroom Housing unit ($3X_{29}$)	29	12,882	12	100
30.	Construction of 3-Bedroom Housing unit ($3X_{30}$)	30	12,882	12	100
31.	Construction of 3-Bedroom Housing unit ($3X_{31}$)	31	8,376	12	100
32.	Construction of 3-Bedroom Housing unit ($3X_{31}$)	32	8,376	12	100
33.	Construction of 3-Bedroom Housing unit ($3X_{33}$)	33	8,376	12	100
34.	Construction of 3-Bedroom Housing unit ($3X_{34}$)	34	8,376	12	100
35.	Construction of 3-Bedroom Housing unit ($3X_{35}$)	35	12,882	12	100
36.	Construction of 3-Bedroom Housing unit ($3X_{36}$)	36	12,882	12	100
37.	Construction of 3-Bedroom Housing unit ($3X_{37}$)	37	12,882	12	100
38.	Construction of 3-Bedroom Housing unit ($3X_{38}$)	38	12,882	12	100
39.	Construction of 3-Bedroom Housing unit ($3X_{39}$)	39	12,882	12	100
40.	Construction of 3-Bedroom Housing unit ($3X_{40}$)	40	12,882	12	100
41.	Construction of 3-Bedroom Housing unit ($3X_{41}$)	41	12,882	12	100

42.	Construction of 3-Bedroom Housing unit ($3X_{42}$)	42	12,882	12	100
43.	Construction of 3-Bedroom Housing unit ($3X_{43}$)	43	12,882	12	100
44.	Construction of 3-Bedroom Housing unit ($3X_{44}$)	44	12,882	12	100
45.	Construction of 3-Bedroom Housing unit ($3X_{45}$)	45	12,882	12	100
46.	Construction of 3-Bedroom Housing unit ($3X_{46}$)	46	12,882	12	100
47.	Construction of 3-Bedroom Housing unit ($3X_{47}$)	47	12,882	12	100
48.	Construction of 3-Bedroom Housing unit ($3X_{48}$)	48	12,882	12	100
49.	Construction of 3-Bedroom Housing unit ($3X_{49}$)	49	12,882	12	100
50.	Construction of 3-Bedroom Housing unit ($3X_{50}$)	50	12,882	12	100
51.	Construction of 3-Bedroom Housing unit ($3X_{51}$)	51	12,882	12	100
52.	Construction of 3-Bedroom Housing unit ($3X_{52}$)	52	12,882	12	100
53.	Construction of 3-Bedroom Housing unit ($3X_{53}$)	53	12,882	12	100
54.	Construction of 3-Bedroom Housing unit ($3X_{54}$)	54	12,882	12	100
55.	Construction of 3-Bedroom Housing unit ($3X_{55}$)	55	12,882	12	100
56.	Construction of 3-Bedroom Housing unit ($3X_{56}$)	56	12,882	12	100
57.	Construction of 3-Bedroom Housing unit ($3X_{57}$)	57	12,882	12	100
58.	Construction of 3-Bedroom Housing unit ($3X_{58}$)	58	12,882	12	100
59.	Construction of 3-Bedroom Housing unit ($3X_{59}$)	59	12,882	12	100
60.	Construction of 3-Bedroom Housing unit ($3X_{60}$)	60	12,882	12	100
61.	Construction of 3-Bedroom Housing unit ($3X_{61}$)	61	12,882	12	100
62.	Construction of 3-Bedroom Housing unit ($3X_{62}$)	62	12,882	12	100
63.	Construction of 3-Bedroom Housing unit ($3X_{63}$)	63	12,882	12	100
64.	Construction of 3-Bedroom Housing unit ($3X_{64}$)	64	12,882	12	100
65.	Construction of 3-Bedroom Housing unit ($3X_{65}$)	65	12,882	12	100
66.	Construction of 3-Bedroom Housing unit ($3X_{66}$)	66	12,882	12	100
67.	Construction of 3-Bedroom Housing unit ($3X_{67}$)	67	12,882	12	100
68.	Construction of 3-Bedroom Housing unit ($3X_{68}$)	68	12,882	12	100
69.	Construction of 3-Bedroom Housing unit ($3X_{69}$)	69	12,882	12	100
70.	Construction of 3-Bedroom Housing unit ($3X_{70}$)	70	12,882	12	100

71.	Construction of 3-Bedroom Housing unit ($3X_{71}$)	71	12,882	12	100
72.	Construction of 3-Bedroom Housing unit ($3X_{72}$)	72	12,882	12	100
73.	Construction of 3-Bedroom Housing unit ($3X_{73}$)	73	12,882	12	100
74.	Construction of 3-Bedroom Housing unit ($3X_{74}$)	74	12,882	12	100
75.	Construction of 3-Bedroom Housing unit ($3X_{75}$)	75	12,882	12	100
76.	Construction of 3-Bedroom Housing unit ($3X_{76}$)	76	12,882	12	100
77.	Construction of 3-Bedroom Housing unit ($3X_{77}$)	77	12,882	12	100
78.	Construction of 3-Bedroom Housing unit ($3X_{78}$)	78	12,882	12	100
79.	Construction of 3-Bedroom Housing unit ($3X_{79}$)	79	12,882	12	100
80.	Construction of 3-Bedroom Housing unit ($3X_{80}$)	80	12,882	12	100
81.	Construction of 3-Bedroom Housing unit ($3X_{81}$)	81	12,882	12	100
82.	Construction of 3-Bedroom Housing unit ($3X_{82}$)	82	12,882	12	100
83.	Construction of 3-Bedroom Housing unit ($3X_{83}$)	83	12,882	12	100
84.	Construction of 3-Bedroom Housing unit ($3X_{84}$)	84	8,606	12	100
85.	Construction of 3-Bedroom Housing unit ($3X_{85}$)	85	12,882	12	100
86.	Construction of 3-Bedroom Housing unit ($3X_{86}$)	86	12,882	12	100
87.	Construction of 3-Bedroom Housing unit ($3X_{87}$)	87	12,882	12	100
88.	Construction of 3-Bedroom Housing unit ($3X_{88}$)	88	8,376	12	100
89.	Construction of 3-Bedroom Housing unit ($3X_{89}$)	89	8,376	12	100
90.	Construction of 3-Bedroom Housing unit ($3X_{90}$)	90	8,376	12	100
91.	Construction of 3-Bedroom Housing unit ($3X_{91}$)	91	8,376	12	100
92.	Construction of 3-Bedroom Housing unit ($3X_{92}$)	92	8,376	12	100
93.	Construction of 3-Bedroom Housing unit ($3X_{93}$)	93	8,376	12	100
94.	Construction of 3-Bedroom Housing unit ($3X_{94}$)	94	8,376	12	100
95.	Construction of 3-Bedroom Housing unit ($3X_{95}$)	95	8,376	12	100
96.	Construction of 3-Bedroom Housing unit ($3X_{96}$)	96	8,376	12	100
97.	Construction of 3-Bedroom Housing unit ($3X_{97}$)	97	8,376	12	100
98.	Construction of 3-Bedroom Housing unit ($3X_{98}$)	98	8,376	12	100
99.	Construction of 3-Bedroom Housing unit ($3X_{99}$)	99	8,376	12	100

100.	Construction of 3-Bedroom Housing unit ($3X_{100}$)	100	8,376	12	100
TOTAL			1,091,086,000.00		

APPENDIX B: **(Year 2)**

Table B. 1: School Projects

S/N	PROJECT TITLE	LOCATION	PROJECT COST (₦)	DURATION (Months)	% COMPLETION
1	Construction of Mega Caring Heart Primary School Blocks. (X_1)	1.	250,000,000.00	15	60
2	Construction and Equipping of Science Laboratory(X_2)	2.	60,000,000.00	15	100
3	Construction and Equipping of Science Laboratory (X_3)	3.	60,000,000.00	15	100
4	Construction of Science Laboratory (X_4)	4.	53,439,465.13	15	70
5	Construction and Equipping of Science Laboratory (X_5)	5.	60,000,000.00	15	100
6	Construction and Equipping of Science Laboratory (X_6)	6.	54,987,302.00	15	100
7	Construction and Equipping of Science Laboratory (X_7)	7.	99,500,000.00	15	100
8	Construction of 24 Classroom Blocks ($24x_8$)	8.	149,999,001.00	15	100
9	Construction of 6 Wooden Classroom Blocks ($6x_9$)	9.	12,897,279.00	15	100
10	Construction of Science Laboratories (X_{10})	10.	53,439,465.13	15	61
11	Construction and Equipping of Science Laboratory (X_{11})	11.	54,987,302.00	15	100
12	Construction and Equipping of Science Lab (X_{12})	12.	54,987,302.00	15	80
13	Construction and Equipping of Science Laboratory (X_{13})	13.	54,987,302.00	15	100
14	Construction of 12 classroom blocks ($12x_{14}$)	14.	49,855,489.00	15	60
15	Construction & Equipping of Science Laboratories (X_{15})	15.	54,987,302.00	15	85
16	Construction of Science Laboratory (X_{16})	16.	64,877,321.07	15	100
17	Construction of Science Laboratory (X_{17})	17.	52,654,164.54	15	100

18	Construction and Equipping of Science Lab (X_{18})	18.	54,987,382.00	15	75
19	Construction and Equipping of Science Laboratories. (X_{19})	19.	61,343,292.50	15	80
20	Construction of 6 Wooden Classroom Block ($6x_{20}$)	20.	12,897,279.00	15	100
21	Construction and Equipping of Science Laboratory (X_{21})	21.	54,987,302.00	15	100
22	Construction and Equipping of Science Laboratory (X_{22})	22.	54,987,302.00	15	100
23	Construction of Science Laboratory (X_{23})	23.	59,900,000.00	15	100
24	Construction and Equipping of Science Laboratory (X_{24})	24.	100,000,000.00	15	85
25	Construction of 12 Classroom Blocks (Composite) $12x_{25}$	25.	49,692,000.00	15	100
26	Construction of 12 Classroom Blocks ($12x_{26}$)	26.	149,986,346.50	15	90
27	Construction and Equipment of Modern Library (X_{27})	27.	44,635,000.00	15	100
28	Construction of 12 classroom blocks ($12x_{28}$)	28.	49,855,489.00	15	85
29	Renovation of 3 classroom blocks (Wooden) ($3x_{29}$)	29.	10,900,118.50	6	100
30	Renovation of 6 classroom blocks (Wooden) ($6x_{30}$)	30.	17,345,269.27	6	100
31	Renovation of 6 classroom blocks (Wooden) ($6x_{31}$)	31.	25,327,670.79	6	80
32	Renovation of 6 classroom blocks (Wooden) ($6x_{32}$)	32.	21,647,427.90	6	80
33	Renovation of 6 classroom blocks (Wooden) ($6X_{33}$)	33.	15,575,665.87	6	95
34	Renovation of 6 classroom blocks (Wooden) ($6X_{34}$)	34.	21,398,639.79	6	100
35	Renovation of 6 classroom blocks (Sandcrete) ($6X_{35}$)	35.	13,155,696.49	6	100
36	Renovation of 6 classroom blocks (Sandcrete) ($6X_{36}$)	36.	20,342,399.29	6	100
37	Renovation of 6 classroom blocks (Sandcrete) ($6X_{37}$)	37.	13,854.092.35	6	95

38	Renovation of 6 classroom blocks (Sandcrete) ($6X_{38}$)	38.	11,876,905.15	6	100
39	Renovation of 4 classroom blocks (Sandcrete) ($6X_{39}$)	39.	14,696,770.33	6	100
40	Renovation of 4 classroom blocks (Sandcrete) ($4X_{40}$)	40.	9,626,265.23	6	100
41	Renovation of 6 classroom blocks (Wooden) ($6X_{41}$)	41.	21,398,639.79	6	100
42	Model School 12 classroom block ($12X_{42}$)	42.	67,634,763.21	15	100
43	Model School 12 classroom block ($12X_{43}$)	43.	67,670,043.21	15	100
44	Model School 22 classroom block ($22X_{44}$)	44.	112,306,007.05	18	95
45	Model School 22 classroom block ($22X_{45}$)	45.	107,213,395.00	18	80
46	Model School 12 classroom block ($12X_{46}$)	46.	69,454,046.97	15	95
47	Model School 24 classroom block ($24X_{47}$)	47.	124,490,011.28	18	80
48	Model School 12 classroom block($12X_{48}$)	48.	62,619,734.36	15	90
49	Model School 12 classroom block ($12X_{49}$)	49.	66,131,400.00	15	100
50	Construction of a 3-classroom block ($3X_{50}$)	50.	8,382,369.00	6	50
51	Construction of 6 classroom blocks (wooden) ($6X_{51}$)	51.	16,328,635.36	6	100
52	Construction of 6 classroom block (wooden) ($6X_{52}$)	52.	16,146,281.75	6	100
53	Construction of 6 classroom blocks (wooden) ($6X_{53}$)	53.	16,500,000.00	6	50
54	Construction of 12 classroom blocks ($12X_{54}$)	54.	99,361,449.24	15	100
55	Construction of 3 classroom blocks ($3X_{55}$)	55.	8,200,000.00	6	100
56	Construction of 3 classroom blocks ($3X_{56}$)	56.	8,200,000.00	6	85
57	Construction and equipping of science lab (X_{57})	57.	61,343,292.59	15	100
58	Construction of 6 classroom blocks (composite) ($6X_{58}$)	58.	37,179,324.00	15	100
59	Construction of 3 classroom blocks ($3X_{59}$)	59.	8,500,000.00	6	100
60	Completion of 6 classroom blocks ($6X_{60}$)	60.	43,286,825.90	15	100
61	Construction of 6 wooden classroom blocks ($6X_{61}$)	61.	42,897,279.80	6	100

62	Construction of 6 classroom blocks ($6X_{62}$)	62.	32,500,000.09	15	70
63	Const.t. of a 3-classroom block ($3X_{63}$)	63.	8,304,540.80	6	100
64	Construction and equipping of science lab (X_{64})	64.	54,987,302.70	15	100
65	Construction and equipping of science lab (X_{65})	65.	54,987,302.00	15	100
66	Construction and equipping of technical college (X_{66})	66.	997,645,634.78	18	100
67	Construction of science laboratory (X_{67})	67.	59,900,000.00	15	100
68	Construction and equipping of science laboratory (X68)	68.	100,000,000.00	15	100
69	Construction of 12 classroom blocks (composite) ($12X_{69}$)	69.	49,692,000.00	15	100
70	Construction of 22 classroom blocks ($22X_{70}$)	70.	149,986,346.50	18	100
71	Construction and equipment of modern library (X_{71})	71.	44,635,000.00	15	100
			4,748,498,634.21		

Table B. 2: Solar-Powered Water Project

S/N	PROJECT TITLE	LOCATION	PROJECT COST (₦)	DURATION (Months)	% COMPLETION
1.	Construction of Solar-Powered Water Project (X_1)	1	51,975,654.47	15	100
2.	Construction of Solar-Powered Water Project (X_2)	2	88,105,920.00	15	100
3.	Construction of Solar-Powered Water Project (X_3)	3	41,703,678.30	15	100
4.	Construction of Solar-Powered Water Project (X_4)	4	41,703,678.30	15	100
5.	Construction of Solar-Powered Water Project (X_5)	5	63,221,832.54	15	100
6.	Construction of Solar-Powered Water Project (X_6)	6	91,594,794.54	15	100
7.	Construction of Solar-Powered Water Project (X_7)	7	89,036,653.20	15	100

8.	Construction of Solar-Powered Water Project (X_8)	8	89,915,232.00	15	100
9.	Construction of Solar-Powered Water Project (X_9)	9	100,000,000.00	15	100
10.	Construction of Solar-Powered Water Project (X_{10})	10	61,035,777.50	15	100
11.	Construction of Solar-Powered Water Project (X_{11})	11	41,703,678.30	15	100
12.	Construction of Solar-Powered Water Project (X_{12})	12	41,703,678.30	15	100
13.	Construction of Solar-Powered Water Project (X_{13})	13	41,703,678.30	15	100
14.	Construction of Solar-Powered Water Project (X_{14})	14	50,000,000.00	15	100
15.	Construction of Solar-Powered Water Project (X_{15})	15	42,305,333.34	15	100
16.	Construction of Solar-Powered Water Project (X_{16})	16	81,265,357.00	15	85
17.	Construction of Solar-Powered Water Project (X_{17})	17	42,305,333.34	15	100
18.	Construction of Solar-Powered Water Project (X_{18})	18	42,000,000.00	15	100
19.	Construction of Solar-Powered Water Project (X_{19})	19	42,305,333.34	15	85
20.	Construction of Solar-Powered Water Project (X_{20})	20	98,500,000.00	15	100
21.	Construction of Solar-Powered Water Project (X_{21})	21	81,265,356.00	15	100
22.	Construction of Solar-Powered Water Project (X_{22})	22	240,020,000.00	15	100
23.	Construction of Solar-Powered Water Project (X_{23})	23	47,825,093.34	15	80
24.	Construction of Solar-Powered Water Project (X_{24})	24	49,999,001.00	15	100
25.	Construction of Solar-Powered Water Project (X_{25})	25	47,825,093.00	15	100
26.	Construction of Solar-Powered Water Project (X_{26})	26	61,243,583.00	15	100

27.	Construction of Solar-Powered Water Project (X_{27})	27	48,690,837.54	15	100
28.	Construction of Solar-Powered Water Project (X_{28})	28	47,825,093.34	15	100
29.	Construction of Solar-Powered Water Project (X_{29})	29	60,179,871.54	15	100
30.	Construction of Solar-Powered Water Project (X_{30})	30	54,262,337.00	15	100
31.	Construction of Solar-Powered Water Project (X_{31})	31	100,000,000.00	15	100
32.	Construction of Solar Powered Water Project (X_{32})	32	49,788,218.77	15	100
33.	Construction of Solar-Powered Water Project (X_{33})	33	42,305,333.34	15	100
34.	Construction of Solar-Powered Water Project (X_{34})	34	51,975,654.42	15	85
35.	Construction of Solar-Powered Water Project (X_{35})	35	55,913,819.40	15	95
36.	Construction of Solar-Powered Water Project (X_{36})	36	99,999,001.00	15	100
37.	Construction of Solar-Powered Water Project (X_{37})	37	50,838,048.00	15	100
38.	Construction of Solar-Powered Water Project (X_{38})	38	60,624,471.54	15	100
39.	Construction of Solar-Powered Water Project (X_{39})	39	41,800,000.00	15	100
40.	Construction of Solar-Powered Water Project (X_{40})	40	79,999,001.00	15	100
41.	Construction of Solar-Powered Water Project (X_{41})	41	100,000,000.00	15	100
42.	Construction of Solar-Powered Water Project (X_{42})	42	83,328,661.90	15	100
43.	Construction of Solar-Powered Water Project (X_{43})	43	41,703,678.30	15	100
44.	Construction of Solar-Powered Water Project (X_{44})	44	41,703,678.30	15	100
45.	Construction of Solar-Powered Water Project (X_{45})	45	81,265,356.00	15	100

46.	Construction of Solar-Powered Water Project (X_{46})	46	55,000,000.00	15	100
47.	Construction of Solar-Powered Water Project (X_{47})	47	46,501,830.00	15	100
48.	Construction of Solar-Powered Water Project (X_{48})	48	50,800,345.10	15	90
49.	Construction of Solar-Powered Water Project (X_{49})	49	59,999,001.00	15	100
50.	Construction of Solar-Powered Water Project (X_{50})	50	49,999,001.00	15	100
51.	Construction of Solar-Powered Water Project (X_{51})	51	50,000,000.00	15	100
52.	Construction of Solar-Powered Water Project (X_{52})	52	41,703,678.30	15	100
53.	Construction of Solar-Powered Water Project (X_{53})	53	47,825,093.34	15	100
54.	Construction of Solar-Powered Water Project (X_{54})	54	41,703,678.30	15	100
55.	Construction of Solar-Powered Water Project (X_{55})	55	47,825,093.34	15	100
56.	Construction of Solar-Powered Water Project (X_{56})	56	42,305,333.34	15	100
57.	Construction of Solar-Powered Water Project (X_{57})	57	65,825,269.00	15	100
58.	Construction of Solar-Powered Water Project (X_{58})	58	42,000,000.00	15	100
59.	Construction of Solar-Powered Water Project (X_{59})	59	59,870,903.00	15	100
60.	Construction of Solar-Powered Water Project (X_{60})	60	47,825,093.34	15	100
61.	Construction of Solar-Powered Water Project (X_{61})	61	42,825,093.34	15	100
62.	Construction of Solar-Powered Water Project (X_{62})	62	41,703,678.30	15	100
63.	Construction of Solar-Powered Water Project (X_{63})	63	88,105,920.00	15	100
64.	Construction of Solar-Powered Water Project (X_{64})	64	100,000,000.00	15	100

65.	Construction of Solar-Powered Water Project (X_{64})	65	100,000,000.00	15	100
66.	Construction of Solar-Powered Water Project (X_{66})	66	100,000,000.00	15	100
67.	Construction of Solar-Powered Water Project (X_{67})	67	171,767,105.00	15	100
68.	Construction of Solar - Powered Water Project (X_{68})	68	45,000,000.00	15	100
69.	Construction of Solar-Powered Water Project (X_{69})	69	45,000,000.00	15	90
70.	Construction of Solar-Powered Water Project (X_{70})	70	45,000,000.00	15	100
71.	Construction of Solar-Powered Water Project (X_{71})	71	45,000,000.00	15	100
72.	Construction of Solar-Powered Water Project (X_{72})	72	45,000,000.00	15	100
73.	Construction of Solar-Powered Water Project (X_{73})	73	45,000,000.00	15	100
TOTAL			**4,626,052,916.20**		

Table B. 3: Communities Utility and Civic Centre

S/N	PROJECT TITLE	LOCATION	PROJECT COST (₦)	DURATION (MONTHS)	% COMPLETION
1.	Construction of Skill Acquisition Centre(X_1)	1	179,000,000.00	15	95
2.	Construction of Modern Civic Centre (X_2)	2	100,000,000.00	15	100
3.	Construction of Community Centre (X_3)	3	99,361,449.24	15	100
4.	Construction of Modern Town Hall (X_4)	4	60,000,000.00	15	100
5.	Construction of Skills Acquisition Centre (X_5)	5	18,680,055.03	15	100
6.	Construction of Community Centre (X_6)	6	99,361,449.24	15	40
7.	Construction of Multi-Purpose Town Hall (X_7)	7	157,896,299.00	15	0
8.	Construction of Public Toilet Block (X_8)	8	30,000,000.00	15	100
9.	Construction of Wooden Civic Centre (X_9)	9	30,858,139.35	15	75
10.	Construction of Public Toilet Block (X_{10})	10	30,000,000.00	15	100
11.	Construction of Modern Town Hall/Civic Centre (X_{11})	11	170,000,000.00	15	100
12.	Construction of Modern Town Hall/Civic Community Centre (X_{12})	12	99,361,449.24	15	70
13.	Construction of Town Hall (X_{13})	13	39,091,167.82	15	100
14.	Construction of Community Centre (X_{14})	14	99,361,449.00	15	100
15.	Construction of Community Centre (X_{15})	15	99,361,449.24	15	100
16.	Completion of Centre (X_{16})	16	39,875,880.00	15	90
17.	Construction of Civic Centre (X_{17})	17	47,789,002.30	15	65

18.	Construction of Community Centre (X_{18})	18	99,361,449.00	15	75
19.	Construction of Community Centre (X_{19})	19	59,879,559.80	15	100
20.	Construction of Community Centre (X_{20})	20	99,361,449.24	15	100
21.	Construction of Civic Centre (X_{21})	21	47,789,002.30	15	100
22.	Rehabilitation of 33kv Overhead Line Network (X_{22})	22	86,088,209.08	15	100
23.	Construction of Multi-Purpose Civic Centre (X_{23})	23	169,836,346.50	15	100
24.	Construction of Town Hall (X_{24})	24	39,091,167.82	15	100
25.	Construction of Lock-Up Shops (X_{25})	25	26,130,407.50	15	100
26.	Construction of Modern Civic Centre (X_{26})	26	60,987,173.50	15	75
27.	Construction and Equipping of Modern Civic Centre (X_{27})	27	99,815,000.00	15	100
28.	Construction of Modern Civic Centre (X_{28})	28	100,000,000.00	15	100
29.	Construction of Modern Town Hall (X_{29})	29	99,361,449.09	15	100
30.	Construction of Modern Town Hall (X_{30})	30	60,000,000.00	15	100
31.	Construction of Skills Acquisition Centre(X_{31})	31	18,680,055.03	15	100
32.	Construction of Community Centre (X_{32})	32	99,361,449.24	15	100
33.	Construction of Multi-Purpose Town Hall (X_{33})	33	157,896,299.00	15	100
34.	Construction of Wooden Civic Centre (X_{34})	34	30,858,139.35	15	100
35.	Construction of Modern Town Hall (X_{35})	35	170,000,000.00	15	100
36.	Construction of Modern Town Hall (X_{36})	36	99,361,449.24	15	70
37.	Construction of Town Hall (X_{37})	37	39,091,167.82	15	70
38.	Construction of Modern Town Hall (X_{38})	38	99,361,449.09	15	100

39.	Completion of Civic Centre (X_{39})	39	39,875,880.90	15	90
40.	Construction of Civic Centre (X_{40})	40	47,789,002.30	15	100
41.	Construction of modern town hall (X_{41})	41	99,361,449.00	15	75
42.	Construction of Civic Centre (X_{42})	42	47,789,002.30	15	100
43.	Construction of multi-purpose Civic Centre (X_{43})	43	169,836,346.50	15	100
44.	Construction of modern town hall (X_{44})	44	39,091,167.82	15	100
45.	Construction of lock-up shops (X_{45})	45	26,130,407.50	15	100
46.	Construction of modern civic centre (X_{46})	46	60,987,173.50	15	75
47.	Construction and equipping of modern civic centre (X_{47})	47	99,815,000.00	15	100
48.	Construction of modern civic centre (X_{48})	48	60,987,173.50	15	100
49.	Construction of Modern Civic Centre (X_{49})	49	100,000,000.00	15	100
50.	Construction Of Skill Acquisition Centre (X_{50})	50	18,680,055.03	15	100
51.	Construction of lock-up shops (X_{51})	51	26,130,407.50	15	100
52.	Construction of Wooden Civic Centre (X_{52})	52	30,858,139.35	15	100
53.	Construction of modern town hall (X_{53})	53	39,091,167.82	15	100
54.	Construction of Modern Town Hall (X_{54})	54	39,091,167.82	15	70
55.	Completion of Civic Centre (X_{55})	55	39,875,880.09	15	90
56.	Construction of Civic Centre (X_{56})	56	47,789,002.30	15	100
57.	Construction of Civic Centre (X_{57})	57	47,789,002.30	15	100
58.	Construction Of Modern Town Hall (X_{58})	58	60,000,000.00	15	100
59.	Construction of Modern Civic Centre (X_{59})	59	60,987,173.50	15	75
60.	Construction of Modern Civic Centre (X_{60})	60	60,987,173.50	15	100

61.	Construction of Modern Town Hall (X_{61})	61	99,361,449.00	15	75
62.	Construction of Modern Town Hall (X_{62})	62	99,361,449.00	15	100
63.	Construction of Modern Town Hall (X_{63})	63	99,361,449.00	15	100
64.	Construction of Modern Town Hall (X_{64})	64	99,361,449.24	15	70
65.	Construction of Community Centre (X_{65})	65	99,361,449.24	15	100
66.	Construction and equipping of Modern Civic Centre (X_{66})	66	99,815,000.00	15	100
67.	Construction of Multi-Purpose Town Hall (X_{67})	67	157,896,299.00	15	100
68.	Construction of Multi-purpose Civic Centre (X_{68})	68	169,836,346.50	15	100
69.	Construction of Modern Town Hall (X_{69})	69	170,000,000.09	15	100
70.	Construction of Wooden Civic Centre (X_{70})	70	30,858,139.35	15	100
71.	Construction of Modern Town Hall (X_{71})	71	170,000,000.00	15	100
	Total Cost		**5,720,463,815.01**		

Table B. 4: ROAD PROJECTS

S/N	PROJECT TITLE	LOCATION	PROJECT COST (₦)	DURATION (Months)	% COMPLETION
1.	Construction of 1km Road (X_1)	1	118,215,175.00	15	95
2.	Construction of 1 Km Road (X_2)	2	108,490,600.00	15	60
3.	Construction of Road (X_3)	3	112,151,425.00	15	90
4.	Construction of 2km Road (X_4)	4	237,317,567.50	15	100
5.	Construction of Close Road (X_5)	5	240,020,000.00	15	100
6.	Construction of Road (X_6)	6	48,786,606.00	15	95
7.	Construction of Road. (X_7)	7	158,003,750.00	15	95
8.	Construction of Road. (X_8)	8	249,557,325.00	15	100

9.	Construction of Flexible Pavement (X_9)	9	113,694,500.00	15	100
10.	Construction of Road (X_{10})	10	193,294,500.00	15	100
11.	Construction of Flexible Pavement (X_{11})	11	113,694,500.00	15	100
12.	Construction of 2km Road (X_{12})	12	238,522,285.00	15	95
13.	Construction of Road (1km) (X_{13})	13	100,000,000.00	15	100
14.	Construction of Road. (X_{14})	14	99,633,150.00	15	96
15.	Remedial Work of Road (X_{15})	15	149,860,360.00	15	100
16.	Construction of Internal Roads, (X_{16})	16	234,470,600.00	15	100
17.	Construction Road (X_{17})	17	99,865,854.00	15	100
18.	Construction of High School Street (X_{18})	18	49,855,489.00	15	98
19.	Construction of 1km Flexible Pavement (X_{19})	19	249,560,400.00	15	75
20.	Construction of Internal Road (X_{20})	20	240,020,000.00	15	60
21.	Construction of Internal Road Network (X_{21})	21	236,371,500.00	15	100
22.	Construction of 2km Road with Drains and Asphalt of Seaside Beach Road (X_{22})	22	399,500,000.00	15	100
23.	Construction of Palace Road. (X_{23})	23	237,249,815.00	15	100
24.	Remedial Works on Road (X_{24})	24	75,572,090.00	15	100
25.	Remedial Works on Road (X_{25})	25	75,000,000.00	15	100
26.	Contract for Remedial Works on Road (X_{26})	26	192,070,378.50	15	100
27.	Construction of Township Internal Road (X_{27})	27	99,633,150.00	15	100
28.	Construction of Street Road (X_{28})	28	86,096,025.00	15	100
29.	Construction of Road. (X_{29})	29	1,304,259,671.93	15	100
30.	Remedial Works Road (X_{30})	30	53,258,181.50	15	100
31.	Construction of Road. (X_{31})	31	199,500,000.00	15	100
32.	Construction of 1km Flexible Pavement. (X_{32})	32	249,500,000.00	15	100

33.	Remedial Work of Road (X_{33})	33	149,860,360.00	15	100
34.	Construction of State Office Road. (X_{34})	34	149,500,000.00	15	60
35.	Construction of Road (X_{35})	35	244,002,873.00	15	100
36.	Construction of Internal Road (X_{36})	36	241,193,500.00	15	100
37.	Construction of New Site Internal Road. (X_{37})	37	99,633,150.00	15	100
38.	Construction of Housing Estate Internal Road (X_{38})	38	99,633,150.00	15	100
39.	Construction of Flexible Pavement (X_{39})	39	113,694,500.00	15	100
40.	Construction of Township Road (X_{40})	40	1,044,039,937.50	15	100
41.	Construction of Flexible Pavement (X_{41})	41	112,635,123.00	15	96
42.	Construction of Road (X_{42})	42	214,967,000.00	15	100
43.	Construction of 1 km Flexible Pavement (X_{43})	43	249,875,680.00	15	100
44.	Construction of Internal Road (X_{44})	44	232,903,550.00	15	100
45.	Construction of Road (X_{45})	45	99,633,150.00	15	95
46.	Construction of Internal Road. (X_{46})	46	200,809,062.00	15	100
47.	Emergency Repairs of Failed Portions of Road (X_{47})	47	163,310,221.95	15	100
48.	Construction of Internal Roads. (X_{48})	48	240,000,000.00	15	100
49.	Construction of Zone 2, Road (X_{49})	49	184,506,801.00	15	100
50.	Construction of Flexible Pavement (X_{50})	50	247,370,000.00	15	100
51.	Construction of Internal Road (X_{51})	51	399,500,000.00	15	100
52.	Construction of Road (X_{52})	52	238,262,410.00	15	100
53.	Construction of Road (X_{53})	53	149,718,657.25	15	100
54.	Construction of Road Project (X_{54})	54	179,480,900.00	15	100
55.	Remedial Works on Road (X_{55})	55	155,822,061.72	15	100
56.	Construction of Road (X_{56})	56	298,456,728.90	15	100
57.	Construction of Internal Roads (X_{57})	57	209,713,112.50	15	100

58.	Construction of Flexible Pavement (X_{58})	58	113,694,500.00	15	90
59.	Construction of Road. (X_{59})	59	122,610,310.00	15	100
60.	Construction of Flexible Pavement Road (X_{60})	60	249,500,000.00	15	90
61.	Construction of 1km Road Project (X_{61})	61	96,463,400.00	15	100
62.	Construction of Flexible Pavement (X_{62})	62	79,435,262.50	15	100
63.	Construction of Road (X_{63})	63	200,000,000.00	15	95
64.	Construction of Road. (X_{64})	64	72,000,000.00	15	100
65.	Construction of Flexible Pavement Road (X_{65})	65	249,500,000.00	15	100
66.	Construction of 2km Road (X_{66})	66	239,171,920.00	15	85
67.	Construction of Road (X_{67})	67	150,000,000.00	15	100
68.	Construction of Road (X_{68})	68	6,136,367,333.25	15	96
69.	Construction of Township Road (X_{69})	69	99,500,000.00	15	100
70.	Construction of 1.5km Flexible Pavement (X_{70})	70	148,486,150.00	15	100
71.	Construction of Internal Roads. (X_{71})	71	221,584,312.75	15	100
72.	Emergency Repairs of Failed Portions of Road (X_{72})	72	189,215,450.00	15	100
73.	Remedial Work on Road. (X_{73})	73	66,689,608.00	15	100
74.	Remedial Work on Road (X_{74})	74	164,903,970.00	15	100
75.	Construction of New High Court Road (X_{75})	75	114,474,528.00	15	100
76.	Construction of Flexible Pavement Road (X_{76})	76	249,500,000.00	15	100
77.	Emergency Repair of Road (X_{77})	77	156,439,000.00	15	100
78.	Remedial Work on Internal Roads (X_{78})	78	199,500,000.00	15	100
79.	Construction of Housing Estate Internal Road (X_{79})	79	99,633,150.00	15	100
80.	Construction of Road (X_{80})	80	236,371,500.00	15	100
81.	Construction of Road (X_{81})	81	195,230,286.00	15	100
82.	Construction of Road and Bridge (X_{82})	82	489,080,761.00	15	100

83.	Construction of 2km Road Project (X_{83})	83	180,000,000.00	15	100
84.	Construction of Road (X_{84})	84	102,000,000.00	15	100
85.	Construction of 2km Rigid Pavement Road (X_{85})	85	248,000,000.00	15	100
86.	Construction of Internal Road (X_{86})	86	480,650,125.00	15	95
87.	Remedial Work of Road (X_{87})	87	149,860,260.00	15	100
88.	Construction of Internal Road (X_{88})	88	719,430,890.00	15	75
89.	Construction of 1km Flexible Pavement. (X_{89})	89	249,500,000.00	15	100
90.	Concrete Pavement with Culvert and Drains (X_{90})	90	239,720,000.00	15	95
91.	Construction of Internal Road (Lot I) (X_{91})	91	209,713,112.50	15	100
92.	Construction of Internal Road (Lot 2) (X_{92})	92	209,713,112.50	15	100
93.	Construction of Internal Road (Lot 3) (X_{93})	93	209,713,112.50	15	100
94.	Construction of Internal Road (Lot 4) (X_{94})	94	209,713,112.50	15	100
95.	Construction of Internal Road (Lot 5) (X_{95})	95	209,713,112.50	15	100
96.	Construction of Internal Road (X_{96})	96	965,080,975.00	15	95
97.	Construction of Road Phase 1 (X_{97})	97	249,500,000.00	15	100
98.	Construction of 2km Road with Rigid Pavement (X_{98})	98	239,750,000.00	15	100
99.	Construction of Internal Road (X_{99})	99	249,500,000.00	15	90
100.	Construction of Flexible Pavement Road (X_{100})	100	249,500,000.00	15	95
101.	Construction of 7.5km Road with Rigid Pavement (X_{101})	101	230,000,000.00	15	100
102.	Construction of 7.5km Road with Rigid Pavement (X_{102})	102	230,000,000.00	15	100
103.	Construction of 7.5km Road with Rigid Pavement (X_{103})	103	230,000,000.00	15	100

104.	Construction of 7.5km Road with Rigid Pavement (X_{104})	104	230,000,000.00	15	100
105.	Construction of 7.5km Road with Rigid Pavement (X_{105})	105	230,000,000.00	15	100
106.	Construction of 7.5km Road with Rigid Pavement (X_{106})	106	230,000,000.00	15	100
107.	Construction of 7.5km Road with Rigid Pavement (X_{107})	107	230,000,000.00	15	100
108.	Construction of 3km Road (X_{108})	108	239,500,000.00	15	100
109.	Construction of 2.5km Road with Drain (X_{109})	109	399,500,000.00	15	100
110.	Construction of Access Road (X_{110})	110	195,230,286.00	15	100
111.	Construction of Road (X_{111})	111	249,500,000.00	15	100
112.	Construction of 2km Road (X_{112})	112	244,630,000.00	15	100
113.	Construction of Road (X_{113})	113	248,900,000.00	15	100
114.	Construction of Road (X_{114})	114	248,900,001.00	15	100
TOTAL			**30,573,672,969.75**		

APPENDIX C: YEAR 3

Table C. 1: MODEL HEALTH CARE

S/N	PROJECT DESCIPTION(MHC)	LOCATION	PROJECT COST (₦)	DURATION (MONTHS)	% COMPLETION
1.	Construction of Comprehensive Health Care Centre (X1)	1.	249,050,000.09	15	100
2.	Construction of Mega Caring Heart Centre (X2)	2.	250,000,000.88	15	88
3.	Construction and Equipping of Mother and Child Hospital (X3)	3.	200,000,000.00	15	100
4.	Reconstruction of Health Care Centre (X4)	4.	24,287,185.00	12	100
5.	Construction of Wooden Comprehensive Health Care Centre (X5)	5.	29,309,767.50	12	100
6.	Construction of Comprehensive Health Care Centre (X6)	6.	29,600,000.00	15	100
7.	Construction of Wooden Comprehensive Health Care Centre (X7)	7.	29,309,767.50	12	100

8.	Construction of Comprehensive Health Care Centre (X8)	8.	33,409,633.50	15	40
9.	Construction of Comprehensive Health Care Centre (X9)	9.	43,948,268.10	15	100
10.	Construction of Comprehensive Health Care Centre (X10)	10.	249,500,000.00	15	80
11.	Construction of Comprehensive Health Care Centre (X11)	11.	249,500,000.00	15	70
12.	Construction of Comprehensive Health Care Centre (Wooden) (X12)	12.	19,240,650.00	12	60
13.	Construction of Wooden Comprehensive Health Care Centre (X13)	13.	43,436,040.67	12	100
14.	Construction of Wooden Comprehensive Health Care Centre (X14)	14.	22,682,356.30	12	100
15.	Construction of Mortuary Building (X15)	15.	79,743,557.50	12	50
16.	Construction of Health Care Centre (X16)	16.	22,682,356.20	12	80
17.	Comprehensive Health Care Centre (X17)	17.	43,436,040.00	15	40
18.	Construction of Comprehensive Health Care Centre (X18)	18.	43,436,040.60	15	50
19.	Construction of Comprehensive Health Care Centre (X19)	19.	27,167,899.80	15	70
20.	Construction of Comprehensive Health Care Centre (X20)	20.	90,175,041.60	15	100
21.	Construction of community health care centre (X21)	21.	49,952,071.50	15	100
22.	Construction of Comprehensive Health Care Centre (X22)	22.	43,436,040.05	15	85
23.	Construction and equipping of mother and child hospital (X23)	23.	199,402,426.08	15	90
24.	Construction of comprehensive health care centre (X24)	24.	29,309,767.50	12	90
25.	Construction of comprehensive health care centre (X25)	25.	100,000,000.00	12	90
26.	Construction and equipping of modern health care centre (X26)	26.	149,586,384.00	15	90
27.	Construction and equipment of basic health care centre (X27)	27.	238,756,824.00	15	100
28.	Construction of comprehensive health care centre (X28)	28.	43,436,040.60	15	100
29.	Construction of health care centre (X29)	29.	43,436,040.60	15	100
30.	Renovation of General hospital (X30)	30.	43,436,040.60	12	100
31.	Renovation of General hospital (X31)	31.	43,436,040.60	12	100
32.	Construction of Comprehensive Health Care Centre (32)	32.	249,050,000.00	15	100
33.	Construction of Mega Caring Health Centre (X_{33})	33.	250,000,000.00	15	90
34.	Construction And Equipping of Mother and Child Hospital (X_{34})	34.	200,000,000.00	15	90
35.	Construction of Comprehensive Health Care Centre (X_{35})	35.	43,948,268.10	15	100

36.	Construction of Comprehensive Health Care Centre (X_{36})	36.	249,500,000.00	15	90
37.	Construction of Comprehensive Health Care Centre (X_{37})	37.	249,500,000.00	15	100
38.	Construction of Mortuary Building (X_{38})	38.	79,743,557.50	15	100
39.	Construction of Comprehensive Health Care Centre (39)	39.	90,175,041.60	15	100
40.	Construction and Equipping of Mother and Child Hospital (X_{40})	40.	199,402,426.00	15	100
41.	Construction of Comprehensive Health Care Centre. (X41)	41.	100,000,000.00	15	90
42.	Construction and Equipping of Modern Health Care Centre. (X_{42})	42.	149,586,384.00	15	100
43.	Construction and Equipping of Basic Health Care Centre. (X_{43})	43.	238,756,824.00	15	100
44.	Construction of Comprehensive Health Care Centre(X_{44})	44.	43,436,040.60	15	90
45.	Construction of Health Care Centre. (X_{45})	45.	43,436,040.60	15	90
46.	Supply and Installation of Medical Equipment at General Hospital. (X_{46})	46.	200,000,000.00	15	100
47.	Construction of Mother and Child Hospital (X_{47})	47.	187,286,789.13	12	95
48.	Construction of Model Health Care Centre (X_{48})	48.	118,715,208.22	12	100
49.	Construction of Model Basic Health Care Centre (X_{49})	49.	98,455,965.45	12	100
50.	Construction of a Health Care Centre (X 50)	50.	149,586,384.00	15	95
51.	Construction of a Health Care Centre (X_{51})	51.	43,436,040.60	15	100
52.	Construction of a Health Care Centre (X52)	52.	200,000,000.00	15	100
53.	Construction of a Health Care Centre (X53)	53.	79,743,557.50	15	100
54.	Construction of Heath Care Centre (X54)	54.	249,500,000.00	15	100
55.	Construction of Health Care Centre (X55)	55.	100,000,000.00	15	100
56.	Construction of Health Care Centre (X56)	56.	43,436,040.60	15	100
57.	Construction of Health Care Centre (X57)	57.	249,500,000.00	15	100
58.	Construction of Health Care Centre (X58)	58.	118,715,208.22	15	100
59.	Construction of Health Care Centre (X59)	59.	90,175,041.60	15	100
			6,879,187,098.49		

Table C. 2: SCHOOL PROJECTS

S/N	PROJECT DESCIPTION (School)	LOCATION	PROJECT COST (₦)	DURATION (MONTHS)	% COMPLETION
1.	Completion of 6 Classroom Block (Wooden) (6X1)	1	12,853,970.08	6	100
2.	Construction and Equipping of Science Laboratory (X2)	2	60,000,000.07	15	100
3.	Construction of 3 Classroom Block. (3X3)	3	6,200,000.66	15	100
4.	Construction and Equipping of Science Laboratory. (X4)	4	60,000,000.08	15	100
5.	Construction of 3 Classroom Block. (3x5)	5	6,500,000.88	6	100
6.	Construction of 3 Classroom Block. (3x6)	6	6,200,000.00	6	100
7.	Construction of 3 Classroom Block. (3x7)	7	6,200.000.00	6	100
8.	Construction of 6 Classroom Blocks. (6x8)	8	14,204,761.60	10	100
9.	Construction of 6 Classroom Block. (6x9)	9	15,500,000.00	10	100
10.	Construction of 12 Classroom Block. (12X10)	10	43,397,703.00	15	100
11.	Construction of Science Laboratory (X11)	11	53,439,465.00	10	100
12.	Construction and Equipping of Science Laboratory (X12)	12	60,000,000.00	15	100
13.	Construction of 3 Classroom Block (3X13).	13	6,200,000.00	6	100
14.	Construction of Carpentry Workshop (X14)	14	35,430,051.93	10	90
15.	Construction of 3 Classroom Block. (3X15)	15	6,469,426.00	6	100
16.	Construction of 3 Classroom Block with Staff Room (3X16)	16	18,350,000.00	8	100
17.	Construction of Office Complex (X17)	17	9,664,5510.20	8	100
18.	Construction of 6 Classroom Block (6X18)	18	12,500,000.00	12	100
19.	Construction of 6 Classroom Block (Wooden) (6X19)	19	17,179,324.00	8	100
20.	Construction of 6 Classroom Block (6X20)	20	12,500,000.00	12	100
21.	Construction of 6 Classroom Block (Wooden) (6X21)	21	10,880,190.00	8	100
22.	Re-habitation of Damaged School Buildings (3X22)	22	10,339,993.50	6	100
23.	Completion of 6 Classroom Block (6X23)	23	17,750,000.00	12	100
24.	Construction of Laboratory Block (X24)	24	11,327,444.87	12	100
25.	Construction of Office Complex (X25)	25	38,145,510.20	12	90
26.	Construction of 3 Classroom Block (3X26)	26	6,450,000.00	6	100

27.	Construction and Equipping of Science Laboratory (X27)	27	54,987,302.00	15	100
28.	Construction of Science Laboratories (3X28)	28	99,500,000.00	12	100
29.	Construction of 12 Classroom Block and Staff Quarters (12X29)	29	77,272,431.20	15	100
30.	Construction of 12 Classroom Block (12X30)	30	69,999,001.00	15	100
31.	Completion of 6 Classroom Block (6X31)	31	15,328,635.36	12	100
32.	Construction of Model 3 Classroom Block (3X32)	32	6,200,000.00	6	100
33.	Construction of 3 Classroom Block (3X33)	33	6,200,000.00	6	100
34.	Construction of 6 Classroom Block (Composite) (6X34)	34	17,179,324.00	6	100
35.	Construction of 6 Wooden Classroom Block (6X35)	35	12,897,279.00	6	100
36.	Construction of Science Laboratories (3X36)	36	53,439,465.13	15	100
37.	Construction and Equipping of Science Laboratory (X37)	37	54,987,302.00	15	100
38.	Construction of Model 6 Classroom Block (6X38)	38	12,500,000.00	6	100
39.	Completion of 6 Classroom Block (6X39)	39	45,995,088.25	6	100
40.	Construction of 3 Classroom Block (3X40)	40	16,845,675.09	6	100
41.	Construction of 6 Classroom Block (6X41)	41	46,872,563.00	6	100
42.	Construction of a Dormitory Block & 2 Classrooms (3X42)	42	20,420,271.00	6	100
43.	Construction of 3 Classroom Block (3X43)	43	6,200,000.00	6	100
44.	Construction of 3 Classroom Block (3X44)	44	6,200,000.00	6	100
45.	Completion of 6 Classroom Block (6X45)	45	47,179,324.00	6	100
46.	Reconstruction of 6 Classroom block (Wooden) (6X46)	46	12,500,000.09	6	100
47.	Construction and Equipping of Science Laboratory (X47)	47	65,4987,302.00	10	100
48.	Completion of a Classroom Building (Woodwork) (X48)	48	6,291,822.00	6	100
49.	Construction of 3 Classroom Block (3X49)	49	16,200,000.00	6	90
50.	Construction of Science Laboratories (3X50)	50	53,368,230.00	15	100
51.	Construction of 3 Classroom Block (3X51)	51	6,463,880.90	6	100
52.	Construction of 6 Classroom Block (6X52)	52	17,179,324.00	12	100
53.	Construction of 6 Classroom Block (6X53)	53	17,179,324.00	12	100
54.	Construction and Equipping of Science Laboratory (X54)	54	54,987,302.00	15	100

55.	Construction of Model 6 Classroom Block (6X55)	55	32,500,000.00	12	100
56.	Construction of 3 Classroom Block (3X56)	56	6,200,000.00	6	100
57.	Construction of Model 6 Classroom Block (6X57)	57	32,500,000.00	6	100
58.	Construction of Model 3 Classroom Block (3X58)	58	26,200,000.00	6	100
59.	Completion of 6 Classroom Block (6X59)	59	33,671,916.00	12	100
60.	Construction of 3 classroom block (3X60)	60	4,671,090.00	6	100
61.	Construction of 6 classroom block (6X61)	61	28,637,045.09	12	100
62.	Construction of 12 classroom high school (12X62)	62	49,855,489.99	12	90
63.	Construction of 22 classroom block (22X63)	63	99,361,449.24	18	100
64.	Construction of 3 classroom block (3X64)	64	6,500,000.90	6	100
65.	Construction of 3 classroom block (3X65)	65	6,200,000.88	6	100
66.	Construction of 6 classroom block (Wooden) (6X66)	66	17,179,324.00	6	100
67.	Construction & equipping of science laboratories (X67)	67	54,987,302.00	15	100
68.	Construction of 6 classroom block (wooden) (X68)	68	8,014,160.00	6	100
69.	Construction of 6 classroom block (wooden) (X69)	69	11,200,000.00	6	90
70.	Construction of science laboratories (3X70)	70	64,877,321.07	15	100
71.	Construction of wooden classroom block (6X71)	71	17,500,000.00	6	100
72.	Completion of 6 classroom block (wooden) (6X72)	72	19,778,886.00	6	100
73.	Construction of 3 classroom block (3X73)	73	6,047,236.79	6	100
74.	Construction of 3 classroom block (3X74)	74	6,200,000.00	6	100
75.	Construction of science laboratory (X75)	75	52,654,164.54	15	100
76.	Construction and equipping of science laboratory (X76)	76	54,987,382.00	15	95
77.	Construction of 6 classroom block (wooden) (6X77)	77	17,179,324.00	6	100
78.	Construction of 6 classroom block (composite) (6X78)	78	17,179,324.00	12	100
79.	Construction of 6 classroom block (wooden) (6X79)	79	12,500,000.00	6	100
80.	Construction of 3 classroom block (3X80)	80	25,286,905.40	6	100
81.	Construction of 12 classroom block (12X81)	81	59,879,559.80	12	100
82.	Construction of a 3-classroom block (3X82)	82	5,382,369.00	6	100
83.	Construction of 6 classroom block (wooden) (6X83)	83	16,328,635.36	6	100

84.	Construction of 6 classroom block (wooden) (6X84)	84	16,146,281.75	6	100
85.	Construction of 6 classroom block (wooden) (6X85)	85	18,500,000.00	6	100
86.	Construction of 12 classroom block (12X86)	86	99,361,449.24	12	100
87.	Construction of 3 classroom block (3X87)	87	6,200,000.00	6	100
88.	Construction of 3 classroom block (3X88)	88	6,200,000.00	6	95
89.	Construction & equipping of science laboratory (X89)	89	61,343,292.50	15	100
90.	Construction of 6 classroom block (composite) (6X90)	90	17,179,324.00	6	100
91.	Construction of 3 classroom block (3X91)	91	6,500,000.00	6	100
92.	Completion of 6 classroom block (6X92)	92	23,286,825.00	6	100
93.	Construction of 6 classroom block (wooden) (6X93)	93	17,897,279.00	6	100
94.	Construction of 6 classroom block (6X94)	94	18,500,000.00	6	100
95.	Construction of 3-classroom block (3X95)	95	7,304,540.80	6	100
96.	Construction and equipping of science laboratory (X96)	96	54,987,302.00	15	100
97.	Construction and equipping of science laboratory (X97)	97	54,987,302.00	15	100
98.	Construction and equipment of technical college (22X98)	98	997,645,634.78	18	100
99.	Construction of science laboratory (X99)	99	59,900,000.00	15	100
100.	Construction and equipping of science laboratory (X100)	100	100,000,000.00	15	100
101.	Construction of 12 classroom block (composite) (12X101)	101	49,692,000.00	12	100
102.	Construction of 22 classroom blocks (22X102)	102	149,986,346.50	18	100
103.	Construction and equipment of modern library (X103)	103	44,635,000.00	6	100
TOTAL			**4,599,781,689.95**		

Table C. 3: HOUSING/HOSTEL

S/N	PROJECT DESCIPTION (Housing)	LOCATION	PROJECT COST (₦ x10^3)	DURATION (MONTHS)	% COMPLETION
1.	Construction of 3-Bedroom Housing unit ($3X_1$)	1.	4,030	12	100
2.	Construction of 3-Bedroom Housing unit ($3X_2$)	2.	6,651	12	95

3.	Construction of 3-Bedroom Housing unit ($3X_3$)	3.	4,730	12	100
4.	Construction of Office Complex (X_4)	4.	36,645	12	100
5.	Construction of 3-Bedroom Housing unit ($3X_5$)	5.	12,476	12	100
6.	Construction of Swimming Platform (X_6)	6.	6,651	6	100
7.	Construction of Swimming Platform(X_7)	7.	8,568	6	90
8.	Construction of 3-Bedroom Housing unit ($3X_8$)	8.	4,730	12	100
9.	Construction of Staff Quarters (X_9)	9.	18,105	12	100
10.	Construction of Public Toilet Block (X_{10})	10.	6,000	6	100
11.	Renovation of Magistrates' Quarters (X_{11})	11.	20,608	10	100
12.	Construction of 3-Bedroom Housing unit ($3X_{12}$)	12.	4,730	12	100
13.	Construction of Public Toilet Block (X_{13})	13.	13,000	6	100
14.	Construction of 3-Bedroom Housing unit ($3X_{14}$)	14.	17,000	12	100
15.	Construction of 3-Bedroom Housing unit ($3X_{15}$)	15.	4,030	12	100
16.	Construction of 3-Bedroom Housing unit ($3X_{16}$)	16.	12,981	12	100
17.	Construction of 3-Bedroom Housing unit ($3X_{18}$)	17.	18,134	12	100
18.	Construction of 3-Bedroom Housing unit ($3X_{18}$)	18.	10,229	12	90
19.	Construction of 3-Bedroom Housing unit ($3X_{19}$)	19.	13,139	12	100
20.	Construction of 3-Bedroom Housing unit ($3X_{20}$)	20.	10,659	12	100
21.	Construction of 3-Bedroom Housing unit ($3X_{21}$)	21.	11,982	12	100
22.	Construction of 3-Bedroom Housing unit ($3X_{22}$)	22.	10,000	12	90
23.	Construction of 3-Bedroom Housing unit ($3X_{23}$)	23.	86,088	12	100

24.	Construction of 3-Bedroom Housing unit ($3X_{24}$)	24.	12,228	12	100
25.	Construction of regional technology village and industrial park (X_{25})	25.	52,796	12	100
26.	Construction of 3-Bedroom Housing unit (3X26)	26.	10,228	12	100
27.	Student Hostel (X_{27})	27.	175,837	12	100
28.	Students Hostel (X_{28})	28.	192,990	12	100
29.	Construction of 3-Bedroom Housing unit ($3X_{29}$)	29.	15,892	12	90
30.	Construction of 3-Bedroom Housing unit ($3X_{30}$)	30.	15,892	12	90
31.	Construction of 3-Bedroom Housing unit ($3X_{31}$)	31.	10,376	12	100
32.	Construction of 3-Bedroom Housing unit ($3X_{32}$)	32.	10,376	12	95
33.	Construction of 3-Bedroom Housing unit ($3X_{33}$)	33.	10,376	12	95
34.	Construction of 3-Bedroom Housing unit ($3X_{34}$)	34.	10,376	12	100
35.	Construction of 3-Bedroom Housing unit ($3X_{35}$)	35.	15,892	12	100
36.	Construction of 3-Bedroom Housing unit ($3X_{36}$)	36.	15,892	12	100
37.	Construction of 3-Bedroom Housing unit ($3X_{37}$)	37.	15,892	12	100
38.	Construction of 3-Bedroom Housing unit ($3X_{38}$)	38.	15,892	12	100
39.	Construction of 3-Bedroom Housing unit ($3X_{39}$)	39.	15,892	12	100
40.	Construction of 3-Bedroom Housing unit ($3X_{40}$)	40.	15,892	12	100
41.	Construction of 3-Bedroom Housing unit ($3X_{41}$)	41.	15,892	12	100
42.	Construction of 3-Bedroom Housing unit ($3X_{42}$)	42.	15,892	12	100
43.	Construction of 3-Bedroom Housing unit ($3X_{43}$)	43.	15,892	12	100
44.	Construction of 3-Bedroom Housing unit ($3X_{44}$)	44.	15,892	12	100

45.	Construction of 3-Bedroom Housing unit ($3X_{45}$)	45.	15,892	12	100
46.	Construction of 3-Bedroom Housing unit ($3X_{46}$)	46.	15,892	12	100
47.	Construction of 3-Bedroom Housing unit ($3X_{47}$)	47.	15,892	12	100
48.	Construction of 3-Bedroom Housing unit ($3X_{48}$)	48.	15,892	12	100
49.	Construction of 3-Bedroom Housing unit ($3X_{49}$)	49.	15,892	12	100
50.	Construction of 3-Bedroom Housing unit ($3X_{50}$)	50.	15,892	12	100
51.	Construction of 3-Bedroom Housing unit ($3X_{51}$)	51.	15,892	12	100
52.	Construction of 3-Bedroom Housing unit ($3X_{52}$)	52.	15,892	12	100
53.	Construction of 3-Bedroom Housing unit ($3X_{53}$)	53.	15,892	12	100
54.	Construction of 3-Bedroom Housing unit ($3X_{54}$)	54.	15,892	12	100
55.	Construction of 3-Bedroom Housing unit ($3X_{55}$)	55.	15,892	12	95
56.	Construction of 3-Bedroom Housing unit ($3X_{56}$)	56.	15,892	12	95
57.	Construction of 3-Bedroom Housing unit ($3X_{57}$)	57.	15,892	12	95
58.	Construction of 3-Bedroom Housing unit ($3X_{58}$)	58.	15,892	12	100
59.	Construction of 3-Bedroom Housing unit ($3X_{59}$)	59.	15,892	12	100
60.	Construction of 3-Bedroom Housing unit ($3X_{60}$)	60.	15,892	12	100
61.	Construction of 3-Bedroom Housing unit ($3X_{61}$)	61.	15,892	12	100
62.	Construction of 3-Bedroom Housing unit ($3X_{62}$)	62.	15,892	12	100
63.	Construction of 3-Bedroom Housing unit ($3X_{63}$)	63.	15,892	12	100

64.	Construction of 3-Bedroom Housing unit ($3X_{64}$)	64.	15,892	12	100
65.	Construction of 3-Bedroom Housing unit ($3X_{65}$)	65.	15,892	12	100
66.	Construction of 3-Bedroom Housing unit ($3X_{66}$)	66.	15,892	12	100
67.	Construction of 3-Bedroom Housing unit ($3X_{67}$)	67.	15,892	12	100
68.	Construction of 3-Bedroom Housing unit ($3X_{68}$)	68.	15,892	12	100
69.	Construction of 3-Bedroom Housing unit ($3X_{69}$)	69.	15,892	12	100
70.	Construction of 3-Bedroom Housing unit ($3X_{70}$)	70.	15,892	12	100
71.	Construction of 3-Bedroom Housing unit ($3X_{71}$)	71.	15,892	12	100
72.	Construction of 3-Bedroom Housing unit ($3X_{72}$)	72.	15,892	12	100
73.	Construction of 3-Bedroom Housing unit ($3X_{73}$)	73.	15,892	12	100
74.	Construction of 3-Bedroom Housing unit ($3X_{74}$)	74.	15,892	12	100
75.	Construction of 3-Bedroom Housing unit ($3X_{75}$)	75.	15,892	12	100
76.	Construction of 3-Bedroom Housing unit ($3X_{76}$)	76.	15,892	12	100
77.	Construction of 3-Bedroom Housing unit ($3X_{77}$)	77.	15,892	12	100
78.	Construction of 3-Bedroom Housing unit ($3X_{78}$)	78.	15,892	12	100
79.	Construction of 3-Bedroom Housing unit ($3X_{79}$)	79.	15,892	12	100
80.	Student Hostel (X80)	80.	674,682	12	100
			2,248,355		

APPENDIX D: Year 4

Table D.1: Solar Powered Water Project

S/N	PROJECT DESCIPTION (SPW)	LOCATION	PROJECT COST (₦)	DURATION (MONTHS)	% COMPLETION
1.	Construction of Solar-Powered Water Project (X1)	1	89,036,653.20	15	100
2.	Construction of Solar-Powered Water Project (X2)	2	88,105,920.00	15	100
3.	Construction Solar-Powered Water Project (X3)	3	89,036,653.20	15	100
4.	Construction of Solar-Powered Water Project (X4)	4	89,036,653.20	15	100
5.	Construction of Solar-Powered Water Project (X5)	5	63,221,832.54	15	100
6.	Construction of Solar-Powered Water Project (X6)	6	91,594,794.54	15	100
7.	Construction of Solar-Powered Water Project (X7)	7	89,036,653.20	15	100
8.	Construction of Solar-Powered Water Project (X8)	8	89,915,232.00	15	100
9.	Construction of Solar-Powered Water Project (X9)	9	100,000,000.00	15	100
10.	Construction of Solar-Powered Water Project (X10)	10	61,035,777.50	15	100
11.	Construction of Solar-Powered Water Project (X11)	11	89,036,653.20	15	100
12.	Construction of Solar-Powered Water Project (X12)	12	41,703,678.30	15	100
13.	Construction of Solar-Powered Water Project (X13)	13	89,036,653.20	15	100
14.	Construction of Solar-Powered Water Project (X14)	14	98,401,076.39	15	100
15.	Construction of Solar-Powered Water Project (X15)	15	98,401,076.39	15	100
16.	Construction of Solar-Powered Water Project (X16)	16	50,000,000.00	15	100

17.	Construction of Solar-Powered Water Project (X17)	17	98,401,076.39	15	100
18.	Construction of Solar-Powered Water Project (X18)	18	89,036,653.20	15	100
19.	Construction of Solar-Powered Water Project (X19)	19	98,401,076.39	15	100
20.	Construction of Solar-Powered Water Project (X20)	20	89,036,653.20	15	100
21.	Construction of Solar-Powered Water Project (X21)	21	98,401,076.39	15	100
22.	Construction of Solar-Powered Water Project (X22)	22	42,305,333.34	15	100
23.	Construction of Solar-Powered Water Project (X23)	23	89,036,653.20	15	100
24.	Construction of Solar-Powered Water Project (X24)	24	42,305,333.34	15	100
25.	Construction of Solar-Powered Water Project (X25)	25	42,000,000.00	15	100
26.	Construction of Solar-Powered Water Project (X26)	26	42,305,333.34	15	95
27.	Construction of Solar-Powered Water Project (X27)	27	98,500,000.00	15	100
28.	Construction of Solar-Powered Water Project (X28)	28	81,265,356.00	15	100
29.	Construction of Solar-Powered Water Project (X29)	29	98,401,076.93	15	100
30.	Construction of Solar-Powered Water Project (X30)	30	240,020,000.00	15	100
31.	Construction of Solar-Powered Water Project (X31)	31	81,265,356.00	15	100
32.	Construction of Solar-Powered Water Project (X32)	32	49,999,001.00	15	100
33.	Construction of Solar-Powered Water Project (X33)	33	47,825,093.00	15	100
34.	Construction of Solar-Powered Water Project (X34)	34	61,243,583.00	15	100
35.	Construction of Solar-Powered Water Project (X35)	35	81,265,356.00	15	100

36.	Construction of Solar-Powered Water Project (X36)	36	98,401,076.39	15	100
37.	Construction of Solar-Powered Water Project (X37)	37	81,265,356.00	15	100
38.	Construction of Solar-Powered Water Project (X38)	38	60,179,871.54	15	100
39.	Construction of Solar-Powered Water Project (X39)	39	81,265,356.00	15	100
40.	Construction of Solar-Powered Water Project (X40)	40	100,000,000.00	15	90
41.	Construction of Solar-Powered Water Project (X41)	41	49,788,218.77	15	100
42.	Construction of Solar-Powered Water Project (X42)	42	81,265,356.00	15	100
43.	Construction of Solar-Powered Water Project (X43)	43	98,401,076.39	15	100
44.	Construction of Solar-Powered Water Project (X44)	44	51,975,654.42	15	85
45.	Construction of Solar-Powered Water Project (X45)	45	55,913,819.40	15	100
46.	Construction of Solar-Powered Water Project (X46)	46	99,999,001.00	15	95
47.	Construction of Solar-Powered Water Project (X47)	47	50,838,048.00	15	100
48.	Construction of Solar-Powered Water Project (X48)	48	81,265,356.00	15	100
49.	Construction of Solar-Powered Water Project (X49)	49	98,401,076.39	15	100
50.	Construction of Solar-Powered Water Project (X50)	50	81,265,356.00	15	100
51.	Construction of Solar-Powered Water Project (X51)	51	79,999,001.00	15	100
52.	Construction of Solar-Powered Water Project (X52)	52	100,000,000.00	15	100
53.	Construction of Solar-Powered Water Project (X53)	53	98,401,076.39	15	100
54.	Construction of Solar-Powered Water Project (X54)	54	98,401,076.39	15	100

55.	Construction of Solar-Powered Water Project (X55)	55	98,401,076.39	15	100
56.	Construction of solar-powered water project (X56)	56	83,328,661.90	15	100
57.	Construction of solar-powered water project (X57)	57	41,703,678.30	15	100
58.	Construction of Solar-Powered Water Project (X58)	58	98,401,076.39	15	100
59.	Construction of Solar-Powered Water Project (X59)	59	81,265,356.00	15	100
60.	Construction of Solar-Powered Water Project (X60)	60	98,401,076.39	15	100
61.	Construction of Solar-Powered Water Project (X61)	61	98,401,076.93	15	100
62.	Construction of solar-powered water project (X62)	62	46,501,830.00	15	100
63.	Construction of Solar-Powered Water Project (X63)	63	98,401,076.39	15	100
64.	Construction of Solar-Powered Water Project ((X64)	64	98,401,076.39	15	100
65.	Construction of Solar-Powered Water Project (X65)	65	59,999,001.00	15	100
66.	Construction of Solar-Powered Water Project (X66)	66	49,999,001.00	15	100
67.	Construction of Solar-Powered Water Project (X67)	67	50,000,000.00	15	100
68.	Construction of Solar-Powered Water Project (X68)	68	98,401,076.39	15	100
69.	Construction of Solar-Powered Water Project (X69)	69	47,825,093.34	15	100
70.	Construction of Solar-Powered Water Project (X70)	70	98,401,076.39	15	100
71.	Construction of Solar-Powered Water Project (X71)	71	47,825,093.34	15	100
72.	Construction of Solar-Powered Water Project (X72)	72	42,305,333.34	15	100
73.	Construction of Solar-Powered Water Project (X73)	73	65,825,269.00	15	100

74.	Construction of Solar-Powered Water Project (X74)	74	98,401,076.39	15	100
75.	Construction of Solar-Powered Water Project (X75)	75	59,870,903.00	15	100
76.	Construction of Solar-Powered Water Project (X76)	76	47,825,093.34	15	100
77.	Construction of Solar-Powered Water Project (X77)	77	42,825,093.34	15	100
78.	Construction of Solar-Powered Water Project (X78)	78	98,401,076.39	15	100
79.	Construction of Solar-Powered Water Project (X79)	79	88,105,920.00	15	100
80.	Water Scheme: Borehole Drilling (X80)	80	72,116,128.65	15	100
81.	Water Scheme: Rig Platform Tank (X81)	81	66,793,826.00	15	100
82.	Water Scheme: Tank Erection (X82)	82	45,770,177.41	15	100
83.	Water Scheme: Tank & Tank Erection (X83)	83	45,770,177.41	15	100
84.	Water scheme Rig/platform tank (X84)	84	66,793,826.00	15	100
85.	Construction Of Solar-Powered Water Project (X85)	85	98,401,076.39	15	100
86.	Construction Of Solar-Powered Water Project (X86)	86	100,000,000.00	15	100
87.	Water Scheme: Tank & Tank Erection (X87)	87	45,770,177.41	15	100
88.	Water Scheme: Generator House, Service Quarters, Reticulation (X88)	88	98,401,076.39	15	100
89.	Construction of Solar-Powered Water Project (X89)	89	98,401,076.39	15	100
90.	Construction of Solar-Powered Water Project (X90)	90	72,106,600.00	15	100
91.	Construction of Solar-Powered Water Project (X91)	91	72,106,600.00	15	100
92.	Construction of Solar-Powered Water Project (X92)	92	66,793,826.00	15	100

93.	Construction of Solar-Powered Water Project (X93)	93	45,770,177.41	15	100
94.	Construction of Solar-Powered Water Project (X94)	94	98,401,076.39	15	100
95.	Construction of Solar-Powered Water Project (X95)	95	53,010,732.94	15	100
96.	Construction of Solar-Powered Water Project (X96)	96	22,246,000.00	15	95
97.	Construction of Solar-Powered Water Project (X97)	97	98,401,076.39	15	100
98.	Construction of Solar-Powered Water Project (X98)	98	72,677,941.15	15	100
99.	Construction of Solar-Powered Water Project (X99)	99	72,877,941.05	15	100
100.	Construction of Solar-Powered Water Project (X100)	100	39,663,595.13	15	100
101.	Construction of Solar-Powered Water Project (X110)	101	72,533,566.00	15	100
102.	Construction of Solar-Powered Water Project (X102)	102	66,793,826.00	15	100
103.	Construction of Solar-Powered Water Project (X103)	103	98,401,076.39	15	100
104.	Construction of Solar-Powered Water Project (X104)	104	120,000,000.00	15	100
105.	Construction of Solar-Powered Water Project (X105)	105	88,401,076.39	15	100
106.	Construction of Solar-Powered Water Project (X106)	106	34,337,541.00	15	90
107.	Water scheme: Service Quarters, Gen. House & Reticulation (X107)	107	98,401,076.39	15	100
108.	Water scheme: Tank Erection (108)	108	45,770,177.41	15	100
109.	Water scheme: Gen. House & Reticulation (X109)	109	98,401,076.39	15	100
110.	Water Scheme: Generator House & Service Quarters (X110)	110	23,163,648.00	15	100
111.	Water Scheme: Gen. House Service Quarters & Reticulation (X111)	111	18,416,784.10	15	100

112.	Water Scheme: Generator House, Service Quarters & Reticulation (X112)	112	27,733,045.73	15	100
113.	Water Scheme: Borehole Drilling (X113)	113	72,333,566.00	15	100
114.	Water Project: Overhead Tank, Water Distribution and Public Water Stand (X114)	114	28,867,077.96	15	100
115.	Construction of Solar-Powered Water Project (X115)	115	98,401,076.39	15	100
116.	Construction of Solar-Powered Water Project (X116)	116	100,000,000.00	15	100
117.	Construction of Solar-Powered Water Project (X117)	117	100,000,000.00	15	100
118.	Water Scheme: Gen. House, Service Quarters & Reticulations (X118)	118	23,424,635.00	15	100
119.	Construction of Solar-Powered Water Project (X119)	119	98,401,076.39	15	100
120.	Construction of Solar-Powered Water Project (X120)	120	45,000,000.00	15	100
121.	Construction of Solar-Powered Water Project (X121)	121	45,000,000.00	15	100
122.	Construction of Solar-Powered Water Project (X122)	122	85,000,000.00	15	100
123.	Construction of Solar-Powered Water Project (X123)	123	55,000,000.00	15	100
124.	Construction of Solar-Powered Water Project (X124)	124	65,000,000.00	15	100
125.	Construction of Solar-Powered Water Project (X125)	125	75,000,000.00	15	100
126.	Construction of Solar-Powered Water Project (X126)	126	98,401,076.39	15	100
	TOTAL		**9,084,908,619.05**		

Table D.2: Road Project

S/N	PROJECT DESCRIPTION (ROAD)	LOCATION	PROJECT COST (₦)	DURATION (MONTHS)	% COMPLETION
1.	Construction of 1km Road (X1)	1.	108,490,600.00	18	95
2.	Construction of 1 km Road (X2)	2.	108,490,600.00	18	60
3.	Construction of road (X3)	3.	112,151,425.00	18	100
4.	Construction of Road (X4)	4.	237,317,567.50	18	100
5.	Construction of 2km Road (X5)	5.	237,317,567.50	18	100
6.	Construction of Road (X6)	6.	240,020,000.00	18	100
7.	Construction of Sawmill Road (X7)	7.	237,317,567.50	18	100
8.	Construction of Celestial Road (X8)	8.	158,003,750.00	18	95
9.	Construction of Road, Phase 1, (X9)	9.	249,557,325.00	18	100
10.	Construction of Flexible Pavement Road Construction (X10)	10.	113,694,500.00	18	100
11.	Construction of Road (X11)	11.	193,294,500.00	18	100
12.	Construction of Flexible Pavement Road Construction (X12)	12.	113,694,500.00	18	100
13.	Construction of 2km Road (X13)	13.	238,522,285.00	18	100
14.	Construction of Road (X14)	14.	100,000,000.00	18	100
15.	Construction of Road (X15)	15.	237,317,567.50	18	100
16.	Remedial Work of Road Construction (X16)	16.	149,860,360.00	18	100

17.	Construction of Internal Roads (X17)	17.	234,470,600.00	18	100
18.	Construction of Road (X18)	18.	99,865,854.00	18	100
19.	Construction of Road (X19)	19.	49,855,489.00	18	100
20.	Construction of 1km Flexible Pavement Road (X20)	20.	249,560,400.00	12	100
21.	Construction of Internal Road (X21)	21.	240,020,000.00	18	80
22.	Construction of Internal Road Network. (X22)	22.	236,371,500.00	18	100
23.	Construction of 2km Road with Drains and Asphalt. (X23)	23.	399,500,000.00	18	100
24.	Construction of Palace Road (X24)	24.	237,249,815.00	18	100
25.	Remedial worksof Road Construction (X25)	25.	75,572,090.00	12	100
26.	Remedial Work of Road Construction (X26)	26.	75,000,000.00	12	100
27.	Remedial Work of Road Construction (X27)	27.	192,070,378.50	12	100
28.	Construction of the internal Road Construction (X28)	28.	99,633,150.00	18	100
29.	Construction of Road Construction (X29)	29.	86,096,025.00	18	100
30.	Construction of Road Construction of the road (X30)	30.	1,304,259,671.93	12	100
31.	Remedial work of Road Construction of the road (X31)	31.	53,258,181.50	12	100
32.	Construction of road Construction of road (X32)	32.	199,500,000.00	12	100
33.	Construction of 1km Flexible Pavement Construction of road (X33)	33.	249,500,000.00	12	100
34.	Remedial work of road Construction of road (X34)	34.	149,860,360.00	18	100
35.	Construction of Road Construction of the Road (X35)	35.	149,500,000.00	18	100

36.	Construction of Road Construction of the road (X36)	36.	244,002,873.00	18	100
37.	Construction of Internal Road Construction of the road (X37)	37.	241,193,500.00	18	100
38.	Construction of Internal Road Construction of the road (X38)	38.	99,633,150.00	18	100
39.	Construction of the Internal Road. Construction of the road (X39)	39.	99,633,150.00	18	100
40.	Construction of flexible Pavement. Construction of road (X40)	40.	113,694,500.00	18	100
41.	Construction of Township Road. Construction of the road (X41)	41.	1,044,039,937.50	18	100
42.	Construction of Flexible Pavement. Construction of road (X42)	42.	112,635,123.00	18	100
43.	Construction of Road Construction of the road (X43)	43.	214,967,000.00	18	100
44.	Construction of 1km Flexible Pavement. Construction of road (X44)	44.	249,875,680.00	18	100
45.	Construction of Internal Road Construction of the road (X45)	45.	232,903,550.00	18	100
46.	Construction of Road Construction of the road (X46)	46.	99,633,150.00	18	75
47.	Construction of Internal Road Construction of the road (X47)	47.	200,809,062.00	18	100
48.	Repairs of Failed Portions of Road. Construction of the road (X48)	48.	163,310,221.95	18	100
49.	Construction of Internal Roads. Construction of the road (X49)	49.	240,000,000.00	18	100
50.	Construction of Road Construction of the road (X50)	50.	184,506,801.00	18	100
51.	Construction of Flexible Pavement. Construction of road (X51)	51.	247,370,000.00	18	100
52.	Construction of Internal road Construction of road (X52)	52.	399,500,000.00	18	100
53.	Construction of Road (X53)	53.	238,262,410.00	18	100
54.	Construction of Road (X54)	54.	149,718,657.25	18	100
55.	Construction of Road (X55)	55.	179,480,900.00	18	100
56.	Remedial Work of Road Construction of the road (X56)	56.	155,822,061.72	18	100

57.	Construction of Road (X57)	57.	298,456,728.90	18	100
58.	Construction of Internal Roads. Construction of the road (X58)	58.	209,713,112.50	18	100
59.	Construction of Flexible Pavement. Construction of road (X59)	59.	113,694,500.00	18	100
60.	Construction of Road (X60)	60.	122,610,310.00	18	100
61.	Construction of Road (X61)	61.	249,500,000.00	18	90
62.	Construction of 1km Road (X62)	62.	96,463,400.00	18	100
63.	Construction of Road (X63)	63.	19,409,143,685.70	18	100
64.	Construction of Flexible pavement (X64)	64.	79,435,262.50	18	100
65.	Construction of Road (X65)	65.	200,000,000.00	18	90
66.	Construction of Road (X66)	66.	72,000,000.00	18	100
67.	Construction of Flexible pavement (X67)	67.	249,500,000.00	18	100
68.	Construction of 2km Road (X68)	68.	239,171,920.00	18	85
69.	Construction of Road (X69)	69.	150,000,000.00	18	100
70.	Construction of Road with Bridge (X70)	70.	6,136,367,333.25	18	100
71.	Construction of Road with Bridge (X71)	71.	587,793,838.90	18	100
72.	Repairs of Failed Road (X72)	72.	94,527,820.00	18	100
73.	Construction of Township Road (X73)	73.	99,500,000.00	18	100
74.	Construction of 1.5km Flexible Pavement (X74)	74.	148,486,150.00	18	100
75.	Construction of Road (X75)	75.	434,000,000.00	18	100
76.	Construction of Internal Roads (X76)	76.	221,584,312.75	18	100
77.	Repairs of Failed Portions of Road (X77)	77.	189,215,450.00	18	100
78.	Remedial Works of Road (X78)	78.	66,689,608.00	18	100
79.	Remedial Works of Road (X79)	79.	164,903,970.00	18	100
80.	Construction of Road (X80)	80.	114,474,528.00	18	95
81.	Construction of Flexible Pavement (X81)	81.	249,500,000.00	18	100
82.	Construction of Road (X82)	82.	1,692,712,715.10	18	100
83.	Repair of Secretariat Road (X83)	83.	156,439,000.00	18	100
84.	Remedial Works of Internal roads (X84)	84.	199,500,000.00	18	100

85.	Construction of Internal Road (X85)	85.	99,633,150.00	18	100
86.	Construction of Road (X86)	86.	236,371,500.00	18	100
87.	Construction of Road (X87)	87.	195,230,286.00	18	100
88.	Construction of Road (X88)	88.	489,080,761.00	18	100
89.	Construction of Road (X89)	89.	237,317,567.50	18	100
90.	Construction of 2km Road (X90)	90.	180,000,000.00	18	100
91.	Construction of Road (X91)	91.	102,000,000.00	18	100
92.	Construction of 2km Rigid pavement (X92)	92.	248,000,000.00	18	100
93.	Construction of Internal Road (X93)	93.	480,650,125.00	18	100
94.	Remedial Work of Road (X94)	94.	149,860,260.00	18	100
95.	Construction of Internal Road (X95)	95.	719,430,890.00	18	100
96.	Construction of Internal Road (X96)	96.	249,500,000.00	18	100
97.	Construction of Internal Road (X97)	97.	239,720,000.00	18	100
98.	Construction of Internal Road (X98)	98.	249,500,000.00	18	100
99.	Construction of Internal Road (X99)	99.	249,500,000.00	18	100
100.	Construction of Internal Road (X100)	100.	249,500,000.00	18	100
101.	Construction of Internal Road (X101)	101.	249,500,000.00	18	100
102.	Construction of Internal Road (X102)	102.	249,500,000.00	18	100
103.	Construction of Internal Road (X103)	103.	965,080,975.00	18	100
104.	Construction of Internal Road (X104)	104.	249,500,000.00	18	100
105.	Construction of Internal Road (X105)	105.	239,750,000.00	18	100
106.	Construction of Internal Road (X106)	106.	249,500,000.00	18	100
107.	Construction of Flexible Pavement (X107)	107.	249,500,000.00	18	100
108.	Construction of Internal Road (X108)	108.	237,317,567.50	18	100
109.	Construction of 7.5km Road with Rigid Pavement (X109)	109.	230,000,000.00	18	100
110.	Construction of 7.5km Road with Rigid Pavement (X110)	110.	230,000,000.00	18	100
111.	Construction of 7.5km Road with Rigid Pavement (X111)	111.	230,000,000.00	18	100
112.	Construction of 7.5km Road with Rigid Pavement (X112)	112.	230,000,000.00	18	100
113.	Construction of 7.5km Road with Rigid Pavement (X113)	113.	230,000,000.00	18	100

114.	Construction of 7.5km Road with Rigid Pavement (X114)	114.	230,000,000.00	18	100
115.	Construction of 7.5km Road with Rigid Pavement (X115)	115.	230,000,000.00	18	100
116.	Construction of 3km Road (X116)	116.	239,500,000.00	18	100
117.	Construction of 2.5km Road (X117)	117.	399,500,000.00	18	100
118.	Construction of Road (X118)	118.	237,317,567.50	18	100
119.	Construction of Road (X119)	119.	237,317,567.50	18	100
120.	Construction of 2km Road (X120)	120.	244,630,000.00	18	100
121.	Construction of Road (X121)	121.	237,317,567.50	18	100
122.	Construction of Road (X122)	122.	248,900,000.00	18	100
123.	Construction of Road (X123)	123.	248,900,001.00	18	100
124.	Repairs of Failed Portions of Road (X124)	124.	89,564,808.37	18	100
125.	Repairs of Failed Portions of Road (X125)	125.	467,848,657.50	18	100
126.	Repairs of Failed Portions of Road (X126)	126.	319,916,178.75	18	100
127.	Repairs of Failed Portions of Road (X127)	127.	465,340,987.13	18	100
128.	Repairs of Failed Portions of Road (X128)	128.	81,435,737.25	18	100
129.	Repairs of Failed Portions of Road (X129)	129.	144,855,082.63	18	100
130.	Repairs of Failed Portions of Road (X130)	130.	506,541,341.25	18	100
131.	Repairs of Failed Portions of Road (X131)	131.	415,263,834.56	18	100
132.	Repairs of Failed Portions of Road (X132)	132.	258,070,452.68	18	100
133.	Repairs of Failed Portions of Road (X133)	133.	246,921,068.63	18	100
134.	Repairs of Failed Portions of Road (X134)	134.	648,620,117.25	18	100
135.	Repairs of Failed Portions of Road (X135)	135.	346,316,532.19	18	100
136.	Repairs of Failed Portions of Road 2 (X136)	136.	336,320,666.06	18	100
137.	Repairs of Failed Portions of Road (X137)	137.	317,957,729.25	18	100
138.	Repairs of Failed Portions of Road (X138)	138.	346,316,532.19	18	100
139.	Repairs of Failed Portions of Road (X139)	139.	494,935,113.75	18	100
140.	Repairs of Failed Portions of Road (X140)	140.	402,609,099.38	18	100
141.	Repairs of Failed Portions of Road (X141)	141.	232,647,200.63	18	100
142.	Repairs of Failed Portions of Road (X142)	142.	307,657,960.31	18	100

143.	Repairs of Failed Portions of Road (X143)	143.	96,610,171.88	18	100
144.	Repairs of Failed Portions of Road (X144)	144.	465,340,987.13	18	100
145.	Repairs of Failed Portions of Road (X145)	145.	205,187,677.75	18	100
146.	Repairs of Failed Portions of Road (X146)	146.	200,917,678.75	18	100
147.	Repairs of Failed Portions of Road (X147)	147.	205,917,678.75	18	100
148.	Repairs of Failed Portions of Road (X148)	148.	115,917,678.75	18	100
149.	Repairs of Failed Portions of Road (X149)	149.	88,921,801.22	18	100
150.	Repairs of Failed Portions of Road (X150)	150.	205,917,678.75	18	100
151.	Repairs of Failed Portions of Road (X151)	151.	441,424,252.50	18	100
152.	Repairs of Failed Portions of Road (X152)	152.	369,498,307.50	18	100
153.	Repairs of Failed Portions of Road (X153)	153.	205,917,678.75	18	100
154.	Repairs of Failed Portions of Road (X154)	154.	505,900,678.75	18	100
155.	Repairs of Failed Portions of Road (X155)	155.	605,917,678.75	18	100
156.	Repairs of Failed Portions of Road (X156)	156.	487,282,359.38	18	100
157.	Repairs of Failed Portions of Road (X157)	157.	586,131,052.50	18	100
158.	Repairs of Failed Portions of Road (X158)	158.	405,917,678.75	18	100
159.	Repairs of Failed Portions of Road (X159)	159.	737,185,512.53	18	100
160.	Repairs of Failed Portions of Road (X160)	160.	735,736,450.05	18	100
161.	Repairs of Failed Portions of Road (X161)	161.	459,581,771.21	18	100
162.	Repairs of Failed Portions of Road (X162)	162.	45,000,000.00	18	100
163.	Repairs of Failed Portions of Road (X163)	163.	628,654,950.00	18	100
164.	Repairs of Failed Portions of Road (X164)	164.	426,896,216,25	18	100
165.	Repairs of Failed Portions of Road (X165)	165.	426,896,216,25	18	100
166.	Construction of Road (X166)	166.	442,504,965.00	18	100
167.	Construction of Road (X167)	167.	343,729,119.26	18	100
168.	Construction of Road (X168)	168.	343,729,119.26	18	100
169.	Construction of Road (X169)	169.	439,383,215.25	18	100
170.	Construction of Road (X170)	170.	439,383,215.25	18	100
171.	Construction of Road (X171)	171.	657,256,548.38	18	100
172.	Construction of Road (X172)	172.	657,256,548.38	18	100
173.	Construction of Road (X173)	173.	439,383,215.25	18	100
174.	Construction of Road (X174)	174.	657,256,548.38	18	100

175.	Construction of Road (X175)	175.	343,729,119.26	18	100
176.	Construction of Road (X176)	176.	657,256,548.38	18	100
177.	Construction of Road (X177)	177.	670,274,981.25	18	100
178.	Construction of Road (X178)	178.	455,247,712.50	18	100
179.	Construction of Road (X179)	179.	363,568,275.00	18	100
180.	Construction of Road (X180)	180.	242,681,827.50	18	100
181.	Construction of Road (X181)	181.	732,880,775.03	18	100
182.	Construction of Road (X182)	182.	733,870,925.03	18	100
183.	Construction of Road (X183)	183.	733,128,250.05	18	100
184.	Construction of Road (X184)	184.	733,400,000.03	18	100
185.	Construction of Road (X185)	185.	732,578,837.55	18	100
186.	Repairs of Failed Portions of Road (X186)	186.	736,750,850.01	18	100
187.	Repairs of Failed Portions of Road (X187)	187.	729,445,250.10	18	100
188.	Repairs of Failed Portions of Road (X188)	188.	450,737,511.00	18	100
189.	Repairs of Failed Portions of Road (X189)	189.	457,022,401.50	18	100
190.	Repairs of Failed Portions of Road (X190)	190.	478,814,322.00	18	100
191.	Repairs of Failed Portions of Road (X191)	191.	445,626,714.75	18	100
192.	Remedial Works on Failed Portions of Road (X192)	192.	445,626,714.75	18	100
193.	Remedial Works on Failed Portions of Road (X193)	193.	445,626,714.75	18	100
194.	Remedial Works on Failed Portions of Road (X194)	194.	440,883,870.00	18	100
195.	Remedial Works on Failed Portions of Road (X195)	195.	803,879,422.50	18	100
196.	Remedial Works on Failed Portions of Road (X196)	196.	440,883,870.00	18	100
197.	Remedial Works on failed Portions of Road (X197)	197.	440,883,870.00	18	100
	Total		**86,303,594,869.21**		

Table D.3: ELECTRIFICATION

S/N	PROJECT DESCRIPTION (ELECTRIFICATION)	LOCATION	PROJECT COST (₦)	DURATION (MONTHS)	COMPLETION %
1	Solar-Powered Street Light (X1)	1	100,000,000.00	6	30
2	Solar-Powered Street Light (X2)	2	199,724,293.50	6	100
3	Solar-Powered Street Light (X3)	3	149,900,000.00	6	100
4	Solar-Powered Street Light (X4)	4	170,000,000.00	6	100
5	Solar-Powered Street Light (X5)	5	199,963,793.50	6	100
6	Solar-Powered Street Light (X6)	6	150,000,000.00	6	100
7	Solar-Powered Street Light (X7)	7	100,000,000.00	6	100
8	Solar-Powered Street Light (X8)	8	200,000,000.00	6	100
9	Solar-Powered Street Light (X9)	9	100,000,000.00	6	0
10	Solar-Powered Street Light (X10)	10	119,974,512.00	6	30
11	Electrification (X11)	11	24,357,310.52	6	100
12	Installation of 1 no. 300kva, 11/0.415kv Transformer (X12)	12	9,000,000.00	6	100
13	Electrification Project (X13)	13	10,804,320.00	6	25
14	Installation of 1 no. 300kva, 11/0.415kv Transformer (X14)	14	9,000,000.00	6	100
15	Installation of 1 no. 300kva, 11/0.415kv Transformer (X15)	15	4,500,000.00	6	100
16	Installation of 1 no. 300kva, 11/0.415kv Transformer (X16)	16	4,500,000.00	6	100
17	Installation of 1 no. 300kva, 11/0.415kv Transformer (X17)	17	4,500,000.00	6	100
18	Installation of 1 no. 300kva, 11/0.415kv Transformer (X18)	18	4,500,000.00	6	100
19	Installation of 500kva, 11/0.415kv Transformer (X19)	19	4,500,000.00	6	100
20	Installation of 1 no. 300kva, 11/0.415kv Transformer (X20)	20	4,500,000.00	6	100

21	Installation of 1 no. 300kva, 11/0.415kv Transformer (X21)	21	4,500,000.00	6	100
22	Electrification Project (X22)	22	43,879,758.00	6	100
23	Installation of 1 no. 500kva, 11/0.415kv Transformer (X23)	23	4,500,000.00	6	100
24	Installation of 1 no. 300kva, 11/0.415kv Transformer (X24)	24	4,500,000.00	6	100
25	Installation of 1 no. 300kva, 11/0.415kv Transformer (X25)	25	4,500,000.00	6	100
26	Installation of 1 no. 300kva, 11/0.415kv Transformer (X26)	26	4,500,000.00	6	100
27	Installation of 1 no. 300kva, 11/0.415kv Transformer (X27)	27	4,500,000.00	6	100
28	Solar-Powered Street Light (X28)	28	150,000,000.00	6	0
29	Improvement of Electricity Supply (X29)	29	10,380,118.80	6	100
30	Installation of 1 no. 500kva, 11/0.415kv Transformer (X30)	30	4,500,000.00	6	100
31	Electrification (X31)	31	11,160,191.00	6	0
32	Installation of 1 no. 300kva, 11/0.415kv Transformer (X32)	32	4,500,000.00	6	100
33	Installation of 1 no. 500kva, 11/0.415kv Transformer (X33)	33	4,500,000.00	6	100
34	Electrification (X34)	34	15,383,697.83	6	25
35	Installation of 1 no. 300kva, 11/0.415kv Transformer (X35)	35	4,500,000.00	6	100
36	Installation of 1 no. 300kva, 11/0.415kv Transformer (X36)	36	4,500,000.00	6	100
37	Solar powered Street Light (X37)	37	99,737,500.00	6	100
38	Installation of 1 no. 500kva, 11/0.415kv Transformer (X38)	38	4,500,000.00	6	100
39	Installation of 300kva, 11/0.415kv Transformer (X39)	39	4,500,000.00	6	100
40	Solar-powered Street Light (X40)	40	200,225,880.00	6	100
41	Solar-powered Street Light (X41)	41	199,863,793.50	6	100
42	Rural Electrification Project (X42)	42	56,806,231.75	6	100
43	Installation of 1 no. 500kva, 11/0.415kv Transformer (X43)	43	4,500,000.00	6	100
44	Electrification (X43)	44	69,979,568.40	6	0

45	Installation of 1 no. 300kva, 11/0.415kv Transformer (X45)	45	4,500,000.00	6	100
46	Installation of 1 no. 500kva, 11/0.415kv Transformer (X46)	46	4,500,000.00	6	100
47	Electrification Project. (X47)	47	39,995,403.00	6	31
48	Solar-Powered Street Light (X48)	48	99,845,367.50	6	0
49	Solar-Powered Street Light (X49)	49	99,899,986.50	6	100
50	Solar-Powered Street Light (X50)	50	119,974,512.00	6	100
51	Solar-Powered Street Light (X51)	51	249,999,001.00	6	100
52	Solar-Powered Street Light (X52)	52	249,999,001.00	6	100
53	Installation of 1 no. 300kva, 11/0.415kv Transformer (X53)	53	4,500,000.00	6	100
54	Installation of 300kva, 11/0.415kv Transformer (X54)	54	4,500,000.00	6	100
55	Electrification (X55)	55	32,155,592.96	6	100
56	Installation of 1 no. 500kva, 11/0.415kv Transformer (X56)	56	4,500,000.00	6	100
57	Installation of 1 no. 500kva, 11/0.415kv transformer (X57)	57	4,500,000.00	6	100
58	Electrification Project (X58)	58	39,998,074.20	6	100
59	Installation of 1 no. 500kva, 11/0.415kv transformer (X59)	59	4,500,000.00	6	100
60	Installation of 1 no. 300kva, 11/0.415kv Transformer (X60)	60	4,500,000.00	6	100
61	Solar Street Light Electrification (X61)	61	150,000,000.00	6	100
62	300kva, 11/0.415kv Transformer (X62)	62	4,500,000.00	6	100
63	Electrification (X63)	63	34,711,751.48	6	100
64	Installation of 1 no. 2.300kva 0.33/0.415kv Transformers (X64)	64	9,143,001.56	6	100
65	Electrification (X65)	65	45,928,205.00	6	100
66	Installation of 2 300kva 0.33/0.415kv Transformers(X66)	66	4,500,000.00	6	100
67	Solar-Powered Street Light (X67)	67	79,899,995.50	6	100
68	Solar-Powered Street Light (X68)	68	99,412,300.00	6	100

69	Electrification Project. (X69)	69	39,994,004.40	6	0
70	Solar-Powered Street Light (X70)	70	249,999,001.00	6	0
71	Installation of 1 no. 500kva, 11/0.415kv Transformer (X71)	71	4,500,000.00	6	100
72	Installation of 1 no. 300kva, 11/0.415kv Transformer (X72)	72	4,500,000.00	6	100
73	Installation of 1 no. 300kva, 11/0.415kv Transformer (X73)	73	4,500,000.00	6	100
74	Installation of 1 no. 300kva, 11/0.415kv Transformer (X74)	74	4,500,000.00	6	100
75	Solar-Powered Street Light (X75)	75	100,000,000.00	6	100
76	Installation of 1 no. 300kva, 11/0.415kv Transformer (X76)	76	4,500,000.00	6	100
77	Installation of 1 no. 300kva, 11/0.415kv Transformer (X77)	77	4,500,000.00	6	100
78	Solar-Powered Street Light (X78)	78	100,000,000.00	6	100
79	Installation of 1 no. 300kva, 11/0.415kv Transformer (X79)	79	4,500,000.00	6	100
80	Solar-Powered Street Light (X80)	80	80,000,000.00	6	100
81	Electrification (X81)	81	12,980,572.82	6	100
82	Electrification (X82)	82	18,628,477.14	6	0
83	Electrification (X83)	83	64,445,822.10	6	20
84	Rural Electrification Project. (X84)	84	39,999,498.00	6	15
85	Electrification (X85)	85	13,991,769.30	6	100
86	Installation of 1 no. 300kva, 11/0.415kv Transformer (X86)	86	4,500,000.00	6	100
87	Solar-Powered Street Light (X87)	87	70,064,940.00	6	100
88	Installation of 1 no. 300kva, 11/0.415kv Transformer (X88)	88	4,500,000.00	6	100
89	Solar-Powered Street Light (X89)	89	99,899,986.50	6	100
90	Solar-Powered Street Light (X90)	90	100,000,000.00	6	100
91	Electrification (Gen. Set) (X91)	91	106,759,328.80	6	60
92	Solar-Powered Street light (X92)	92	121,442,120.00	6	100
93	Installation of 1 no. 300kva, 11/0.415kv Transformer (X93)	93	4,500,000.00	6	100

94	Installation of 1 no. 500kva, 11/0.415kv Transformer (X94)	94	4,500,000.00	6	100
95	Installation of 1 no. 300kva, 11/0.415kv Transformer (X95)	95	4,500,000.00	6	100
96	Electrification (X96)	96	17,957,682.60	6	30
97	Solar-Powered Street Light (X97)	97	200,000,000.00	6	100
98	Installation of 1 no. 300kva, 11/0.415kv Transformer (X98)	98	4,500,000.00	6	100
99	Installation of 1 no. 300kva, 11/0.415kv Transformer (X99)	99	4,500,000.00	6	100
100	Installation of 1 no. 300kva, 11/0.415kv Transformer (X100)	100	4,500,000.00	6	100
101	Installation of 1 no. 300kva, 11/0.415kv Transformer (X101)	11	4,500,000.00	6	100
102	Solar-Powered Street Light (X102)	102	99,899,986.50	6	100
103	Installation of 1 no. 300kva, 11/0.415kv Transformer (X103)	103	4,500,000.00	6	100
104	Installation of 1 no. 300kva, 11/0.415kv Transformer (X104)	104	4,500,000.00	6	100
105	Installation of 1 no. 300kva, 11/0.415kv Transformer (X105)	105	4,500,000.00	6	100
106	Solar-powered Street Light (X106)	106	150,000,000.00	6	100
107	300kva, 11/0.415kv Transformer (X107)	107	4,500,000.00	6	100
108	1 x 1.5mva 33/11kv Injection Substation (X108)	108	247,675,960.68	6	100
109	Solar-Powered Street Light (X109)	109	49,199,982.50	6	100
110	Installation of 1 no. 500kva, 11/0.415kv Transformer (X110)	110	4,500,000.00	6	100
111	Installation of 1 no. 300kva, 11/0.415kv Transformer (X111)	111	4,500,000.00	6	100
112	Installation of 1 no. 500kva, 11/0.415kv Transformer (X112)	112	4,500,000.00	6	100
113	Installation of 1 no. 500kva, 11/0.415kv Transformer (X113)	113	4,500,000.00	6	100
114	Installation of 1 no. 300kva, 11/0.415kv Transformer (X114)	114	4,500,000.00	6	100
115	Solar-Powered Street Light (X115)	115	200,000,000.00	6	100

116	Installation of 1 no. 300kva, 11/0.415kv Transformer (X116)	116	4,500,000.00	6	100
117	Installation of 1 no. 500kva, 11/0.415kv Transformer (X117)	117	4,500,000.00	6	0
118	Electrification (Gen-Set) (X118)	118	46,789,800.00	6	100
119	Solar-Powered Street Light (X119)	119	121,442,120.00	6	100
120	Electrification project (X120)	120	24,994,561.20	6	74
121	Installation of 1 no. 300kva, 11/0.415kv Transformer (X121)	121	4,500,000.00	6	100
122	Installation of 1 no. 500kva, 11/0.415kv Transformer (X122)	122	4,500,000.00	6	100
123	Solar-Powered Street light (X123)	123	120,000,000.00	6	100
124	Installation of 1 no. 300kva, 11/0.415kv Transformer (X124)	124	4,500,000.00	6	100
125	Solar-Powered Street Light (X125)	125	100,000,000.00	6	100
126	Installation of 1 no. 300kva, 11/0.415kv Transformer (X126)	126	4,500,000.00	6	100
127	Installation of 1 no. 500kva, 33/0.415kv Transformer (X127)	127	9,000,000.00	6	100
128	Installation of 1 no. 300kva, 33/0.415kv Transformer (X128)	128	13,500,000.00	6	100
129	Installation of 1 no. 300kva, 11/0.415kv Transformer (X129)	129	4,500,000.00	6	100
130	Solar-Powered Street Light (X130)	130	99,899,986.50	6	100
131	Installation of 1 no. 300kva, 11/0.415kv Transformer (X131)	131	4,500,000.00	6	100
132	Installation of 1 no. 300kva, 11/0.415kv Transformer (X132)	132	4,500,000.00	6	100
133	Installation of 1 no. 300kva, 11/0.415kv Transformer (X133)	133	4,500,000.00	6	100
134	Installation of 1 no. 300kva, 11/0.415kv Transformer (X134)	134	4,500,000.00	6	100
135	Installation of 1 no. 500kva, 11/0.415kv Transformer (X135)	135	4,500,000.00	6	100
136	Installation of 1 no. 300kva, 11/0.415kv Transformer (X136)	136	4,500,000.00	6	100

137	Installation of 1 no. 500kva, 11/0.415kv Transformer (X137)	137	4,500,000.00	6	100
138	Installation of 1 no. 500kva, 11/0.415kv Transformer (X138)	138	4,500,000.00	6	100
139	Installation of 1 no. 500kva, 11/0.415kv Transformer (X139)	130	4,500,000.00	6	100
140	Installation of 1 no. 300kva, 11/0.415kv Transformer (X140)	140	4,500,000.00	6	100
141	Installation of 1 no. 300kva, 11/0.415kv Transformer (X141)	141	4,500,000.00	6	100
142	Installation of 1 no. 300kva, 11/0.415kv Transformer (X142)	142	4,500,000.00	6	40
143	Solar-Powered Street Light (X143)	143	150,000,000.00	6	100
144	Installation of 1 no. 300kva, 11/0.415kv Transformer (X144)	144	4,500,000.00	6	100
145	Installation of 1 no. 500mva 33/11kv Injection Substation (X145)	145	247,675,960.68	6	100
146	Solar-Powered Street Light (X146)	146	49,199,982.50	6	100
147	Installation of 1 no. 500kva, 11/0.415kv Transformer (X147)	147	4,500,000.00	6	100
148	Installation of 1 no. 300kva, 11/0.415kv Transformer (X148)	148	4,500,000.00	6	100
149	Installation of 1 no. 500kva, 11/0.415kv Transformer(X149)	149	4,500,000.00	6	100
150	Installation of 1 no. 500kva, 11/0.415kv Transformer (X150)	150	4,500,000.00	6	100
151	Installation of 1 no. 300kva, 11/0.415kv Transformer (X151)	151	4,500,000.00	6	100
152	Solar-Powered Street Light (X152)	152	200,000,000.00	6	100
153	Installation of 1 no. 300kva, 11/0.415kv Transformer (X153)	153	4,500,000.00	6	100
154	Installation of 1 no. 500kva, 11/0.415kv Transformer (X154)	154	4,500,000.00	6	0
155	Electrification (gen-set) (X155)	155	46,789,800.00	6	100
156	Solar-Powered Street Light (X156)	156	121,442,120.00	6	100
157	Electrification Project (X157)	157	24,994,561.20	6	74

158	Installation of 1 no. 300kva, 11/0.415kv Transformer (X158)	158	4,500,000.00	6	100
159	Installation of 1 no. 500kva, 11/0.415kv Transformer (X159)	159	4,500,000.00	6	100
160	Solar-Powered Street Light (X160)	160	120,000,000.00	6	100
161	Installation of 1 no. 300kva, 11/0.415kv Transformer (X161)	161	4,500,000.00	6	100
162	Solar-Powered Street Light (X162)	162	100,000,000.00	6	100
163	Installation of 1 no. 300kva, 11/0.415kv Transformer (X163)	163	4,500,000.00		100
164	Installation of 2 no. 500kva, 11/0.415kv Transformer (X164)	164	9,000,000.00	6	100
165	Installation of 3 no. 300kva, 11/0.415kv Transformer (X165)	165	13,500,000.00	6	100
166	Installation of 1 no. 300kva, 11/0.415kv Transformer (X166)	166	4,500,000.00	6	100
167	Installation of 1 no. 500kva, 11/0.415kv Transformer (X167)	167	4,500,000.00	6	100
168	Installation of 1 no. 300kva, 11/0.415kv Transformer (X168)	168	4,500,000.00	6	100
169	Installation of 1 no. 300kva, 11/0.415kv Transformer (X169)	169	4,500,000.00	6	100
170	Installation of 1 no. 300kva, 11/0.415kv Transformer (X170)	170	4,500,000.00	6	100
171	Installation of 1 no. 300kva, 11/0.415kv Transformer (X171)	171	4,500,000.00	6	100
172	Installation of 1 no. 500kva, 11/0.415kv Transformer (X172)	172	4,500,000.00	6	100
173	Installation of 1 no. 300kva, 11/0.415kv Transformer (X173)	173	4,500,000.00	6	100
174	Solar-Powered Street Light (X174)	174	199,999,001.00	6	100
175	Electrification (Completion) (X175)	175	95,684,125.02	6	100
176	Installation of 1 no. 300kva, 11/0.415kv Transformer (X176)	176	4,500,000.00	6	0
177	Installation of 1 no. 300kva, 11/0.415kv Transformer (X177)	177	4,500,000.00	6	100
178	Construction of 132kv Transmission Line &	178	6,073,379,900.87	18	100

	132kv/33kv Substation (X178)				
179	Electrification (X179)	179	249,975,360.75	6	0
180	Electrification (X180)	180	570,601,633.80	6	100
181	Installation of 1 no. 300kva, 11/0.415kv Transformer (X181)	181	4,500,000.00	6	100
182	Installation of 1 no. 300kva, 11/0.415kv Transformer (X182)	182	4,500,000.00	6	100
183	Installation of 1 no. 300kva, 11/0.415kv Transformer (X183)	183	4,500,000.00	6	100
184	Installation of 1 no. 300kva, 11/0.415kv Transformer (X184)	184	4,500,000.00	6	100
185	Electrification (X185)	185	12,735,008.00	6	100
186	Installation of 1 no. 300kva, 11/0.415kv Transformer (X186)	186	4,500,000.00	6	100
187	Installation of 1 no. 500kva, 11/0.415kv Transformer (X186)	187	4,500,000.00	6	100
188	Installation of 1 no. 300kva, 11/0.415kv Transformer (X188)	188	4,500,000.00	6	100
189	Installation of 1 no. 500kva, 11/0.415kv Transformer (X189)	189	4,500,000.00	6	100
190	Installation of 1 no. 500kva, 11/0.415kv Transformer (X190)	190	4,500,000.00	6	100
191	Rural Electrification (X191)	191	40,501,132.50	6	100
192	Electrification (X192)	194	20,046,631.25	6	100
193	Electrification Project/ Rehabilitation of Township Distribution Network (X193)	193	16,777,332.74	6	60
194	Installation of 1 no. 300kva, 11/0.415kv Transformer (X194)	192	4,500,000.00	6	100
195	Installation of 1 no. 500kva, 11/0.415kv Transformer (X195)	195	4,500,000.00	6	100
196	Installation of 1 no. 300kva, 11/0.415kv Transformer (X196)	196	4,500,000.00	6	100
197	Installation of 1 no. 300kva, 11/0.415kv Transformer (X197)	197	4,500,000.00	6	100
198	Installation of 1 no. 300kva, 11/0.415kv Transformer (X198)	198	4,500,000.00	6	100
199	Installation of 1 no. 300kva, 11/0.415kv Transformer (X199)	199	4,500,000.00	6	100

200	Installation of 1 no. 300kva, 11/0.415kv Transformer (X200)	200	4,500,000.00	6	0
201	Installation of 1 no. 300kva, 11/0.415kv Transformer (X201)	201	4,500,000.00	6	100
202	Installation of 1 no. 500kva, 11/0.415kv Transformer (X202)	202	4,500,000.00	6	100
203	Installation of 1 no. 500kva, 11/0.415kv Transformer (X203)	203	4,500,000.00	6	100
204	Installation of 1 no. 300kva, 11/0.415kv Transformer (X204)	204	4,500,000.00	6	100
205	Installation of 1 no. 300kva, 11/0.415kv Transformer (X205)	205	4,500,000.00	6	100
206	Installation of 1 no. 300kva, 11/0.415kv Transformer (X206)	206	4,500,000.00	6	100
207	Installation of 1 no. 300kva, 11/0.415kv Transformer (X207)	207	4,500,000.00	6	100
208	Installation of 1 no. 500kva, 11/0.415kv Transformer (X208)	208	4,500,000.00	6	100
209	Installation of 1 no. 500kva, 11/0.415kv Transformer (X209)	209	4,500,000.00	6	100
210	Installation of 1 no. 500kva, 11/0.415kv Transformer (X210)	210	4,500,000.00	6	100
211	Installation of 1 no. 500kva, 11/0.415kv Transformer (X211)	211	4,500,000.00	6	100
212	Installation of 1 no. 300kva, 11/0.415kv Transformer (X212)	212	4,500,000.00	6	100
213	Electrification Project. (X213)	213	49,999,370.40	6	100
214	Installation of 1 no. 300kva, 11/0.415kv Transformer (X214)	214	4,500,000.00	6	100
215	Installation of 1 no. 300kva, 11/0.415kv Transformer (X215)	215	4,500,000.00	6	100
216	Solar-Powered Street Light (X216)	216	80,000,000.00	6	100
217	Solar Electrification (X217)	217	80,000,000.00	6	100
218	Installation of 1 no. 300kva, 11/0.415kv Transformer (X218)	218	4,500,000.00	6	0
219	Installation of 1 no. 300kva, 11/0.415kv Transformer (X219)	219	4,500,000.00	6	0
220	Installation of 1 no. 300kva, 11/0.415kv Transformer (X220)	220	4,500,000.00	6	100

221	Installation of 1 no. 500kva, 11/0.415kv Transformer (X221)	221	4,500,000.00	6	100
222	Electrification (X222)	222	52,542,061.88	6	75
223	Solar-Powered Street Light (X223)	223	249,999,001.00	6	100
224	Installation of 1 no. 500kva, 11/0.415kv Transformer (X224)	224	4,500,000.00	6	100
225	Installation of 1 no. 300kva, 11/0.415kv Transformer (X225)	225	4,500,000.00	6	100
226	Solar-Powered Street Light (X226)	226	199,863,793.50	6	100
227	Installation of 1 no. 300kva, 11/0.415kv Transformer (X227)	227	4,500,000.00	6	100
228	Installation of 1 no. 300kva, 11/0.415kv Transformer (X228)	228	4,500,000.00	6	100
229	Installation of 1 no. 300kva, 11/0.415kv Transformer (X229)	229	4,500,000.00	6	100
230	Installation of 1 no. 300kva, 11/0.415kv Transformer (X230)	230	4,500,000.00	6	100
231	Solar-Powered Street Light (X231)	231	99,690,000.00	6	100
232	Solar-Powered Street Light (X232)	232	199,780,000.00	6	100
233	Solar-Powered Street Light (X233)	233	249,896,000.00	6	100
234	Solar-Powered Street Light (X234)	234	249,895,000.00	6	100
	TOTAL		**16,955,636,537.63**		

Table D.4: Water Jetty and Walkway

S/N	PROJECT TITLE	LOCATION	PROJECT COST (₦ x10^3)	DURATION (Months)	COMPLETION%
1	Construction of Walkway (X1)	1	174,394	12	100
2	Construction of 1.5km Foot Bridge (X2)	2	150,000	12	100
3	Construction of 1.5km Foot Bridge (X3)	3	225,000	12	100
4	Construction of Concrete Jetty and Walkway (X4)	4	229,050	12	100
5	Construction of Landing Jetty (X5)	5	53,766	12	100
6	Construction of Concrete Jetty and Walkway (X6)	6	219,500	12	100
7	Construction of Concrete Landing Jetty (X7)	7	82,830	12	100
8	Construction of Concrete Landing Jetty (X8)	8	82,830	12	100
9	Construction of Concrete Landing Jetty (X9)	9	82,830	12	100

10	Construction of Concrete Landing Jetty and Walkway (X10)	10	198,810	12	100
11	Construction of Concrete Landing Jetty and Walkway (X11)	11	200,000	12	100
12	Construction of Concrete Jetty and Walkway (X12)	12	200,000	12	100
13	Construction of Walkway (X13)	13	39,680	12	100
14	Construction of Concrete Jetty and Walkway (X14)	14	117,913	12	100
15	Construction of Concrete Jetty and Walkway (X15)	15	214,372	12	100
16	Construction of Concrete Jetty and Walkway (X16)	16	214,372	12	100
17	Construction of Concrete Jetty and Walkway (X17)	17	226,257	12	100
18	Construction of Concrete Jetty and Walkway (X18)	18	216,257	12	100
19	Construction of Concrete Jetty and Walkway (X19)	19	214,372	12	100
20	Construction of Concrete Jetty and Walkway (X20)	20	214,372	12	100
21	Construction of Concrete Jetty and Walkway (X21)	21	226,257	12	100
22	Construction of Concrete Jetty and Walkway (X22)	22	226,257	12	100
23	Construction of Concrete Jetty and Walkway (X23)	23	226,041	12	100
24	Construction of Concrete Jetty and Walkway (X24)	24	224,156	12	100
25	Construction of Concrete Jetty and Walkway (X25)	25	216,041	12	100
26	Construction of Concrete Jetty and Walkway (X26)	26	217,083	12	100
27	Construction of Concrete Jetty and Walkway (X27)	27	226,537	12	100
28	Construction of Concrete Jetty and Walkway (X28)	28	226,537	12	100
29	Construction of Concrete Jetty and Walkway (X29)	29	226,257	12	100
30	Construction of Concrete Jetty and Walkway (X30)	30	218,230	12	100
31	Construction of Concrete Jetty and Walkway (X31)	31	218,108	12	100
32	Construction of Concrete Jetty and Walkway (X32)	32	227,125	12	100
33	Construction of Concrete Jetty and Walkway (X33)	33	226,340	12	100
34	Construction of Concrete Jetty and Walkway (X34)	34	226,340	12	100
35	Construction of Concrete Jetty and Walkway (X35)	35	218,324	12	100
36	Construction of Concrete Jetty and Walkway (X36)	36	214,987	12	100
37	Construction of Concrete Jetty and Walkway (X37)	37	226,340	12	100
38	Construction of Concrete Jetty and Walkway (X38)	38	227,688	12	100
39	Construction of Concrete Jetty and Walkway (X39)	39	227,477	12	100

40	Construction of Concrete Jetty and Walkway (X40)	40	226,936	12	100
41	Construction of Concrete Jetty and Walkway (X41)	41	227,135	12	100
42	Construction of Concrete Jetty and Walkway (X42)	42	226,257	12	100
43	Construction of Concrete Jetty and Walkway (X43)	43	226,257	12	100
44	Construction of Concrete Jetty and Walkway (X44)	44	226,041	12	100
45	Construction of Concrete Jetty and Walkway (X45)	45	226,257	12	100
46	Construction of Concrete Jetty and Walkway (X46)	46	212,683	12	100
47	Construction of Concrete Jetty and Walkway (X47)	47	213,098	12	100
48	Construction of Concrete Jetty and Walkway (X48)	48	229,391	12	100
49	Construction of Concrete Jetty and Walkway (X49)	49	227,911	12	100
50	Construction of Concrete Jetty and Walkway (X50)	50	227,082	12	100
51	Construction of Concrete Jetty and Walkway (X51)	51	229,272	12	100
52	Construction of Concrete Jetty and Walkway (X52)	52	228,526	12	100
53	Construction of Concrete Jetty and Walkway (X53)	53	228,526	12	100
54	Construction of Concrete Jetty and Walkway (X54)	54	229,193	12	100
55	Construction of Concrete Jetty and Walkway (X55)	55	228,893	12	100
56	Construction of Concrete Jetty and Walkway (X56)	56	224,144	12	100
57	Construction of Concrete Jetty and Walkway (X57)	57	214,741	12	100
58	Construction of Concrete Jetty and Walkway (X58)	58	214,570	12	100
59	Construction of Concrete Jetty and Walkway (X59)	59	218,324	12	100
60	Construction of Concrete Jetty and Walkway (X60)	60	217,298	12	100
61	Construction of Concrete Jetty and Walkway (X61)	61	215,513	12	100
62	Construction of Concrete Jetty and Walkway (X62)	62	219,279	12	100
63	Construction of Concrete Jetty and Walkway (X63)	63	210,084	12	100
64	Construction of Concrete Jetty and Walkway (X64)	64	214,703	12	100
65	Construction of Concrete Jetty and Walkway (X65)	65	212,288	12	100
66	Construction of Concrete Jetty and Walkway (X66)	66	225,184	12	100
67	Construction of Concrete Jetty and Walkway (X67)	67	226,257	12	100
68	Construction of Concrete Jetty and Walkway (X68)	68	227,683	12	100

69	Construction of Concrete Jetty and Walkway (X69)	69	212,893	12	100
70	Construction of Concrete Jetty and Walkway (X70)	70	214,446	12	100
71	Construction of Concrete Jetty and Walkway (X71)	71	227,233	12	100
72	Construction of Concrete Jetty and Walkway (X72)	72	224,245	12	100
73	Construction of Concrete Jetty and Walkway (X73)	73	213,735	12	100
74	Construction of Concrete Jetty and Walkway (X74)	74	214,123	12	100
75	Construction of Concrete Jetty and Walkway (X75)	75	226,128	12	100
76	Construction of Concrete Jetty and Walkway (X76)	76	214,672	12	100
77	Construction of Concrete Jetty and Walkway (X77)	77	216,281	12	100
78	Construction of Concrete Jetty and Walkway (X78)	78	217,789	12	100
79	Construction of Concrete Jetty and Walkway (X79)	79	215,092	12	100
80	Construction of Concrete Jetty and Walkway (X80)	80	218,320	12	100
81	Construction of Concrete Jetty and Walkway (X81)	81	226,281	12	100
82	Construction of Concrete Jetty and Walkway (X82)	82	226,281	12	100
83	Construction of Concrete Jetty and Walkway (X83)	83	217,186	12	100
84	Construction of Concrete Jetty and Walkway (X84)	84	217,484	12	100
85	Construction of Concrete Jetty and Walkway (X85)	85	215,908	12	100
86	Construction of Concrete Jetty and Walkway (X86)	86	213,308	12	100
87	Construction of Concrete Jetty and Walkway (X87)	87	224,636	12	100
88	Construction of Concrete Jetty and Walkway (X88)	88	215,283	12	100
89	Construction of Concrete Jetty and Walkway (X89)	89	227,323	12	100
90	Construction of Concrete Jetty and Walkway (X90)	90	215,108	12	100
91	Construction of Concrete Jetty and Walkway (X91)	91	217,300	12	100
92	Construction of Concrete Jetty and Walkway (X92)	92	214,644	12	100
93	Construction of Concrete Jetty and Walkway (X93)	93	214,649	12	100
94	Construction of Concrete Jetty and Walkway (X94)	94	215,920	12	100
95	Construction of Concrete Jetty and Walkway (X95)	95	217,247	12	100
96	Construction of Concrete Jetty and Walkway (X96)	96	215,302	12	100
97	Construction of Concrete Jetty and Walkway (X97)	97	218,925	12	100

98	Construction of Concrete Jetty and Walkway (X98)	98	217,660	12	100
99	Construction of Concrete Jetty and Walkway (X99)	99	216,939	12	100
100	Construction of Concrete Jetty and Walkway (X100)	100	214,741	12	100
101	Construction of Concrete Jetty and Walkway (X101)	101	217,913	12	100
102	Construction of Concrete Jetty and Walkway (X102)	102	214,372	12	100
	TOTAL		**21,465,623,000**		