



**EVALUATION OF SUSTAINABLE ENERGY PROJECTS SUCCESS IN
NEPAL**

Rajeev Ranjan Pandey

**A Thesis Submitted in Fulfillment of the Requirements for the Degree of Doctor
of Philosophy in Sustainable Energy Management (International Program)**

Prince of Songkla University

2025

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SUCCESS IN NEPAL

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ABSTRACT

This study evaluates the success factors of a renewable energy (RE) projects in Nepal. The timely completion of these projects is seen to be uncertain, as past experiences have shown that they often take longer than expected and exceed the allocated budget. This research aims to uncover project success factors and business models for the generation and application of renewable sources of energy, such as hydro, solar, wind and biogas, in Nepal. In this thesis, a research study has been conducted to identify the factors that contribute to projects success in the field of energy projects in Nepal. Quantitative research is carried out using a survey questionnaire and Likert scale (1-5) via an online form. Quota sampling is employed with a sample size of 388, and data are analyzed using factor analysis (exploratory and confirmatory) with structural equation modeling (SEM) to develop the Project Success Model (PSM) Framework. A thorough review of available literature is conducted to propose a Sustainable Energy Business Model Canvas (SEBMC) Framework. The validity and reliability of the research instruments and the results for PSM Framework are successfully tested with statistical parameters, and the application of the frameworks allows for measuring project success probability and identifying areas for improvement. From this research, a tool called the Project Success Probability (PSP) is developed to measure the success probability of the RE projects in Nepal. The tool reveals that in the present context, success probability is 63%, indicating a need for improvement in several areas. By focusing on areas of improvement identified by the tool, such as consistent PPA policies, discouraging corruption, and legal framework to facilitate project, the success probability can be increased significantly. This research is limited to RE projects and stakeholders in Nepal. However, the approaches used for designing the PSM Framework, SEBMC Framework and PSP Tool can be explored in other settings too. Finally, a spreadsheet is utilized herein to present Project Success Probability (PSP), but it can also be incorporated into more intricate project management software as well as supplemented by artificial intelligence (AI) functionality drawing from extensive data available within an organization or project. Thus, numerous technical advancements can potentially enhance PSP's applicability. This study aims to bridge the research gap and provide guidance to professionals, stakeholders, and policy makers in Nepal while undertaking RE initiatives.

Keyword : Sustainable Energy, Renewable Energy, Project Success, Success Probability, Success Factors, Business Model

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List of Abbreviations and Symbols

A

AEPC	
Alternative Energy Promotion Center.....	5
AGFI	
Adjusted Goodness of Fit.....	17
Adjusted Goodness-of-fit Index.....	17
AMOS	
Analysis of Moment Structures	16
AVE	
Average Variance Extracted	19

B

BMC	
Business Model Canvas	45

C

CFA	
Confirmatory Factor Analysis.....	11
CFI	
Comparative-Fit Index.....	18
CR	
Composite Reliability	20

E

EDA	
Exploratory Data Analysis.....	16
EFA	
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F

FY	
Fiscal Year	2

G

GFI	
Goodness-of-fit Index	16
GHG	
Greenhouse Gases.....	1
GWh	
Gigawatt Hour.....	2

I

IOC	
Item-Objective Congruence	22
IPPs	

Independent Power Producers.....	21
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RE	
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RMSEA	
Root Mean Square Error of Approximation	17

S

SDG	
Sustainable Development Goals	1
SE	
Sustainable Energy.....	1
SEBMC	
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SEM	
Structural Equation Modeling.....	15
SPSS	
Statistical Program for Social Sciences	13
SRMR	
Standardized Root Mean Square Residual.....	18

T

TLBMC	
Triple Layer Business Model Canvas	10

U

UN	
United Nations	1

Chapter 1 Introduction

1.1 Background

The recent developments in United Nations (UN) Climate Change Conference COP26 and COP27 conventions and negotiations, held in November 2021 and 2022, were based on four pillars of collective climate action – adaptation, accountability, finance, and mitigation [1,2]. Nationally Determined Contributions (NDCs) were submitted by 151 countries to dramatically reduce their greenhouse gases (GHG) emissions by 2030. Nepal has also committed for mitigation and adaptation strategies to combat climate change impacts [3]. One of the strategies agreed by the member countries to meet the objective of “Affordable and Clean Energy” [4] is to shift to Renewable Energy (RE) resources to meet their energy needs.

The global community has realized the potential harmful impacts of climate change and hence, have agreed to address global emissions as an emergency. The sustainable development goals [4] and Paris Agreement on Climate Change, December 2015 [5] show the global commitment to tackle issues of climate change through the promotion and expansion of RE projects.

The Renewable Energy (RE) resources refer to hydro, solar, wind and biogas [6] that are utilized in energy projects. Additionally, sustainability of such resources is equally important, hence, the Sustainable Energy (SE) projects utilize clean and renewable energy sources along with RE products for economic evaluation and decision-making. These projects prioritize sustainability, continued extraction, and renewal [7] [8].

By implementing the RE projects, the world is attempting to accomplish Sustainable Development Goals (SDGs) [4]. But the success of the programs is still in question [9] with no straight answer. The success of these projects depends on multiple factors like financing [10], policies [11], community engagement [12], infrastructure [13], environmental factors [14] and alike. Therefore, it is important to understand the factors contributing to the RE projects’ success.

1.1.1 Global Context

The global data suggest that in 2021 more than 60% of the global cumulative CO₂ emissions were shared by United States (24.29%), European Union (27) (16.88%), China (14.36%), United Kingdom (4.52%) and India (3.29%). The annual global CO₂ emissions have increased from 25.45 billion tons to 37.12 billion tons from 2000 to 2021 [15]. This has caused global temperatures to rise resulting in extreme natural events like unbalanced rain, drought, rapid melt of glaciers and polar ice caps etc. Towards the beginning of the twenty-first century, the world realized the long-term consequences of GHG emissions. Therefore, all the countries updated their legal framework in favor of adopting renewable and sustainable sources of energy [16].

1.1.2 Nepal's Context

Nepal lies between two big countries China and India which have highest populations in the world and are huge contributors of GHG emissions. It is obvious that Nepal is easily victimized from the global impacts. Being a sensible part of global community, Nepal implemented the Electricity Act in 1992 [6] and reaffirmed its commitment to tackle global crisis of climate change in COP26 [3].

The national survey data of 2019 shows that biofuels and waste are still the major sources of energy contributing to 72% of the national energy mix of Nepal. However, coming to the production of electricity, hydropower stations are dominant contributing to 4% of the total energy mix [16,17]. Considering hydropower, solar and wind as green sources of energy, Nepal produced about 10 GWh of electricity to fulfill all its domestic demand of 8.8 GWh in Fiscal Year (FY) 2021/22 [18]. If the generation of electricity only is considered, 95% comes from the hydropower stations alone [19].

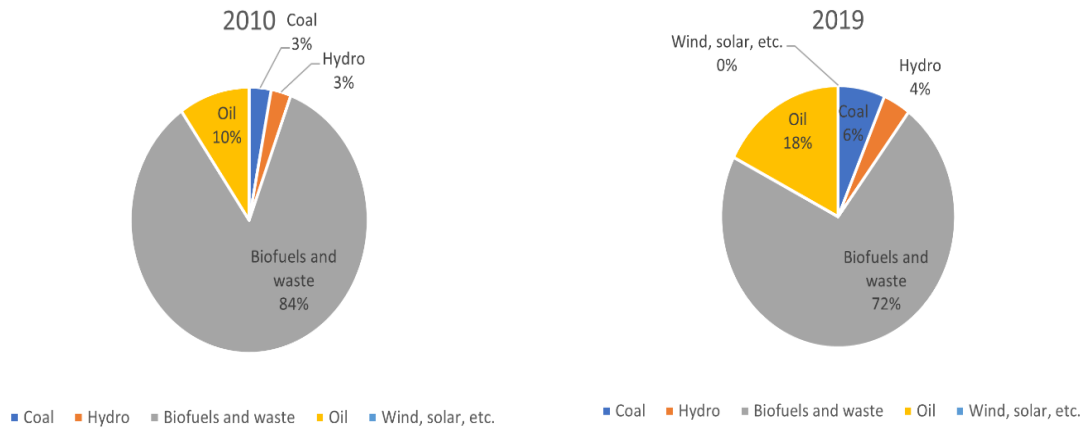


Figure 1: Nepal's Energy Mix by source compared over last decade [17]

Table 1: Nepal's Electricity Mix [19]

Source	No. of Plants	Installed Capacity (MW)	Contribution	Updated On
Hydro (< 1 MW)	18	14.22	0.5%	28-Feb-2024
Hydro (> 1 MW)	144	2,625.26	95.0%	
Thermal (Fossil Fuels)	2	53.41	1.9%	
Solar	13	68.38	2.5%	
Wind	0	-	0.0%	
Biomass	0	-	0.0%	

Co-Generation*	1	3.00	0.1%	
Total		2,764.28		

*Co-Generation was done as a pilot project by two sugar mills in 2017. The electricity is generated by burning sugarcane residues to produce steam in the boilers which in turn rotates the turbine [20].

Now Nepal is looking forward to electrifying the kitchen, transport, and manufacturing areas where most of the biofuels are consumed. To meet the objectives, many RE projects are in pipeline at different phases. Over 2,000 MW installed capacity is planned to be constructed and connected to the national grid [16,19]. But on-time completion of those projects is in question. Past experiences have shown that RE projects have taken an exceptionally long time and budget to complete. For example, the recently completed upper Tamakoshi hydropower project with installed capacity of 456 MW was delayed by 60 months and saw variation of 73.5% over-budget to complete [16,21].

1.2 Problem Statement

On the one hand there is a pressing need to complete RE projects faster to tackle global warming and climate change issues. On the other hand, however, these projects face problems which hinder the timely completion. The annual report of the Ministry of Finance of Nepal in 2015 revealed the problematic situations such as lack of planning and investment, delay in implementation due to lack of legal requirements to ease the way to set priorities, right-of-way, forest clearance approval, land acquisition and conflicts [22]. Power Purchase Agreement (PPA) inconsistency, lack of detailed planning, delays in procurement procedures and lack of project management capabilities are the additional issues in the power sector of Nepal [22,23].

Nepal is not alone. The reports from neighboring country India also express that many of its RE projects are delayed by 5 to 16 months [16,24]. The examples from Nepal and India indicate that the RE projects face lots of problems to complete the project on time and on budget.

Globally scholars have contributed significantly to the knowledge of critical success factors, influencing factors, drivers, barriers, enablers and policies in the development of renewable energy shift from traditional fossil fuels. For example, overcoming the barriers for the transition towards sustainable energy system has been explained in context of Kuwait [13], Pakistan [11], Greece [25] and Barbados [26]. Policy updates are suggested for development of RE projects and the transition in Balkans [27], Niger [28], Cameroon [29] and the Netherlands [30]. Moreover, implementation of circular economy principles is highly stressed for Africa's transition from fossil fuels to renewable energy by Mutezo et al. [31]. New dimensions in RE project success are added by the scholars suggesting the enablers, drivers and critical factors from the research conducted in Australia [32], European Union (EU) [33], India [34,35], Nigeria [36], and Kazakhstan [37]. Similarly, research on sustainability have also suggested

that appropriate business models have considerable contribution to the success of a project [38–43].

These research works, however, lack to identify the RE project success factors in Nepal's context. As Nepal is committed to achieving the SDGs and, therefore, working on several renewable energy projects to fulfill the energy demand, there is severe need for developing a framework that explains the success factors of these projects. Moreover, a mechanism must be developed to check the status of each success factor to find the problem areas that require more attention for improvement. This thesis addresses the solution to the above research problems.

1.3 Research Objectives

In the given context of global and local scenario, it is utmost necessary to understand the project management practices of RE projects and underlying root issues hindering the progress. Hence, this research aims to uncover project success factors and business models for generations and applications of renewable sources of energy like hydro, solar, wind and biogas in Nepal. The objectives of this thesis are four-fold. The first objective fulfills the research gap in identifying and developing a framework for project success factors of RE projects in context of Nepal. The findings will help project initiators and stakeholders to focus on these factors while performing an RE project. The second objective fulfills the research gap in calculating the probability of RE project success in Nepal. This will benefit the sponsors, performing teams and stakeholders to gauge the chances of success in advance. The third objective enables the policy makers, sponsors and project teams to give special attention to the factors which require efforts for improvement to increase the project success probability. Finally, the fourth objective fulfills the research gap by recommending the business model suitable for the sustainable energy projects / businesses for Nepal.

The specific research objectives are:

- Objective 1:** To develop a framework for project success factors of RE Projects in Nepal.
- Objective 2:** To measure the success probability of RE Projects in Nepal.
- Objective 3:** To identify the areas of improvement to increase success probability of RE projects in Nepal.
- Objective 4:** To contextualize the business model for sustainable energy projects for Nepal.

1.4 Conceptual Framework

The conceptual framework of this thesis is depicted in Figure 2. The success factors (observed variables) are synthesized from literature review. The survey data is fed-in for the factor analyses (Exploratory and Confirmatory). Next, the factors are validated which may result in a reduced set of the factors. This thesis also aims to establish Sustainable Energy Business Model Canvas (SEBMC) for Nepal through survey data and validation process, provided the business model survives as a validated factor from factor analyses procedures. Once the factors are validated, the latent variables are provided appropriate thematic names (categories) that explain their related observed variables. Finally, a model is developed with the combination of relationships between the validated success factors and the categories resulting into project success for Nepal.

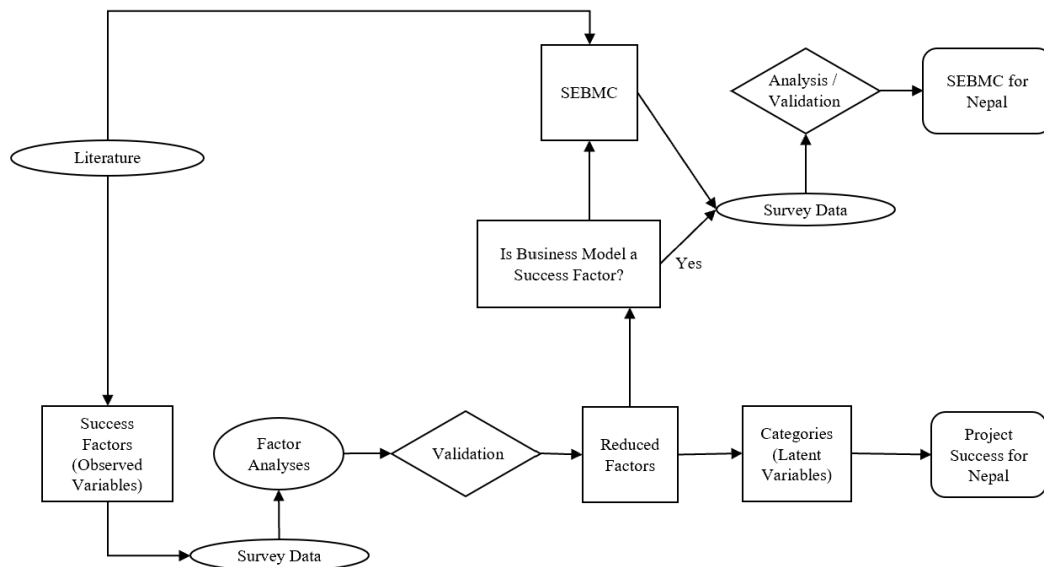


Figure 2: Conceptual Framework

1.5 Significance of the study

Involvement and contribution of multiple parties are the keys to success of policy improvements and its implementation. Nepal has number of legal provisions and frameworks in place to support and promote the use of RE sources in daily life of a common citizen. Number of institutional arrangements like Nepal Electricity Authority (NEA) and Alternative Energy Promotion Center (AEPC) have also been done to facilitate the process. Government channels have been utilized from central to local governments to encourage the use of RE technologies like micro-hydro, solar and biogas in the form of subsidy and direct investments [44,45]. According to the Department of Electricity Development, about 8,000 MW capacity of construction license have been awarded to generate electricity from different renewable sources. In such a scenario, successful completion and long-term benefits realization is utmost important. Project success in general is a keen field of interest for the researchers. Studies on the factors affecting success of a construction project [46], project performance[47], project management practice [48] and sustainability of projects in

relation to Industry 4.0 [49] have suggested the project success factors in various industries. Similarly, investigations on project management skills on the performance of RE projects[50], challenges and risks[51,52], motivators, enablers and barriers [51,53–59] have been done in various countries in relation to the renewable energy projects. However, very few research work on RE projects of Nepal in context of barriers to RE development [60], viability of solar Photovoltaic (PV) projects in Province-2 [61], drivers of micro-hydropower project [23], solar energy potential[62], energy sector assessment, strategy and road map[63] have been performed which lack focus on evaluating the success factors of the RE projects. Therefore, it would be beneficial for all the stakeholders to learn from Nepal's own experience and findings of the scholars around the world. Through primary data investigation, this research molds all these ideas into a single framework suitable for Nepal such that the RE initiatives be successful. An attempt has been made to introduce a comprehensive framework of success factors and its application to measure the project success probability in case of Nepal.

Specifically, this research will contribute to understand the factors that need attention from policymakers, power producers and stakeholders for making RE project initiatives successful in context of Nepal. Additionally, researchers will have added knowledge about the project management practices, business model, project success factors and current challenges of RE projects for lower-income countries like Nepal.

1.6 Organization of Thesis

This research is organized into five chapters for easy readability. Each chapter is briefly explained here.

Chapter 1 is an introduction to the agenda of this research. This chapter gives a glance at the global and local context in terms of renewable and sustainable energy sector. Next, research problems are identified followed by research objectives to establish a rationale for this study. The conceptual framework is presented which explains the process of research and getting the results. The chapter concludes by highlighting the significance of the study.

Chapter 2 is dedicated to the literature review to support this research. A thorough investigation into available literature relevant to RE project success and its business model has been carried out. Next, a review of the statistical process of Factor Analysis is done. It is further broken down into Exploratory Factor Analysis (EFA), Structural Equation Model (SEM) and Confirmatory Factor Analysis (CFA) with the suggested statistical parameters by various scholars.

Chapter 3 is focused on the research methodology adopted for this research. This chapter highlights the source of information, research method and tool, questionnaire development, data collection method, data analysis and results.

Chapter 4 is on the presentation of key findings and how the research objectives are met.

Chapter 5 is the conclusion and recommendations of the findings of this research. It also explains the limitations of this investigation and scope for future research. All the literature cited in this thesis is listed in the reference section and other relevant details are mentioned in annexes.

Chapter 2 Review of Literature/Methodology

2.1 Renewable Energy Project Success Factors

Global standards like Project Management Body of Knowledge (PMBOK) Guide [64] and [65] are popular frameworks followed for the procedures and principles during a project life cycle in general. Studies have been conducted to identify the factors and their interrelationship in order to provide recommendations for project success. The Project Excellence Model proposes a connection between success criteria and critical success factors to demonstrate project improvement [66].

More specifically, International Renewable Energy Agency (IRENA) has outlined 30 drivers and 46 barriers for RE development categorized into Political & Institutional, Economic, Social, Environmental and Technological groups [67]. Barriers in the Indian scenario of renewable energy (RE) development and growth include market, policy, finance, technology, information, and institution obstacles [68]. On a separate study, 42 barriers and 20 enablers are classified under technical, economic, political, marketing, social, environmental, and infrastructural clusters for the development of community energy projects in India [54].

A strategic portfolio management technique is emphasized to overcome project issues like cost overrun and delay of energy projects in China [69]. Likewise, good stakeholder engagement is highly important for resolving unforeseen issues [70] like fulfilling the expectations of buyers in terms of energy prices [71]. Silva and Ferrão argue that understanding the customer expectations at the earlier stage is crucial to manage projects in a better manner [72].

From a leadership perspective, a study conducted in Ghana identified four critical success factors as clarity of project purpose and project success goals, stakeholder involvement, effective communication, and top management support [73].

Even in developed countries, there have been efforts to make RE projects more successful. For example, to identify critical success factors, renewable energy projects in the United States have been explored [74]. The result showed that Agile methodology was more suitable than the traditional waterfall method. In the same study, success of a project was evaluated on the basis of three main criteria – contentment of interest groups, implementation of the project within stipulated budget, schedule, performance and environmental protection. In addition, the study identified five critical success factors were also identified in the research - (i) information / communication, (ii) sufficient resources, (iii) genuine cost and time estimates, (iv) planning / controlling and (v) capable project team. A study on the African country of Ghana also concluded relatable findings. The expertise of project managers in Ghana was found to be weak in terms of project scope, risk, integration, quality, communications and human resources management knowhow [75].

Similar conclusions can be drawn from cross-industry studies regarding important factors for success, such as human factors, proficient project management. [46], external issues and project related factors, project procedures, project management

action [48]. Additionally, alteration due to project uniqueness, complexity and size [76–78], long-term priorities on social, economic and environment benefits [79], finances, employees, leadership, flexibilities and experiences [49], managing risks [80], project management skills like human resources, knowledge sharing and transformational leadership [50] contribute to success of a project.

As a result of the literature review 61 unique factors are identified which are responsible for the success of RE initiatives. More details on literature review process and identification of the success factors are explained by the authors Pandey et al. in their review article [16]. But the findings of the article are limited to a list of success factors as a compilation of critical success factors, enablers, and barriers-to-overcome based on the literature. Therefore, those 61 success factors must be investigated for their significance in context of Nepal.

2.2 Renewable Energy Project Business Model

Historically, the business model emerged in the late 1990s, when it became a popular presentation in popular science articles and in the media. Since then, it has attracted much attention from researchers and scholars. Business models are considered an important concept that focuses on different aspects and integrates the whole [81,82]. The business model theory helps managers as a tool to plan, execute, act, modify, and control their businesses [83,84].

Recently, academics have discussed the need for energy suppliers to reform their business models, that is, replace the purchase of electricity as a commodity and offer it as a service [85]. While research on business model development has focused on business operations, business model researchers have begun to focus on the development of new organizational architectures that address aspirations beyond economic profit, such as solving social problems and addressing sustainability issues [86,87].

Based on the literature review [88–95], it can be shown that there are three main categories of business model definitions that are relevant to the energy sector:

- Economics: Cash flows and cost structures are the main sources of profit for the models.
- Operations: Organization of various business operations is the main focus of this approach.
- Strategies: The mode's capacity to ascertain the company's place in its business environment shapes its strategy.

2.2.1 Sustainable Energy Business Model Canvas

While there have been numerous studies on the use of the business model by various companies [88–91], there is still little information on how the business model can be applied by energy companies [96]. However, the conventional Business Model Canvas

cannot be seen as a collective method for the energy sector. Mission and Impact & Accountability blocs are introduced to suite business models for energy firms [97].

A Triple Layer Business Model Canvas (TLBMC) was introduced by Joyce and Paquin [98], as a result of research conducted for sustainability of businesses. The layered format of the TLBMC made it easier for users to visualize the connections and relationships between the current actions of organizations and their economic, ecological and social implications by creating environmental and social layers as a direct additions of the business model canvas proposed by Osterwalder and Pigneur [81]. A useful and simple-to-use tool, the TLBMC encourages innovatively creating, illustrating, and sharing sustainable business model innovations [99].

A comprehensive understanding of the business model, according to Casadesus-Masanell and Ricart, can shed light on how an organization's high-level plans and underlying activities connect, supporting strategic competitiveness in the process [100]. To support the ideology, the business models have evolved to “project specificity” or “solution specificity” to create values to customer for longer term [101]. In 2003, Hedman and Kalling [102] divided business model into four levels – Level 1: market level (which includes market and industry views with customers and competitors); Level 2: offering level (which includes price, cost, physical and service components); Level 3: activity and organizational level (which includes firm and scope of management) and Level 4: resource level (human, physical, suppliers and supplier networks and organizational).

A recent study on financing model of off-grid RE projects categorized in four major groups (i) Subsidized, (ii) Non-Subsidized, (iii) Public and (iv) Private [103]. The most common financing models in practice have been summarized in the Table 2 below.

Table 2: Financing Models and their categorization

SN	Financing Model	Category				Source
		Subsidized	Non-Subsidized	Public	Private	
1	Donation model	x		x		[104]
2	Commercial model		x		x	
3	Multi-stakeholder model			x	x	
4	Dealer model	x			x	
5	Concession model	x			x	
6	Free-for service model	x		x	x	[105]
7	Cash sales		x		x	
8	Direct subsidies	x		x		
9	Customer credit sales	x	x	x	x	
10	Government/donation model	x		x		[106]
11	Utility model	x		x		
12	Mixed model	x			x	
13	Decentralized model		x		x	

14	Regulated Purchase Tariff			x	x	[107]
15	Connection-based subsidy	x		x		
16	Clean Development Mechanism		x			
17	Power Purchase Agreement	x	x		x	
18	Micro-financing	x	x	x	x	
19	Donations	x		x		

2.3 Factor Analysis

Factor analysis is a multivariate statistical methodology. In the past, factor analysis has been used mainly in psychology and education but has become more common in the health science sector in recent decades. The application of multivariate statistics is not limited to Health Sciences only. This is likely to increase over time, especially as more researchers adopt the factor analysis in various research areas [47,108–110].

Through the work of Pearson [111] and Spearman [112] on personality theory the history of factor analysis dates to over 100 years from now. In recent years researchers are using the factor analysis approach to achieve the benefits of its practical applications in numerous fields.

The multivariate statistical procedure of factor analysis has many applications [113–116]. First, factor analysis consists of reducing many variables into smaller sets of variables (also called factors). Second, it creates the fundamental dimensions between the variables assessed and the latent structure, letting the formation and improvement of theory. At last, it provides confirmation of the validity of the construct testified.

There are two forms of Factor Analysis: Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). EFA is heuristic because it is effective when the researcher does not expect in priori the number and nature of variables in their studies, and therefore, it is exploratory in nature. In other words, it allows researchers to explore the main factors of generating a theory or model of a relatively large set of latent constructs that are often represented by a set of elements [116–119]. Whereas, researchers using CFA use this method to test proposed theories (CFA is a form of structural equation modeling) or models, but unlike EFA, it is based on prior theories for assumptions and expectations about the number of factors, and the best combinations of theory and models.

It is worth noting that factor analysis as a statistical instrument is subject to debate and critique. Most of the criticism is directed at EFA. The criticism is largely made upon the subjective nature of the results concluded by the investigators [116,118]. Therefore, Henson and Roberts [118] argue that in order to reduce the EFA subjectivity, the researcher should be systematic, considerate, and apply good reasoning to latent variables, factor elimination, and constructions.

2.3.1 Exploratory Factor Analysis

The following five steps are executed to decide the factors extraction using EFA [120].
Step 1: Decide suitability of the data for factor analysis

(i) Sample Size

There are several opinions and guidelines suggested by various researchers regarding the sample size required for factor analysis. From different literatures we find that sample size of 300 or more is considered a good sample size [120]. In this study the sample size of 385 is considered as explained in section 3.4.

(ii) Sample to Variable Ratio (N:p ratio)

There is another set of guidelines that help researchers understand how many participants they need for each variable. This is often referred to as the sample-to-variable ratio (N:p ratio), where “N” stands for participants number and “p” stands for number of variables [115,118]. As a rule of thumb N:p ranges from 3:1, 6:1, 10:1, 15:1 and 20:1[120]. However, Hogarty et al. [121] concluded that there was no minimum N:p ratio to accomplish good factor recovery under the conditions studied.

In our study there are maximum 11 factors under the category of “Project Governance” leading to N:p ratio of 35:1 (where N=385 and p=11), which is sufficient as per the recommended range.

(iii) Factorability of the correlation matrix

A correlation matrix (also termed as Factorability of R) is used in the EFA process to show the relationships between the individual variables. The correlation coefficient over ± 0.50 is considered practically significant [115].

(iv) Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy/Bartlett's Test of Sphericity

Suitability of the respondent data for factor analysis is assessed through several tests before the extraction of the factors. These tests include Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity [120]. When the categories to variable ratio are less than 1:5, the KMO index is recommended. The range of KMO index is from 0 to 1, with >0.50 considered suitable for factor analysis [114,115]. The Bartlett's Test of Sphericity should be significant ($p < 0.05$) for factor analysis to be suitable [115,117].

Step 2: Extraction of Factors

The factor arrangement of a group of items is simplified by the execution of rotation, that is, high item loadings on one factor and lower item loadings on the other factors. There are several methods of factors extraction namely Principal Components Analysis (PCA), principal axis factoring (PAF), image factoring, maximum likelihood (for normal distribution), alpha factoring, and canonical [120].

Among these methods, PCA is widely used by investigators and is taken as the default method of factor extraction in EFA. Moreover, PCA is also recommended when no priori theory or model exist making it highly suitable for EFA process [117,120].

Step 3: Criteria in determining factor extraction

Data extraction aims to reduce a large number of items into smaller number of factors implementing a range of methods available to researchers. Factor analysis can be complex and confusing, so it's important not to rely on just one criterion to determine factor extraction [122]. This is also suggested by Thompson and Daniel [123], who stated “the simultaneous use of multiple decision rules is appropriate and often desirable”. Hair et al. emphasized that most factor analysts tend to use multiple criteria [115]. There are many extraction rules and approaches, including Kaiser’s criteria (eigenvalue > 1 rule) [124], the Scree test [125], the cumulative percentage of variance extracted, and parallel analysis [126]. Therefore, several approaches have been proposed to extract the factors. Kaiser’s criteria (eigenvalue > 1 rule) and Scree test are the most popularly used methods by researchers.

(i) Cumulative Percentage of Variance and Eigenvalue > 1 Rule

Researchers have different opinions regarding the value of cumulative percentage of variance in the areas of natural science, psychology, and humanities [118]. Hair et al. [115] suggest for 95% of cumulative variance in natural science whereas, in humanities it is as low as 50% to 60% [115,117]. Nevertheless, only those factors are considered practically significant which have Eigenvalue >1 [108–110,115,120].

(ii) Scree Test

Cattell [127] named the “Scree Test” after the visual resemblance of its graphical presentation to the rock debris (Scree) found at the base of a mountain. A typical scree plot is shown in Figure 3 as an output of data processing software Statistical Program for Social Sciences (SPSS). There are 20 components out of which only 6 components have Eigenvalue >1. Therefore, this Scree Test indicates that only these 6 components should be kept for analysis.

The inspection and interpretation of a Scree plot involves two parts [120].

Part 1: Plot a straight line through the lower eigenvalues and mark the point where there is a deviation from this line. This point indicates the location of the debris or break.

Part 2: The number of factors to be kept is represented by the spot above the debris or break, but the breaking point itself is not considered.

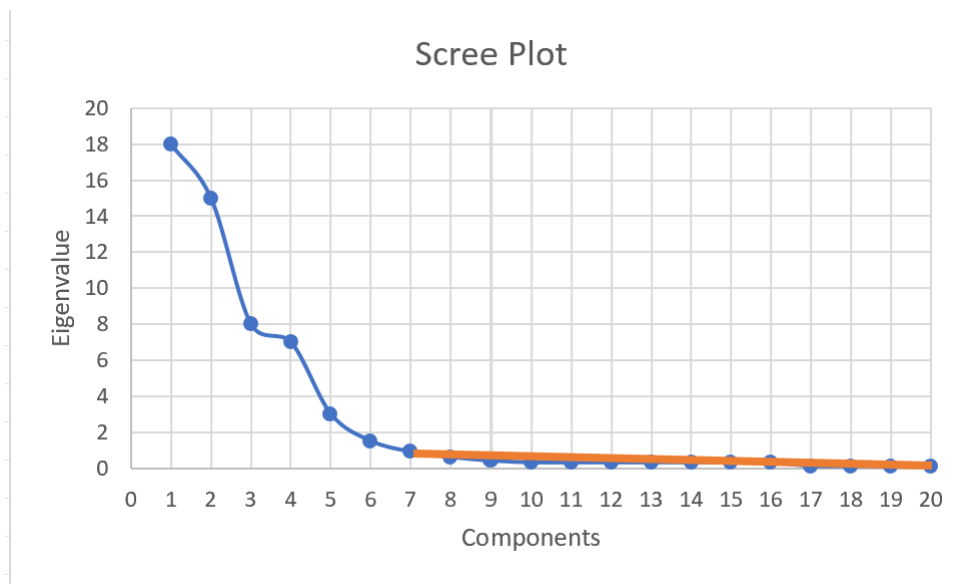


Figure 3 Typical Scree Plot as an SPSS Output

Researchers use a combination of these tests to analyze the ultimate number of factors or the best-fit solution. At this phase, the researcher needs to apply sensible and thorough decision to determine which solution is the best-fit and which of the extracted factors make the most conceptual sense [120].

Step 4: Selecting the Rotational Method

When determining the number of factors to analyze the data, it is important to consider if a variable may be related to one or more factors. Rotation aims to increase high items loadings and decrease low items loadings, resulting in a clearer and simpler result. There are two main rotation techniques: orthogonal rotation and oblique rotation. Researchers have multiple options to select from both rotation methods, for example, orthogonal varimax/quartimax or oblique oblimin/promax. First developed by Thompson [123], Orthogonal Varimax rotation is the used rotation technique in factor analysis [120] which produce factor structures that are uncorrelated [128]. Oblique rotation, on the other hand, results in correlated factors, which generally considered to yield more precise outcomes for studies related to human behaviors, or when the data does not adhere to prior assumptions [128].

As recommended by Pett et al.[117], and Kieffer [129], PCA analysis must be followed by PAF to compare and assess for best-fit. Put simply, the researcher should use the rotated solution that offers the best fit and factorial suitability, both intuitively and conceptually. After evaluating this, the researcher checks for items that do not load or cannot be assigned to a factor using the instructions above and decides if they should be removed.

Step 5: Interpretation

Interpreting data requires the researcher to identify which variables are related to a specific factor and then assign a name or theme to that factor. Typically, a factor needs to have at least two or three variables associated with it in order to be interpreted meaningfully [118]. The naming of factors is a subjective, theoretical, and inductive method [117]. Henson and Roberts state “the meaningfulness of latent factors is ultimately dependent on researcher definition” [118]. Detailed and systematic factor analyses are conducted to identify items with high loadings in the resulting pattern matrices. This process aims to uncover the factors that, when combined, account for the majority of the responses [120]. These labels or constructs need to accurately represent the theoretical and conceptual intent.

2.3.2 Structural Equation Modeling

Structural Equation Modeling (SEM) is a comprehensive modeling framework that combines various multivariate techniques into one overall framework. In simple words, SEM is a path analysis using latent variables. SEM is built upon Measurement Theory, Factor Analysis, Path Analysis, Regression Modeling and Simultaneous Equations. All these several methods together form structural equation modeling as a general modeling environment. SEM is specifically suited in situations where the researchers are interested in key constructs which are complex and multifaceted, often relating to social and psychological concepts. These kinds of concept can be quite difficult to measure and are often measured with error, where SEM has the ability to correct the errors of measurement. SEM is also suitable if a researcher is interested in modeling a causal system in which variable X influences variable Y. As an extension of causal system, SEM is applicable in situations where a mediating or indirect effect is to be measured, for example, first variable X perhaps influences a second variable Z which then has a second effect on variable Y. Such complex equations with multiple observed variables influencing an unobserved variable with additional errors (noises) represented in diagrammatic form with their relationships shown with arrows are generally termed as paths. These path diagrams are easy to follow for non-mathematician researchers. And its analysis is called path analysis.

2.3.3 Confirmatory Factor Analysis

Exploratory factor analysis is utilized to examine data and identify the number and type of factors that explain the relationship between variables when the researcher lacks prior evidence to form a hypothesis about the factors underlying the data. Consequently, EFA is commonly employed as a method for generating theories [130].

Confirmatory Factor Analysis (CFA) is a method used to test theories rather than generate them. When using CFA, the researcher starts with a hypothesis before conducting the analysis. This hypothesis outlines the expected relationships between variables and factors, and is grounded in solid theoretical and/or empirical evidence [131]. When prior factors are specified, confirmatory methods aim to best align the observed and theoretical factor structures in a given dataset to establish the goodness of fit of the predetermined factor model [130].

The steps of Confirmatory Factor Analysis (CFA) are explained below which starts with a correlation matrix, a variance/covariance matrix, or a similar matrix. The researcher suggests different models, based on theory or existing data, that are hypothesized to be suitable for the data. The actual CFA is usually conducted using computer programs such as Linear Structural Relations (LISREL) and Analysis of Moment Structures (AMOS). The analyzed models produce various statistics to assess how well they fit the data or account for the relationship between the variables. These statistics are called “fit statistics” [130]. If the model does not match the data, it is not considered as a potential causal structure for the observed variables. If the model cannot be statistically rejected, it is a reasonable representation of the causal structure [132]. The following five steps are followed for the CFA process.

Step 1: Data Screening

- (i) “Unengaged Respondents” are those respondents who prefer to rate all items with the same value. It can be determined by calculating the standard deviation of responses for each respondent. Preferably such data should be removed before analysis for more accurate results.
- (ii) “Missing Values” from the data set should also be detected and the particular respondent be removed.
- (iii) Finally, the outliers and extreme values should be detected and removed by performing Exploratory Data Analysis (EDA), particularly the Box-plot. But this technique is applicable for interval data only.

Step 2: Analyze Fit Statistics

The fit statistics or “goodness-of-fit” test evaluates how well the model(s) fit the data [133]. These statistics include (i) chi square, (ii) chi square / degrees of freedom ratio, (iii) the Bentler comparative fit index (CFI) [132], (iv) the parsimony ratio, and (v) the Goodness-of-fit Index (GFI) [134].

- (i) Chi square and Chi square / Degree of freedom ratio

The chi square tests the hypothesis that the model is consistent with the pattern of covariation among the observed variables. The smaller value of chi square usually indicates the good fit. It is quite sensitive to sample size and in many situations describes whether the statistical significance of chi-square statistics is due to poor model fit or sample size. The uncertainty has led to the development of many other statistics to assess the fit of the overall model[131].

Recommended Values:

- (a) Chi-square should be used only for sample size (n) < 200 or $p > 0.05$ [135,136]. However, this needs to be reported by the researchers. The recommended cut-off value is $p > 0.05$ [137].
- (b) Chi-square / degree of freedom, also referred to as relative or normed chi-square [138] is used only for sample size (n) > 200 or if $p < 0.05$ [135,136].

(ii) Root Mean Square Error of Approximation (RMSEA)

RMSEA is taken as a variant of Chi-square goodness-of-fit in that it sees how much the data is deviated from the model [139].

Recommended Values [139]:

- (a) RMSEA value > 0.10 is considered to be a bad fit.
- (b) RMEA value < 0.08 reflects a reasonable fit
- (c) RMEA value < 0.07 indicates a good fit [140]

(iii) Goodness-of-fit Index (GFI) and Adjusted Goodness-of-fit Index (AGFI)

The goodness-of-fit index (GFI) measures how much of the variances and covariances are collectively explained by the model [130,134]. Thomas and Thompson proposed that a model is deemed more suitable when it has a lower ratio calculated as the non-centrality parameter divided by the degrees of freedom [130].

Recommended Value:

The model is considered a better fit to the data when GFI is greater than 0.95 and as close to value 1.00. But for some models GFI > 0.8 is also acceptable [141–144].

The adjusted goodness of fit (AGFI) statistic is corrected as the number of degrees of freedom in a less constrained model achieved by freeing more parameters. Both the GIF and the AGFI are less influenced by sample size than the Chi-square statistic [130].

Recommended Values:

- (a) Hu and Bentler suggested that the AGFI > 0.80 indicates good fit [132].
- (b) Whereas, Hooper et al. claimed that AGFI > 0.90 is an indicator of good fit of the model [145].

(iv) Parsimony Ratio

Interpreting data relies on the parsimony ratio, which considers the number of parameters estimated in the model. A model with fewer parameters needed for specification is considered more parsimonious. Parsimony Goodness-of-fit index (PGFI) is the product of parsimony ratio and a fit statistic. It is an index of both the overall efficacy of the model describing the covariance among the variables and the parsimony of the anticipated model [133,146].

Recommended Values:

Mulaik et al. suggested the PGFI value > 0.90 , however, no absolute cut-off value is recommended.

(v) Normed and Non-Normed fit Index

The normed and non-normed fit indices can be used to compare nested or non-nested models within any sample, including possible cross-validation or repeating samples. In addition, the goodness of fit indices can be useful for comparing a particular model across samples, when the chi-square statistics and the related probability levels may not be analogous due to unequal sample sizes [135]. These indices are sensitive to sample size <200 [133,147], so other indices must be added to them [148].

Recommended Values:

- (a) NFI >0.90 is a good-fit suggested by Bentler and Bonnet [135].
- (b) NFI >0.95 is a good-fit claimed by Hu and Bentler [147].
- (c) NNFI >0.80 is a good-fit according to Bentler and Bonnet [135].
- (d) NNFI >0.95 is a good-fit recommended by Hu and Bentler [147].

(vi) Comparative-Fit Index (CFI)

CFI is a revised version of NFI [149] and less affected by sample size [150].

Recommended Values:

- (a) As per Bentler the CFI value should be ≥ 0.90 [132].
- (b) According to Hu and Bentler the CFI should be ≥ 0.95 [147].

(vii) Other Indices

Root Mean Square Residual (RMR) does not have any recommended value. While value for the Standardized Root Mean Square Residual (SRMR) is recommended to be <0.05 by Byrne [149], Diamantopoulos & Siguaw [151], whereas <0.09 by Hu & Bentler [147].

As a conclusion of fit statistics, Hair et al. [115] suggest that at least one index for each type should be analyzed. However, one should be mindful of the limitations of each model of fit index. Some indices need to be reaffirmed with another indices.

Step 3: Check Unidimensionality

Unidimensionality is achieved by eliminating problematic / redundant items. For this, any items with factor loading <0.50 (for newly developed items) or <0.60 (for established items) should be eliminated [152]. However, in some cases, in order to ensure 'no violation' of discriminant validity, the factor loading <0.70 should be eliminated [153].

If all items worth elimination are deleted and still the model is unfit, Modification Index (MI) > 15 and R^2 value < 0.40 must be inspected for the model to be good-fit [153].

Step 4: Construct Validity Check

In SEM, CFA is usually used to evaluate construct validity [134]. The construct validity can be achieved when all the model fit indices are fit as recommended. However, determining the general fitness of a model is not adequate in deciding about instrument validity to confirm the capability of an instrument to gauge a certain incident.

The instrument validity is checked by inspecting convergent validity and discriminant validity [154].

(i) Convergent Validity

The convergent validity refers to the magnitude of confidence to reflect that a trait (construct) is adequately gauged by the indicators [154]. In other words, if it is disregarded, it means that the item do not correlate well with each other within their parent factor, meaning that the underlying (latent) factor is not properly described by its observed variables. The convergent validity is examined based on Average Variance Extracted (AVE) value for each construct must be > 0.5 [155].

(ii) Discriminant Validity

Discriminant validity, also referred to as Fornell-Larcker criterion, is the degree to which measures of different traits (constructs) are unrelated [156]. When the Fornell-Larcker criterion is violated, it indicates that it is more closely related to constructs outside of its original factor than to the variables within its original factor. In other words, the latent factors is better explained by variables from a different factor than by its own observed variables. AVE is often regarded as too strict and thus according to Fornell and Larcker [157] and Malhotra and Dash [158] reliability and validity can be established through CR alone.

Recommended Values:

- (a) The correlation among constructs must be < 0.85 [152,155].
- (b) Square root of AVE must be greater than inter-construct correlations [157].

Step 5: Construct Reliability Check

(i) Cronbach Alpha

The Cronbach Alpha is commonly used in assessing the reliability of an instrument. Although it is not a common practice to report this value in CFA. If the researcher wishes to report the Cronbach's alpha value for each latent construct and the total measurement model, it is only to determine the composite reliability (CR) value for each latent construct [153].

(ii) Composite Reliability (CR)

The Composite Reliability (CR) is often used to refer to the reliability of both the latent construct and the instrument as a whole. The reason that CR was chosen over Cronbach's alpha in CFA is its less biased estimate than Cronbach's alpha [159].

Recommended Value:

- (a) Awang et al. suggests CR value for each construct must be ≥ 0.60 [152].
- (b) Hair et al. claims that the CR value for each construct must be ≥ 0.70 [155].

Chapter 3 Research Methodology

3.1 Source of Information

The Project Management Success Factors presented in [16] is the foundation of this study. This research aims to understand opinions of multiple stakeholders so that their partnership can be ensured with a higher degree of participation. Therefore, related stakeholders and organizations belonging to Government Ministries, Departments and other organizations, Independent Power Producers (IPPs), Banks, Companies who invest and work in installing power plants , producing electricity and maintaining the plants; importers of equipment and consultants are contacted to collect primary data in Nepal. The dataflow diagram is presented in Figure 4.

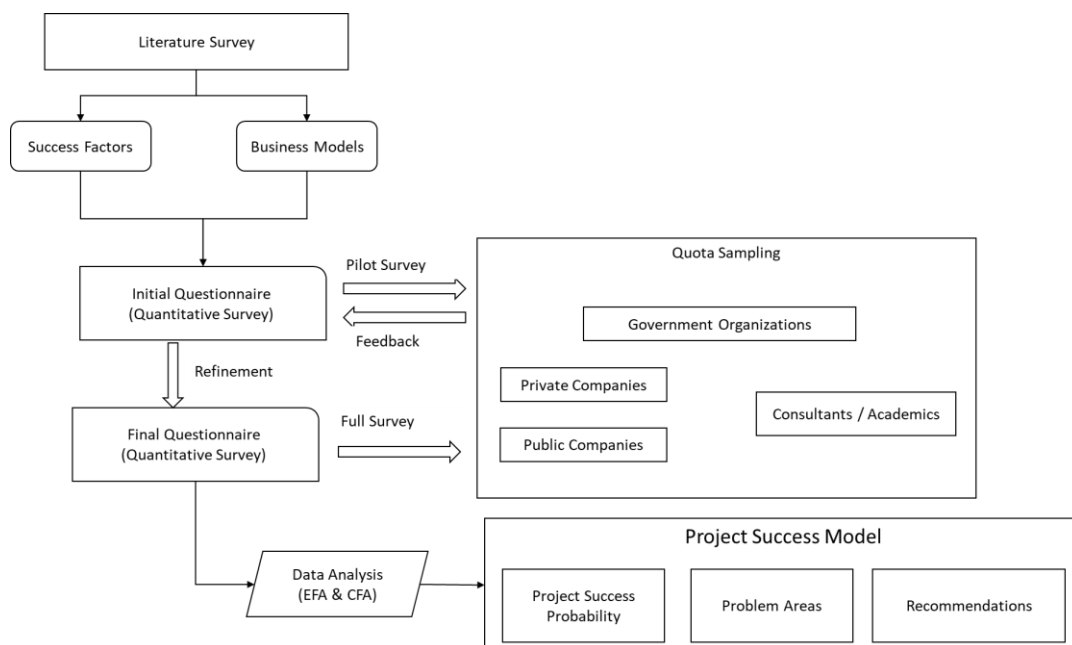


Figure 4: Dataflow Diagram

3.2 Research Method and Tool

The quantitative method is used in this research whereby a statistical tool namely Factor Analysis determines the statistically significant variables (factors). The survey data set is fed-in as the input to the analysis process in which statistically insignificant variables are removed from the list leading to the factor reduction. This is performed to establish a theory through the process of exploratory factor analysis (EFA). Further to validate the relationship between the observed variables and latent variables in the model, confirmatory factor analysis (CFA) is used. Factor analysis is a powerful tool in

establishing a theory, reducing the correlated observed variables (factors) and establishing relationships between the observed variables and underlying latent constructs based on the given data set. The whole process leads to a valid, reliable, and best-fit model of success factors, making the tool suitable for this research. Being the quantitative method, data collection and analysis is easy and cost effective in performing factor analysis [137,139,145,153,157,160,161].

3.3 Questionnaire Development

A questionnaire is drafted which consists of an explanation and a question for each success factor identified through the literature review. The questionnaire is designed in such a way that the respondents from all the four groups – government organizations, public companies, private companies and consultants/researchers can easily interpret to their familiar RE projects. The respondents are focused to the professionals who have experience and knowledge of the project management practices in the renewable energy sector of Nepal. The respondents must give their opinion in Likert Scale of 1 to 5 (where 1= Strongly Disagree; 2 = Disagree; 3 = Undecided; 4 = Agree and 5 = Strongly Agree). Then, the questionnaire draft is sent to 6 experts for validation. The Item-Objective Congruence (IOC) score is calculated. If the IOC score of a question is <0.5, it must be removed from the questionnaire. At the end, IOC score of all the questions stands out to be ≥ 0.5 . Therefore, all the questions are included in the questionnaire for primary data collection. The questionnaire format (research instrument) is presented in **Error! Reference source not found..**

3.4 Data Collection

The process starts from determining the population size and sample size. As the population size is unknown, the sample size is calculated using the following formula:

$$\text{Sample Size } (n) = \frac{Z^2 PQ}{\varepsilon^2}$$

Where,

Z = Z value for 95% confidence = 1.96

P = Population Proportion

= 0.5 (recommended for unknown population size)

Q = 1-P = 0.5

ε = Margin of Error = 0.05

This gives the Sample Size = 384.16

Considering some respondents may fail to send the response on time, questionnaire was sent to over 426 potential respondents (which is >10% of 384.16).

Since the respondents belong to specific groups of government, public and private organizations, quota sampling method is used to determine the sample size in each group. One third of 426, which is 142, respondents are selected randomly from each group and the questionnaire is sent to them using online platforms like email and messages.

Table 3: Sample Size in Each Quota

Responding Entity	No. of Respondents*
Government Organizations	142
Public Organizations	142
Private Organization	142
TOTAL	426

*Consultants / Academics group is identified during the survey process. Hence, quota is not allocated while determining the sample size initially.

Following steps are followed for data collection:

- (i) The identified respondent group or entities are contacted by the official phone number provided on their websites. Most of the organizations have their offices in Kathmandu. Only the local government offices are located in their respective provinces. Those offices can also be reached by phone and email.
- (ii) The researcher requests to get connected with appropriate official who can participate in the study.
- (iii) The potential respondent is explained about the study, its objectives and expected results on phone and same is mentioned in the body of email while sending consent form and questionnaire spreadsheet. Alternatively, all the details are included in the online survey form to be circulated among the respondents.
- (iv) After the respondent agrees to participate in the study, the consent form and online survey form link are sent via email. The questionnaire spreadsheet is attached in the same email with an explanation to the respondent how to provide the response in 1-5 Likert scale. To avoid errors, respondents are asked to fill out the online survey form instead.
- (v) The respondents fill out the questionnaire spreadsheet and send as soft-copy attachment back to the researcher's email address. The email reply or submission of online form is considered as the action consent provided by the respondents.
- (vi) Language of communication and all the documents are in English.
- (vii) A sample email draft sent to the respondents is presented in **Error! Reference source not found.** of this thesis document.

The survey data is collected from various stakeholders related to the sustainable energy sector of Nepal. Altogether 405 responses are gathered through an online survey from September to November 2023. Next, data is checked for missing responses, duplicate responses, and standard deviation < 0.5 . The data check criteria lead to removal of 17 data, ultimately 388 data are found suitable for the analyses.

Table 4: Data Check

Data Collected	A	405
Missing Responses	B	1
Duplicate Responses	C	28
Duplicates Removed	D	14
Standard Deviation (STDEV) <0.5	E	14
Responses Removed based on low STDEV	F	2
Final Data Retained	$G = A - B - D - F$	388

Chapter 4 Result and Discussion

A review of research problems, objectives and processes is presented in brief in Table 5. The key findings of the research work are systematically discussed below in relation to the research objectives.

Table 5: Research Summary Review

Background	In context of rising global warming, there is pressing need to successfully complete RE projects in a sustainable manner.
Research Problem	There is no research performed to investigate the project success factors in context of Nepal which can even measure the success probability.
Aim	This research is conducted to fill the research gap and contribute to making RE projects successful in general.
Research Objectives	Objective 1: To develop a framework for project success factors of RE Projects in Nepal. Objective 2: To measure the success probability of RE Projects in Nepal. Objective 3: To identify the areas of improvement to increase success probability of RE projects in Nepal. Objective 4: To contextualize the business model for sustainable energy projects for Nepal.
Research Type	Quantitative
Data Collection Method	Survey questionnaire, Likert scale (1-5) via online form.
Sampling Technique	Quota Sampling
Sample Size	388 data retained after cleansing for data analysis
Sample Diversity	Government Organizations (23%), Private Companies (31%), Public Companies (30%), Academics and Consultancy (16%).
Method of Analysis	Factor Analysis (Exploratory and Confirmatory) using SEM.
Validity and Reliability	Successfully tested according to the recommended statistical parameters.
Outcome	Project Success Model (PSM) Framework, Project Success Probability (PSP) tool and Sustainable Energy Business Model Canvas (SEBMC) Framework.
Application	Measure the project success probability and identify the areas of improvement.

4.1 Data Analysis and Results

4.1.1 Establishment of Theory

As there is no priory theory which explains the relationship between the success factors and underlying latent constructs (categories), a theory must be established first. The Exploratory Factor Analysis (EFA), as its name suggests, is a powerful tool to develop a theory by exploring the factors (observed variables) that have lower correlation among each other in a given data set. In this study, the EFA is performed using the software SPSS 26 to establish the theory. The variables and data are loaded on the software to check if their distribution is normal. Since Kolmogorov-Smirnov and Shapiro-Wilk test resulted significance value <0.05 , the data distribution is proved to be non-normal.

The detailed settings and iterations of exploratory factor analysis is mentioned in Appendix C. Only the final results are presented in this section.

For this study, Principal Axis Factoring (PAF) is selected because multiple trials resulted that PAF extraction method gave better factor loadings than Principal Components Analysis (PCA) for non-normal distribution of the data set. Also, Promax rotation method is selected which assumes that the data are correlated and there is no priori established hypothesis. The EFA process is followed based on the above settings to obtain a theory showing the relationship between the factors.

The results are explained below.

1. KMO = 0.908 which is > 0.5 indicating that the data set is suitable for the exploratory factor analysis.
2. Bartlett's Test of Sphericity is < 0.05 which shows the data set is statistically significant.
3. After eliminating variables that have cross loadings on multiple categories and loading values below 0.35, the total variance table shows that there are now 13 latent constructs with Eigenvalues greater than 1. In other words, the observed variables (success factors) are clustered into 13 categories (latent variables). More details are explained in Table 21 and Figure 16.
4. The number of success factors for this study was initially 61, gathered from the literature. However, after the EFA process it has now been reduced to 50.

4.1.2 Validation of Theory

After establishing the theory by EFA process, the model must be validated statistically to ensure that the model is fit and reliable to apply for the given context. Confirmatory Factor Analysis (CFA) has been used to test the validity and reliability of the model based on the data set obtained from the survey. The CFA process is conducted with the help of AMOS software which is manually integrated to the SPSS. The model or theory generated from EFA is drawn to connect the observed variables, latent constructs and

errors represented by their respective arrow heads Figure 5. CFA also passes through multiple iterations which are explained in Appendix D.

The final model-fit results and the model diagram are presented in this section.

Model-Fit Results

Different statistical parameters have been recommended by research scholars to confirm the best-fit of a model. These recommendations are based on various statistical analyses and research findings. The results obtained in this study have been compared with the recommended values to confirm the model-fit. The parameters comparisons are shown in Table 6 and Table 7.

Table 6: Parameters Comparison for Model-Fit

Statistics Parameters	Recommendation	Obtained	Result
Chi Square	No recommended value	629.404	Met
Chi Square/Degree of Freedom	1 to 3	2.163	Met
RMSEA	< 0.07	0.055	Met
GFI	>= 0.80	0.897	Met
AGFI	>= 0.80	0.856	Met
PGFI	No cut-off recommended	0.643	
CFI	>= 0.90	0.916	Met
RMR	No recommended value	0.044	
SRMR	<0.08	0.046	Met
AVE of each construct	> 0.5	AVE < 0.5 for 5 constructs	Partly Met
Discriminant Validity	The correlation among constructs must be <0.85	Yes	Met
	Square root of AVE must be greater than inter-construct correlations	Not met by 3 inter-construct correlations	Partly Met
CR of each construct	>= 0.60	> 0.6 for all constructs	Met

Construct Reliability Check Report

Table 7: Construct Reliability Check

Constructs	CR	AVE	Remarks
Two	0.642	0.473	AVE < 0.5
Three	0.748	0.498	AVE < 0.5
Four	0.786	0.647	
Six	0.734	0.484	
Seven	0.74	0.588	
Eight	0.674	0.41	AVE < 0.5
Nine	0.789	0.555	
Ten	0.604	0.351	AVE < 0.5
Eleven	0.637	0.378	AVE < 0.5
Twelve	0.688	0.531	
Thirteen	0.775	0.634	

It is observed that all the recommended parameters are met by the results obtained in this study, except AVE statistics. However, it is noteworthy that all the CR values are greater than 0.60 which is acceptable according to Awang et. al. [152]. Likewise, as AVE is too strict, Fornell and Larcker [157] and Malhotra and Dash [158] argued that the reliability and validity of the model can be established through CR values alone. Hence, the analysis of various statistical parameters concludes that the model for project success factors is valid, reliable, and acceptable.

Final Model Diagram

Of the 50 factors derived from the EFA process, only 28 factors can survive due to the strict process of CFA. In other words, because the model's statistical requirements for being fit, valid, and reliable are not met, 22 more factors were eliminated. The final SEM model diagram is presented in Figure 5.

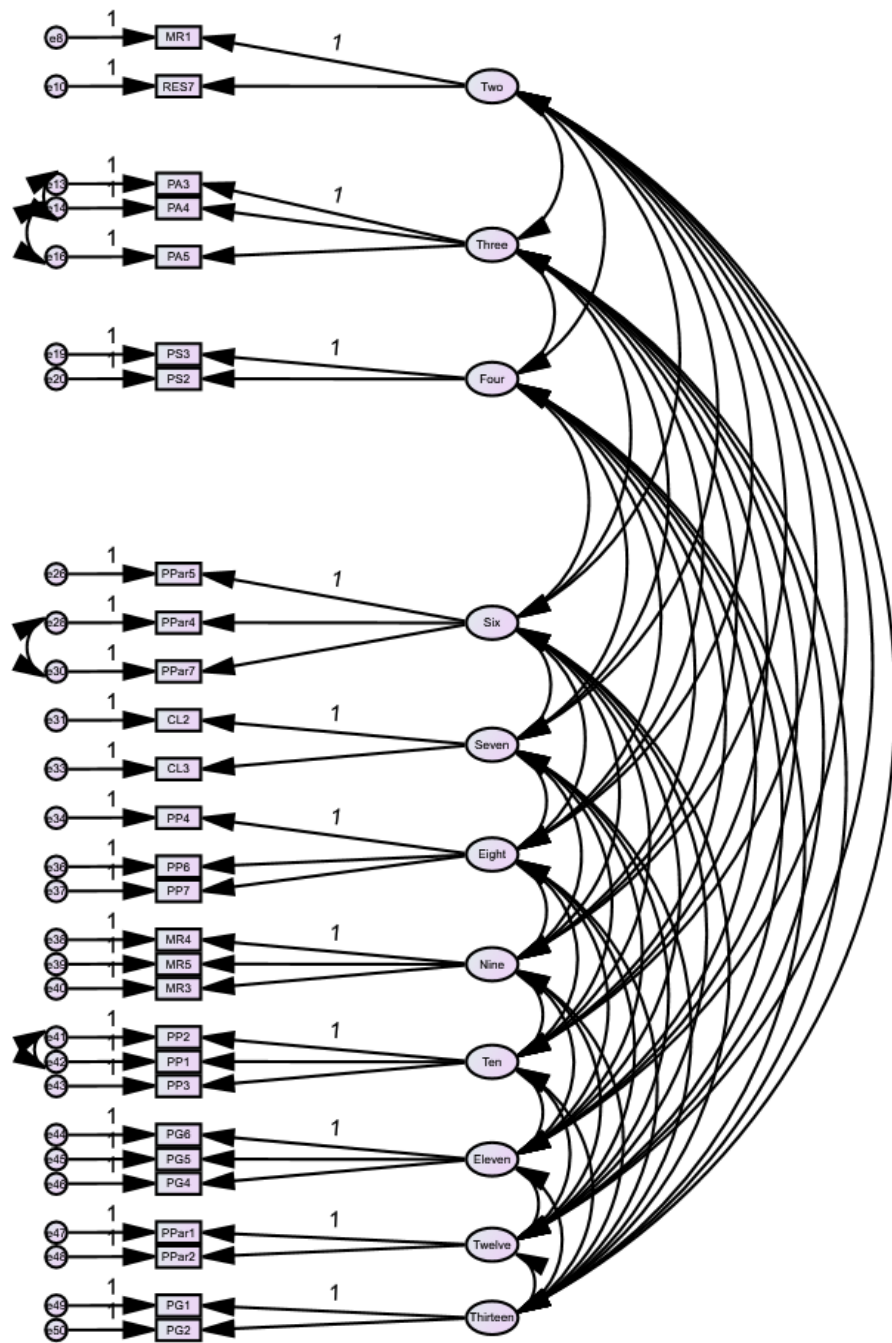


Figure 5: Final SEM Model after Confirmatory Factor Analysis (CFA)

4.2 Model for Sustainable Energy Project Success in Nepal

4.2.1 Observed and Latent Variables Explained

The CFA process has established a meaningful relationship between the observed variables and the latent constructs. It is obvious that all the variables were encoded throughout the analysis process for maintaining anonymity and aesthetic purpose due to space limitation on the drawing area of the software. After running the confirmatory factor analysis (CFA) the 11 latent constructs are given their thematic names which are best explained by the corresponding observed variables. Naming the latent constructs is important because a suitable name describes and establishes a logical connection with the respective observed variables. However, nomenclature of the latent constructs is a comprehensive exercise as described in [162], where researchers name the constructs as they prefer based on personal evaluation or logical relevance to the research. Table 8 presents the decoding of observed variables, nomenclature of the latent constructs and explanation of each observed variable.

Table 8: Observed and Latent Variables Explained

Observed Variables (Success Factors)		Latent Constructs (Categories)		Explanation
MR1	Controlled Change Management	Two	Managing Changes and Human Behaviors	Changes in the project are properly evaluated considering probable risks. All the changes pass through approval process to ensure impacts are under control of the performing team.
RES7	Handling of Human factors	Two		Associated organization(s), leaders and managers are able to handle human factors with humanity. Human factors can be personality conflicts, human errors, negligence, ego clash, emotional imbalance, being disrespectful to others etc.
PA3	Evaluate Project Complexity	Three	Project Attributes	Complexity of the project is evaluated properly so that funding arrangements and other planning are done appropriate for the project. Complexity may refer to project size, technology used, stakeholders involved etc.

Observed Variables (Success Factors)		Latent Constructs (Categories)		Explanation
PA4	Evaluate Project Uniqueness	Three		Uniqueness of the project is evaluated properly so that funding arrangements and other planning are done appropriate for the project. Uniqueness may refer to the unique objectives, approach, situation, environment, resources, technology etc. applicable for the given project.
PA5	Evaluate Social, Environmental and Economic long-term priorities	Three		A project is sufficiently evaluated for social, environmental and economic long-term priorities and benefits. The project has categorical and specific evaluation for long-term needs and benefits of the larger society fulfilled by the project. Similarly, whether the project contributes in protecting and even rejuvenating the degraded natural environment and ecosystem. And finally, the project serves a long-term economic benefits prioritized over other alternative projects.
PS3	Project prioritization	Four	Project Strategy	Projects are prioritized based on specific needs and criteria transparently. For example country need, consumer need, energy development strategy, demand and supply strategy etc.
PS2	Project selection & market conditions	Four		Projects are selected based on specific criteria considering the present and future market conditions. Project selection process is performed transparently. For example increase in demand, change in technology, change in user preference, tariff etc.
PPar5	Satisfactory Project Performance	Six	Project Parameters	Project performance parameters are well established based on standard practices and stakeholders' expectations.

Observed Variables (Success Factors)		Latent Constructs (Categories)		Explanation
PPar4	Project Management Schedule	Six		Project schedule estimate, progress milestones, buffer time, dependencies, assumptions, complexity considerations, monitoring, evaluation and control principles are in place. Schedule management is performed within agreed limits of variation.
PPar7	Sufficient & Timely Financing	Six		Project gets financing in sufficient amount on agreed upon financing milestones.
CL2	Top management support	Seven	Project Leadership	Top management of the associated organization(s) give full support to the agreed processes and to the employees.
CL3	Demonstrate clear Leadership styles	Seven		Leaders from associated organizations and stakeholder groups are able to show clear vision, establish trust and facilitate in handling difficult situations.
PP4	Consistent PPA policies	Eight	Purpose and Policies	Power Purchase Agreement (PPA) policies are consistent and unbiased to foster good business environment.
PP6	Clarity of project purpose and goals	Eight		Project purpose and goals are clearly defined and explained such that all the stakeholders can understand easily.
PP7	Transparent & Realistic Project awarding process	Eight		Project bidding and awarding process is transparent and based on realistic grounds to give confidence on successful completion and achievement of project goals. Hypothetical considerations, assumptions, dependencies etc. are avoided as much as possible.
MR4	Managing project related factors	Nine	Managing Risks	The project related factors like scope, cost, quality, resources, procurement, stakeholder satisfaction etc. are well managed so that risks do not arise from ill management of the project itself.

Observed Variables (Success Factors)		Latent Constructs (Categories)		Explanation
MR5	Recognize source of risks	Nine		Project team is proactive to recognize sources from where probable risks may arise. Early recognition of sources of risks can help for better preparation for risk response strategy.
MR3	Managing External issues	Nine		Stakeholders and project team are always willing to manage external issues beyond their control. Managing external issues may refer to exchanging right information, seeking help, escalating issues to higher authorities etc.
PP2	Encourage circular economy principles	Ten	Laws and Regulations	Country has sufficient policies to encourage circular economy principles like recycle and reuse of old devices and materials.
PP1	Legal framework to facilitate project	Ten		Country's central and provincial legal framework and policies related with energy development and utilization are sufficient to facilitate project development, execution and sustainable operation.
PP3	Discourage corruption	Ten		Country and organizations have clear guidelines and practices to discourage corruption for best utilization of fund and resources.
PG6	Geographical Knowledge	Eleven	Project Governance	All the project stakeholders and teams should have sufficient knowledge of project site geography. Governance approach has considered the challenges associated with specific site geography.
PG5	Technological Knowhow	Eleven		Technological know-how of domestic team and stakeholders are improved through the governance structure. Technology knowledge transfer is ensured.
PG4	Balance and Control	Eleven		Project governance structure is designed in such a way that involved stakeholders and organization(s) can balance and control the

Observed Variables (Success Factors)		Latent Constructs (Categories)		Explanation
				events which are not in favor of achieving project goals.
PPar1	Effective & transparent communication with all stakeholders and team	Twelve	Engagement and Implementation	Project related communication like stakeholder's concerns, suggestions, grievances, needs and updates are effectively and transparently communicated to project team and other stakeholders.
PPar2	Adequate Planning & implementation	Twelve		All the project components are adequately discussed, planned and executed based on agreed upon project management framework.
PG1	Integrated management & governance	Thirteen	Integrated Management	Project governance structure is based on a holistic and integrated management approach. Project monitoring, performance evaluation, controlling actions, decisions etc. are all done in favor of meeting the project objectives successfully.
PG2	Project integration Management	Thirteen		All the components of project like scope, cost, schedule, quality, resources, risks, procurement, communications, stakeholder satisfaction etc., are integrated together so that project initiation, planning, execution, monitoring, evaluation, controlling, and closing are performed in coherence to meet the project goals.

4.2.2 Project Success Model Framework

Final model for sustainable energy project success in Nepal is obtained after passing through extremely rigorous and iterative statistical processes. The dummy latent variables are given their thematic names which explain the corresponding observed variables (the project success factors). The success factors are categorized into eleven themes with direct impacts on the project success. The model diagram is presented in Figure 6 which is a modified form of the final model achieved from the CFA process. The project success model (PSM) framework is a simple diagram in which the success factors are connected to their respective themes or categories which in turn is connected to the project success. This logical connection indicates how the success factors are linked to the final success of the RE projects.

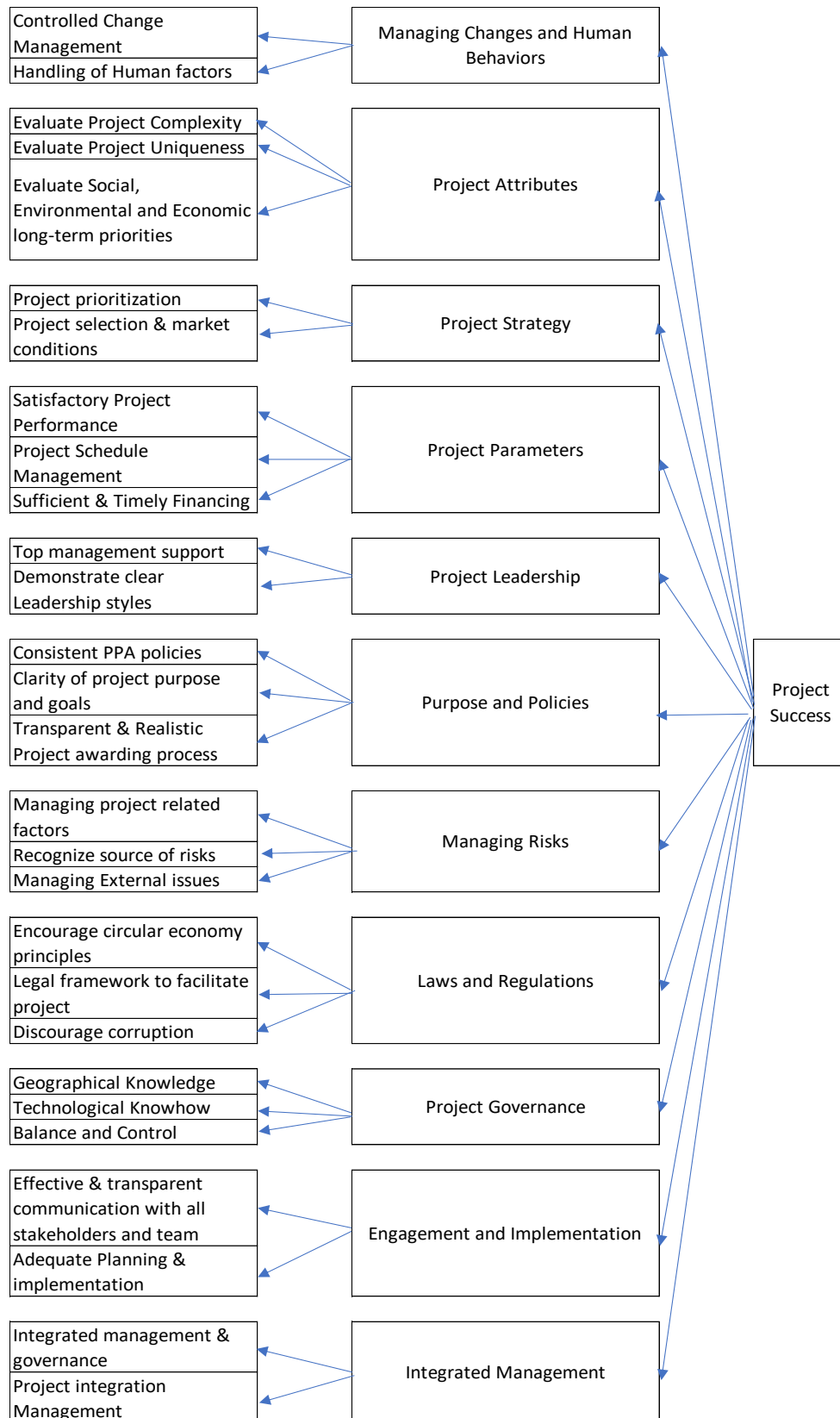


Figure 6: Final Model for Sustainable Energy Project Success in Nepal

4.2.3 Project Success Probability

An application of the project success model framework is presented here. The statistically valid model of sustainable energy project success is used to evaluate the ongoing or future projects to gauge the probability of their success. First, the average value of the observed variables (success factors) is calculated from the values given by the respondents on Likert scale of 1 to 5. As an illustration, the average score of the observed variable “Controlled Change Management” is found to be 3.29 based on the scores on the Likert scale responses from 388 respondents. Then, the category score is determined as the average of the average factor score of each observed variable falling within their respective latent variables. For example, the category score of “Managing Changes and Human Behaviors” is the average of 3.29 and 3.41, which is 3.35. Further, the category weight is the number of observed variables in each category divided by the sum of the total number of observed variables in all the categories. For example, the category weight of “Managing Changes and Human Behaviors” is 2 divided by 28, that is 0.071. Next, the weighted average score is calculated by simply multiplying the category score and category weightage. That is, the weighted average score of “Managing Changes and Human Behaviors” is the product of 3.35 and 0.071 which gives 0.239. Finally, the probability of project success is calculated by summing up all the weighted average scores divided by 5, as the scale of measurement in this survey is 1 to 5. In this model, the sum of weighted average score of all the categories, that is sum of 0.239, 0.331, 0.233, 0.324, 0.248, 0.320, 0.325, 0.276, 0.370, 0.230 and 0.229 is 3.125. Dividing 3.125 by 5 results to 0.63 indicating that the success probability of sustainable energy projects in Nepal in current situation is only 63%.

The success probability calculations steps and formula are presented here in brief, while the detail explanation can be referred to the review article by Pandey et. al. [16].

Step 1: The respondents in the field of RE projects were requested to give score to all the factors on the scale of 1-5, where 1 = Least, 2 = Less, 3 = Neutral, 4 = Moderately and 5 = Most likely, satisfied, agreed etc. as appropriate.

Step 2: The factor score is calculated by averaging scores of each factor from all the respondents.

$$\text{Factor Score (FS)} = \frac{\sum_{i=1}^n S_i}{n}$$

Where, S is the score given by individual respondent and n is the number of respondents.

Step 3: Averaging the Factor Scores of all the factors under that specific category gives the Category Score.

$$\text{Category Score (CS)} = \frac{\sum_{j=1}^m FS_j}{m}$$

Where, m is number of factors belonging to the category.

Step 4: Category Weightage is calculated based on the number of factors under a category divided by total number of factors.

$$\text{Category Weightage (CW)} = \frac{\text{Number of Factors in the Category}}{\text{Total Number of Factors}}$$

Step 5: Weighted Average Score of each Category (k) is calculated.

$$\text{Weighted Average Score (WAS)}_k = (CS)_k \times (CW)_k$$

Step 6: Probability of Project Success is calculated.

$$\text{Probability of Project Success} = \frac{\sum_{l=1}^k (WAS)_k}{5} \times 100\%$$

Where, l indicates all the Categories from 1 to k .

Table 9: Project Success Probability (PSP) Tool

Observed Variables (Success Factors)	Average Factor Score	Latent Variables (Categories)	Category Score	Category Weightage	Weighted Average Score	Probability of Project Success
Controlled Change Management	3.29	Managing Changes and Human Behaviors	3.35	0.071	0.239	63%
Handling of Human factors	3.41					
Evaluate Project Complexity	3.08	Project Attributes	3.09	0.107	0.331	
Evaluate Project Uniqueness	3.00					
Evaluate Social, Environmental and Economic long-term priorities	3.19					
Project prioritization	3.26	Project Strategy	3.26	0.071	0.233	
Project selection & market conditions	3.27					
Satisfactory Project Performance	2.99	Project Parameters	3.02	0.107	0.324	
Project Schedule Management	3.04					
Sufficient & Timely Financing	3.04					
Top management support	3.56	Project Leadership	3.47	0.071	0.248	
Demonstrate clear Leadership styles	3.38					
Consistent PPA policies	2.76	Purpose and Policies	2.99	0.107	0.320	

Observed Variables (Success Factors)	Average Factor Score	Latent Variables (Categories)	Category Score	Category Weightage	Weighted Average Score	Probability of Project Success
Clarity of project purpose and goals	3.24					
Transparent & Realistic Project awarding process	2.97					
Managing project related factors	2.99					
Recognize source of risks	3.08	Managing Risks	3.03	0.107	0.325	
Managing External issues	3.02					
Encourage circular economy principles	2.37					
Legal framework to facilitate project	2.75	Laws and Regulations	2.58	0.107	0.276	
Discourage corruption	2.61					
Geographical Knowledge	3.48					
Technological Knowhow	3.66	Project Governance	3.45	0.107	0.370	
Balance and Control	3.22					
Effective & transparent communication with all stakeholders and team	3.11					
Adequate Planning & implementation	3.32					
Integrated management & governance	3.17	Integrated Management	3.21	0.071	0.229	
Project integration Management	3.25					

Current survey responses show that the probability of project success in general is 63%, which doesn't seem appealing. The table also shows that there are a few factors with average scores less than 3, such as "Consistent PPA policies", "Encourage circular economy principles", "Legal framework to facilitate project" and "Discourage corruption", that need significant improvement to increase the success probability of

sustainable energy projects in Nepal. In short, the PSP tool is able to calculate the success probability and identify the problem areas simultaneously.

4.3 Benefits of Project Success Model Framework

Due to an urgent need to act on sustainable development goals, the energy sector must need close attention in reducing GHGs to stop global warming further. Although Nepal is a very tiny contributor of the GHG emissions but is badly affected by global activities. Since Nepal is committed to fulfill its energy requirements from green and sustainable sources like hydro, solar, wind and waste-to-energy, making such projects successful is highly important. Not only in Nepal, but also in global scale scholars and practitioners are struggling to define project success factors and ways to integrate them in a framework model.

This research has addressed the gap by identifying and developing a framework for the factors that contribute to RE project success. Respondents working in the field of energy projects in Nepal are requested to participate in questionnaire survey. The responses so collected are processed rigorously in statistical procedures of Exploratory Factor Analysis (EFA) to establish a theoretical model and further Confirmatory Factor Analysis (CFA) is conducted to test the validity and reliability of that model. Finally, a valid and reliable construct of project success relevant to the Nepali context is achieved. For this research, the identification of project success factors started with literature review which resulted in 61 factors. Cross-industry research findings were also included during the identification stage with an expectation that experiences from other industries than renewable energy will complement in developing a comprehensive framework of project success. In the next step, data collected from the survey was processed using factor analysis methods. The analyses resulted 28 factors (identified variables) grouped into 11 categories (constructs) which contribute to the success of RE projects in Nepal.

Most of the researchers globally have interpreted project success linking with the elements like critical success factors, motivators, drivers, enablers, and barriers [34,35,53–55,160,163–170]. Logically speaking, overcoming the barriers and challenges, and promoting other elements lead to the project success. There is ample evidence from many different countries, but very few studies have been done to identify these elements in case of Nepal. In 2018 Ghimire and Kim [60] identified 22 barriers of renewable energy development in Nepal through literature review and interactions with the stakeholders. Those barriers were then ranked using the AHP method. Similarly, in 2021 Karan and Singh [61] used system dynamics model to identify 4 sub-systems which influence solar PV installation in Province-2 of Nepal. Likewise, Thapa and Shrestha [171] investigated the critical success factors of project management in hydropower projects of Nepal. They collected 36 success factors from literature review and interaction with the respondents, then used the method of relative importance index to short-list top 7 critical success factors of hydropower projects of Nepal. Additionally, in recent years, from sustainability of waste to energy point of view, studies have shown that there is ample opportunity to improve the policies and practices in Nepal [172–174].

A minute observation at the literature reveals that previous works have failed to suggest a comprehensive framework of the project success for RE initiatives in Nepal. This research has filled the gap by developing the framework, and therefore, has achieved the first objective of this thesis. The main benefit of designing this framework is that the framework provides a ready list of the areas to be assessed before taking RE initiatives. The assessment will be helpful in understanding the project management environment, complexity, practices, strategies, goals and appropriate governance structures. Each factor has been explained clearly for easy interpretation by all the key stakeholders. The practitioners, policy makers and performing team members can refer to the framework for ensuring sustainable energy projects' success.

The factors and their categories (constructs) obtained in this research are analogous to the findings of previous studies. Here are the references in support of our results.

Table 10: References in support of our findings

Observed Variables	Latent Constructs	References
(Success Factors)	(Categories)	
Controlled Change Management	Managing Changes and Human Behaviors	[33,48,66,169,175,176]
Handling of Human factors		
Evaluate Project Complexity	Project Attributes	[167,177–179]
Evaluate Project Uniqueness		
Evaluate Social, Environmental and Economic long-term priorities		
Project prioritization	Project Strategy	[58,166,177,180–183]
Project selection & market conditions		
Satisfactory Project Performance	Project Parameters	[55,168,177,182]
Project Schedule Management		
Sufficient & Timely Financing		
Top management support	Project Leadership	[28,35,37,49,73,177,180,183]
Demonstrate clear Leadership styles		
Consistent PPA policies	Purpose and Policies	[29,51,55,164,176,177,184]
Clarity of project purpose and goals		
Transparent & Realistic Project awarding process		
Managing project related factors	Managing Risks	[66,70,169,175]
Recognize source of risks		
Managing External issues		

Observed Variables	Latent Constructs	References
(Success Factors)	(Categories)	
Encourage circular economy principles	Laws and Regulations	[29,51,55,164,176,177,184]
Legal framework to facilitate project		
Discourage corruption		
Geographical Knowledge	Project Governance	[70,177]
Technological Knowhow		
Balance and Control		
Effective & transparent communication with all stakeholders and team	Engagement and Implementation	[70,164,168,177,178,185]
Adequate Planning & implementation		
Integrated management & governance	Integrated Management	[35,167,168,177,178,181,182,186]
Project integration Management		

4.4 Benefits of Project Success Probability Tool

The professional community, policy makers and the stakeholders are keenly looking for ways to check and predict the probability of making their projects successful. But there is a lack of a reliable model and mechanism to gauge the success probability, especially in the field of renewable energy projects. A recently published article by Akbar et al. in January 2024 has suggested a method of predicting project success probability of quantum computing software development projects using genetic algorithm [187]. In this article, the authors have fed-in the survey data in a model developed by using the genetic algorithm through computer programming. This method has found that as the quantum software development process matures, the chances of the project being successful are high and the cost is significantly reduced. However, the method and results suggested in the research has a different approach. The success factors (variables) are linked to the cost of the project and are optimized by the genetic algorithm. More attention is given to the higher-ranking factors in the model.

On the contrary, this thesis has adopted a new approach of calculating the project success probability. The aim is to measure the probability at the time of responses collected from the stakeholders. It neither draws any future trend line nor an optimized value to show an increase in the probability figures. Rather, the probability is calculated based on the weighted average values of the categories (latent constructs) in the current context.

The method of probability calculations has been explained in the section 4.2.3. This tool is simple to use without the requirement of any sophisticated software or technology. Since the national level responses are collected from multiple groups of stakeholders irrespective of any source of renewable energy, at present the probability of such projects being successful is found to be 63%. This is not an encouraging value.

Obviously, it will be interesting to understand more about the areas of improvement for increasing the probability of success.

The results shown in Table 9 reveal that 21 factors have average scores equal to or above 3.0. Likewise, 7 factors have average scores below 3.0. Notably, none of the factor's average score is above 4.0. Therefore, the overall success probability has just reached 63%. This is not a good probability, in our opinion. Considering the complex dynamics of success factors, categories and their interrelationships in the real world, an average score of 4.0 for each factor resulting to 80% of success probability would be considered a good value. This is only possible when all the groups of stakeholders have a high level of satisfaction with all the success factors. In other words, people from all the stakeholder groups such as government, public, private, researchers and consultants believe that the energy projects in Nepal meet the success factors highly satisfactorily, and hence, give their response score as 4 or 5 for each factor. The success probability scale is presented in Figure 7 followed by its interpretation.

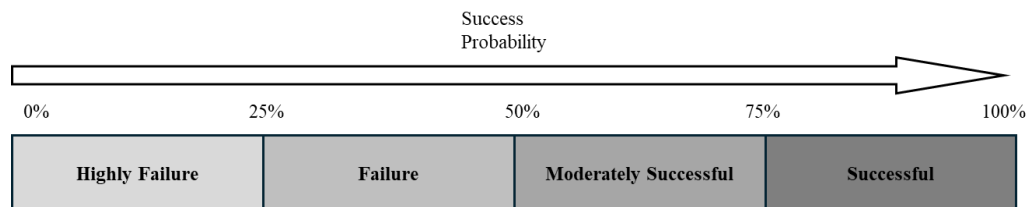


Figure 7: Project Success Scale

Interpretation

1. **Highly Failure:** Success factors are not met. Overhaul of all the factors is required by all the stakeholders.
2. **Failure:** Success factors are met lower than the general perception of satisfaction. Major improvements are required in several factors.
3. **Moderately Successful:** Success factors are partly met to the satisfaction of the stakeholders. Improvement on a few factors is required.
4. **Successful:** Success factors are met to or above the satisfaction level of all the stakeholders. Minor continuous improvement may be required for some of the factors.

During the survey, it was found that respondents from one organization tend to show similar responses but different from another organization. This indicates that different stakeholders have different satisfaction or agreement levels on the same success factor. In other words, national consensus is not shown by the respondents for every success factor in the questionnaire. This exercise of collecting responses from different varieties of stakeholders gave an opportunity to observe their difference in opinions on the same factor. Therefore, it can also be seen as a check and balance of opinions in anonymous manner.

In summary, the project success probability (PSP) tool was not formulated in previous research works; therefore, this is a unique tool contributing to the knowledge and improvement of project management practices in the field of renewable energy projects in Nepal. Moreover, the PSP tool can be taken as the application of Project Success Model (PSM) Framework developed in this thesis. The main benefit of the PSP tool is that the project team can assess the success probability even before officially starting the project. Moreover, they can run the assessment process on a regular basis to check the probability status which may change due to the changes in the dynamics of project environment, policies, strategies, improvement efforts and governance structures.

4.5 Areas of Improvement

The average score of each factor in the PSP tool gives a clear indication of respondents' agreement whether the factor is meeting their satisfaction. It is obvious that a low score is recorded if most of the respondents do agree that the factor(s) are not meeting their satisfaction level. Therefore, all the factors with relatively lower scores are identified as the areas of improvement. In a real project scenario, success probability greater than 80% can be considered a good success, which is not the case here.

Measuring the success probability is not sufficient, rather, identifying poor performing factors is even more important for the improvement of project management practices. Therefore, this thesis also aims to identify those factors which are dragging the probability of success. The PSP tool can fulfil this objective. The 7 factors – “Satisfactory Project Performance”, “Managing project related factors”, “Transparent & Realistic Project awarding process”, “Consistent PPA policies”, “Legal framework to facilitate project”, “Discourage corruption” and “Encourage circular economy principles” have received average scores lower than 3.0 from the respondents. Therefore, these factors deserve serious attention for improvement.

In fact, the improvement journey is iterative and continuous. The project sponsor, team and all key stakeholders must endeavor to increase the general confidence towards project success which is reflected from their responses through Likert score. The main advantage of the PSP tool is that it does not only indicate the probability of project success but also points out the problematic factors which need improvement. Once the improvement plan is implemented, a similar survey can be conducted again to check the progress. Iteratively, this cycle is repeated to improve remaining low scoring factors. This iterative cycle is believed to contribute to gauging the gradual improvement in making RE projects successful.

Moreover, a suitable modification of this tool is useful for every project in every organization which are related to sustainable energy development in context of Nepal. The government organizations like ministries, National Planning Commission, Nepal Electricity Authority, and policy makers can be benefited from the PSP tool. Nevertheless, the researchers, academics community and professionals will find it a novel contribution in terms of the uniqueness of the tool which is based on intensive

research and can be easily used by a non-technical person with a simple help of a spreadsheet or manual process.

It is evident from previous studies that the factors identified as the improvement areas in this research were also pointed out as the barriers and challenges of renewable energy development. The references cited in Table 10 support our findings of the areas of improvement to increase project success probability.

4.6 Contextualization of Sustainable Energy Business Model Framework

Studies have found that a suitable business model is one of the important aspects of sustainability of renewable energy projects to be successful with lasting benefits. Literature is vast and many models of financing and business are available in various contexts. The popular Business Model Canvas (BMC) of Osterwalder and Pigneur is followed by various industries worldwide. Many researchers have suggested modifications in the original model to suit specific business and industry. However, such modifications are lacking for SE businesses in available literature.

In this report, an altered form of the novel business canvas model is contextualized which is specific to sustainable energy sector, and thus named as Sustainable Energy Business Model Canvas (SEBMC). It consists of 13 dimensions of a business model arranged in the form of a canvas. The major modifications in the original model are addition of new dimensions viz. “Environmental”, “Social”, “Customer Expectations”, and “Financing Models”. It is obvious that environmental and social dimensions must be analyzed to ensure the sustainability of RE projects. Similarly, it is important to understand what do the customers of the project expect. If the customer expectations are not addressed, the business model itself will collapse soon. And lastly, the sponsors and stakeholders of an RE project must ensure a sustainable financing model for lasting benefits. There are different choices of financing methods mentioned in Table 2. The financing agencies may choose to pick one or more methods of financing best suitable to their project context. The main advantage of SEBMC is that it presents a comprehensive framework in decision-making of suitable business model ensuring the sustainability of the business, society, and environment at large.

Considering the business models suggested in various literature, a consolidated sustainable energy business model canvas (SEBMC) has been synthesized as described in Table 11. It consists of 13 elements to be considered for building a robust business model for sustainable energy projects.

Unfortunately, the “Suitable Business Model” as a success factor collected from the literature cannot survive the CFA process in this research. Therefore, further investigation is not performed for this thesis. However, global studies have suggested that a suitable business model is an important contributor to the project success. Hence, a separate investigation can be performed grounded on the suggested SEBMC framework, which is contextualized for Nepal based on the available references.

Table 11: Sustainable Energy Business Model Canvas (SEBMC)

ENVIRONMENTAL This building block describes current and future environmental challenges such as water scarcity, climate change, pollution, and environmental threats that can affect the business model.	KEY PARTNERS This fundamental element delineates the intricate interconnections among various suppliers and partners that are essential for the functioning of the business model.	KEY ACTIVITIES This building block describes the most important things a company must do to make its business model work.	VALUE PROPOSITIONS This building block describes the product and service bundles that bring value to specific customer segments. Solving customer problems and meeting customer needs.	CUSTOMER RELATIONSHIP This element describes the type of relationship that a company establishes with specific segments of its customers.	CUSTOMER SEGMENTATION This element defines the different groups and organization a company aims to reach and serve.	SOCIAL This building block describes current and future societal and technological challenges, such as digital technology, manufacturing, and cultural shifts that shape customers' perceived values, beliefs, and behaviors over time.
KEY RESOURCES This building block describes the most important assets that are needed to run the business model. They may be physical, financial, intellectual or human.			CUSTOMER EXPECTATIONS This building block describes what customers will receive from the delivery system. These expectations are beliefs about future events which, when compared with the perceived actual service delivered, are presumed to influence satisfaction and assessments of overall service quality [188].		CHANNEL This element describes how a company communicates with its customer segments and reaches them to provide a value proposition. The channels are customer contact points.	
FINANCING MODELS This building block describes all possible methods of financing a project which are low cost, fulfill the cost structure and are paid back from revenue streams.						
COST STRUCTURE This component describes all the costs associated with operating a business model.				REVENUE STREAMS This building block represents the cash produced by a company in each customer segment (to generate income, costs must be deducted from revenues). Multiple revenue streams must be generated through main products and services and subsidiary services. Pricing mechanisms may be different.		
IMPACT AND ACCOUNTABILITY This block shows the impact on environment, society and customer segments which the company is accountable for. Appropriate indicators of the impact and accountability are implemented.						

Chapter 5 Conclusion and Recommendation

5.1 Conclusion

As member countries of the United Nations, fulfilling the Sustainable Development Goals (SDGs) is not only their responsibility but also the need of this era. Recent data and global summits have shown that global warming must be controlled on urgent basis by extending support to the advancement and execution of renewable sources of energy [189].

Scientific research and publicly available reports from governments and global organizations is rich with the data and information on business models, project critical success factors, barriers and challenges to the development of renewable and sustainable energy projects. Project delays, cost overrun, poor financing strategies, stakeholder dissatisfaction, lower value generation and lack of a strong basis of sustainable business model are some of the common problems faced by many countries and project stakeholders. These are only the end results that appear on the surface when it is too late to fix the problems. Therefore, it will be quite appealing to use such frameworks and tools which can help in establishing the basis for sustainable business models and measure the project success probability pointing out the factors that need to be improved.

The first part of this report is engrossed in a rigorous statistical process of establishing a framework model to explore the success factors and measure success probability in context of Nepal. The process started with the literature review to formulate a theoretical concept and survey questionnaire were validated by experts. Next, the survey was conducted within relevant respondents via an online survey form. A sufficient sample size of 388 was collected to proceed further with the statistical methods of EFA and CFA using IBM SPSS and AMOS 26 software. All the statistical parameters were met as explained in the section “Data Analysis and Results”.

The first objective is met by identifying 28 factors and 11 categories (constructs) responsible for RE projects success in the context of Nepal. One of the achievements of this research is the development of project success model (PSM) framework. This framework is unique in terms of its comprehensiveness and the wide range of factors it covers. Further, the second objective is achieved by utilizing the same response data collected in the Likert scale of 1 to 5 for calculating the project success probability also, which came to be 63%. Certainly, this is not an encouraging value, and thus, it becomes necessary to look for the factors that are dragging down the project’s success. This tool is named Project Success Probability (PSP) Tool which is unique in nature because to our knowledge, no such tool is available that calculates the success probability so easily. Third objective is also met through the PSP tool to identify the factors that need improvement so that progressive actions can be taken to increase the probability of success. It is simply done by checking the average score of each factor and picking the lower values like less than 3.0 considered in this research. It is noteworthy that

improvement can only happen if necessary action is taken. Therefore, the iterative process of continuous improvement should be followed at sufficient intervals to gauge and track the probability of the project success.

The second part of this research is focused on exploring the components of a business model suitable for the sustainable energy sector. Previously established business model canvas (BMC) is the foundation of the proposed sustainable energy business model canvas (SEBMC). The SEBMC is developed with the help of research findings that recommend modifying the BMC to the respective business domain as required. Many modifications are available in the literature but a comprehensive model for RE / SE projects is not available. Therefore, this research fills the gap by proposing the SEBMC which is comprised of 13 components to ensure sustainability of RE projects. They are (i) Environmental, (ii) Key Partners, (iii) Key Activities, (iv) Key Resources, (v) Value Propositions, (vi) Customer Expectations, (vii) Customer Relationship, (viii) Channels, (ix) Customer Segmentation, (x) Social, (xi) Financing Models, (xii) Cost Structure and (xiii) Revenue Streams.

Addressing these thirteen components in integration is believed to build a strong foundation of the desired business model. However, the SEBMC could not be examined for this thesis because “Suitable Business Model” as a project success factor was eliminated during the CFA process. Despite several studies linking the business model with the project success, further investigation was hindered by the process of CFA. Therefore, the research work is concluded by meeting the fourth objective of this thesis by contextualizing the business model for sustainable energy projects for Nepal.

In conclusion, this research has contributed to designing the framework for projects success factors, business model and project success probability (PSP) in the context of RE projects in Nepal. The PSP tool is a unique tool which is easy to use and possesses multiple benefits. Use of this tool can be beneficial to project management team, stakeholders, policy makers and project financiers by checking the success probability in given context and making strategies for improvement. Moreover, the findings of this thesis have filled the research gaps which are attractive to the researchers and academicians too. No research of this kind is available in scientific and government publications.

This thesis presents a unique approach to evaluating the RE projects in a framework structure for any given context of a country or organization. The powerful method of Exploratory Factor Analysis (EFA) equips a researcher to establish a theory from basic information collected from literature, reports and experts. Once a theory is established, a much rigorous method of Confirmatory Factor Analysis (CFA) refines the framework by eliminating major correlations and statistical errors thereby statistically confirming the validity and reliability of the framework. This systematic approach can be implemented as a generic method to any country other than Nepal. The main beauty of this approach is that it can be scaled for any individual organization, project types, sector and a country as a whole. Furthermore, the PSP tool presented in this thesis is capable of representing subjective nature of success factors on a numerical scale. The initiatives become more predictive for the project team, sponsors and policy makers when the probability of success is represented on the numerical scale as illustrated in

Figure 7. Therefore, this systematic method and approach can be equally applied to renewable energy and other sectors as a scientific theoretical foundation.

5.2 Limitations and Future Research

Like other research works, this thesis also has its limitations and thus, future scope of research has been explained below.

- a) This research and the outcomes are limited to renewable energy sector and its sustainability for Nepal only. The survey respondents were also limited to the stakeholders related to such projects implemented in Nepal. A similar approach can be taken to explore the success factors in other contexts as well.
- b) The proposed SEBMC is purely literature based. Qualitative or quantitative analysis can be done in future to establish its validity and reliability.
- c) Here the Project Success Probability (PSP) tool is illustrated using a spreadsheet. This can also be integrated into more sophisticated project management software for project selection and reporting purposes. Further, with the use of artificial intelligence (AI) programming this tool can give the results based on large database of documents available in a particular project and organization. Hence, there are ample opportunities to introduce several technical variations and sophistications.

5.3 Recommendations

Despite the hinderance imposed by the strict CFA process, the proposed SEBMC can still be used by professionals as it is strongly based on previous scientific research works. Similarly, the model for project success factors and PSP tool should be used in an iterative manner. The stakeholders are suggested to conduct a quick survey to check the probability of success at the given point in time. Then identify the problem areas so that progressive actions are taken. After a reasonable interval the survey is conducted again to compare the improvement. This cycle is repeated at regular intervals until the success probability score is satisfactorily high. As the success factors are related to the entire project management ecosystem, the success probability thus obtained from PSP tool is expected to match closely with reality.

From ethical considerations, the survey should be conducted by a third party who is neutral, unbiased and does not carry any prejudice to the project being checked. During the survey for this research, it is found that many respondents hesitate to express their dissatisfaction with some sensitive factors. They have a fear that they will be exposed to their higher management which may create more problems in their career growth. Hence, the surveying third party must remain indifferent and ensure that the respondents remain anonymous all the time.

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Appendix

Appendix A

Sample Email Draft sent to the respondents

Dear Sir / Madam,
Greetings!

It was a pleasure talking to you today and thank you for accepting to participate as a respondent for my PhD Research.

My thesis title is “EVALUATION OF SUSTAINABLE ENERGY PROJECTS AND BUSINESS MODELS WITH SOLAR ADOPTION IN NEPAL”

About this study

As the literatures and government reports suggest that most of the hydro, solar and wind energy projects in Nepal face many problems like significant delay, cost overrun, poor project management capabilities, sluggish procurement process, difficult to get right of way approval etc., this study is being performed to understand the project success factors applicable in context of renewable energy (RE) projects in Nepal. There are 61 factors compiled from various literatures which are grouped into 9 categories. The respondents are requested to give their opinion in the Likert Scale from 1-5 (1 = Strongly Disagree; 2 = Disagree; 3 = Undecided; 4 = Agree and 5 = Strongly Agree).

Objectives

The objectives of this study are as follows:

- a. To find the project success factors of RE Projects in Nepal.
- b. To measure the project success probability of RE Projects in Nepal.
- c. To identify the areas of improvement to increase success probability.

Expected Result

Based on your valuable response this study will provide very useful results. These results can be implemented for improving project management, policy and practices. Moreover, this study will also validate the tool to measure “Project Success Probability”. This scientifically validated tool can be used to review the status and areas of improvement in the RE projects undertaken.

Attachment – 1: Consent form (to be signed on hard copy and sent back via email as scan/photo attachment, e-signature is not acceptable).

Attachment – 2: Questionnaire Spreadsheet (to be filled and replied as spreadsheet soft-copy attachment)

Kindly find attached the questionnaire spreadsheet “Success Factors” for your response. You will select 1-5 Likert Scale as indicated. Kindly consider sustainable energy projects in general like hydro, solar and wind.

Attachment – 3: Survey Letter from Prince of Songkla University, Thailand, for your reference.

You can share your response within 2-4 days due to strict time limitation as per university calendar.

For any questions, feel free to contact me anytime.

Best Regards

Rajeev R Pandey

9801100232

PhD Candidate

Prince of Songkla University,

Hat Yai, Thailand

Alternative for Online Survey Form

Dear sir/maam,

It was pleasure meeting you today.

For your convenience I have created Google Form for my PhD survey questionnaire.

You can submit your response via the link below.

<https://forms.gle/cX9D4XCVXaDJemhm6>

Expecting your response at the earliest due to very tight deadline.

Request you to kindly circulate to potential respondents as well.

Best Regards,

Rajeev Pandey

9801100232 / 9761612200

Demographic information

Table 12: Education Level

Education	Count of Respondents
Bachelor	97
Master	264
MPhil	8
PhD	19
Grand Total	388

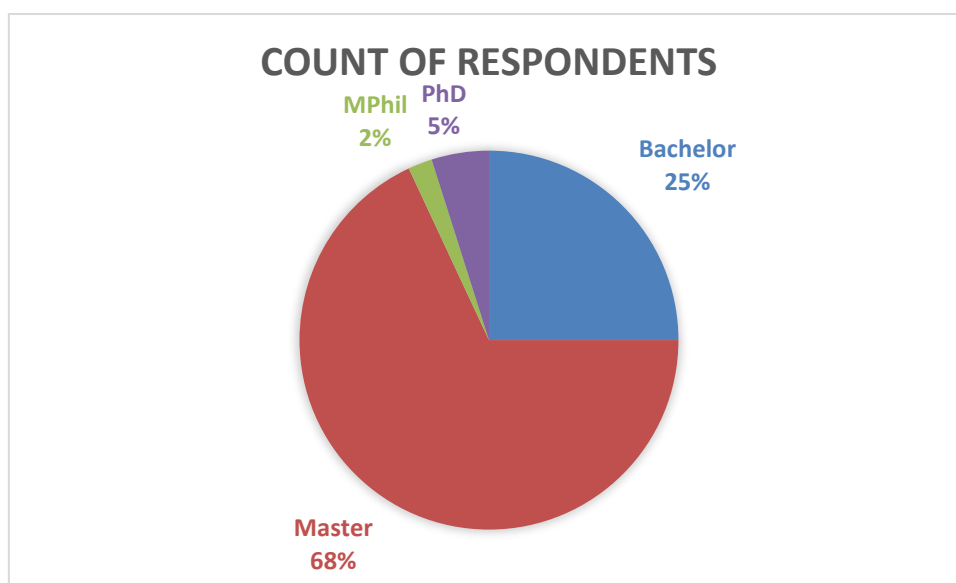


Figure 8: Demography by Education Level

Table 13: Professional Sector

Professional Sector	Count of Respondents
Academics / Consultancy	62
Government	88
Private Company	122

Public Company	116
Grand Total	388

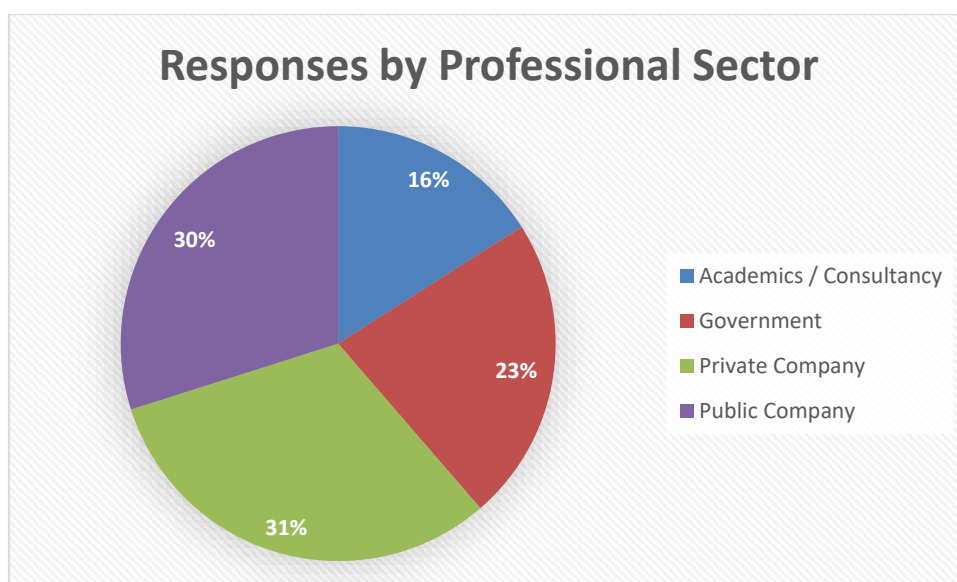


Figure 9: Demography by Professional Sector

Appendix B

Research Instrument

(A) Research Instrument: Survey Questionnaire

Table 14: Questionnaire

SN	Factors of RE Project Management	Explanation of the Factor	Questions to Respondents	Score (On Likert-Scale from 1-5) 1= Strongly Disagree 5= Strongly Agree
1	Follow PMI / PRINCE2 Framework	<i>Globally accepted and practiced Project Management Framework standardized by Project Management Institute (PMI) or PProjects IN Controlled Environments 2 (PRINCE2).</i>	<i>Do the projects follow any globally accepted and practiced Project Management Framework like PMI or PRINCE2?</i>	
2	Project selection & market conditions	<i>Projects are selected based on specific criteria considering the present and future market conditions. Project selection process is performed transparently. For example increase in demand, change in technology, change in user preference, tariff etc.</i>	<i>Are the projects selected transparently based on specified criteria considering the market conditions?</i>	
3	Project prioritization	<i>Projects are prioritized based on specific needs and criteria transparently. For example country need, consumer need, energy development strategy, demand and supply strategy etc.</i>	<i>Are the projects prioritized based on specific needs and criteria transparently?</i>	

SN	Factors of RE Project Management	Explanation of the Factor	Questions to Respondents	Score (On Likert-Scale from 1-5) 1= Strongly Disagree 5= Strongly Agree
4	Suitable Financing Strategy	<i>Project financing strategy is sufficiently analyzed and secured suitable for the given project.</i>	<i>Is the project financing strategy analysis sufficiently done so that it's secured till end of the project?</i>	
5	Suitable Business Model	<i>All the components of business model are sufficiently analyzed suitable for the given project. Widely practiced Business Model canvas analyses the components: Key Partners, Key Activities, Key Resources, Value Propositions, Customer Relationships, Distribution Channels, Customer Segments, Cost Structure and Revenue Streams.</i>	<i>Are the business models sufficiently analyzed before finalizing a project?</i>	
6	Legal framework to facilitate project	<i>Country's central and provincial legal framework and policies related with energy development and utilization are sufficient to facilitate project development, execution and sustainable operation.</i>	<i>Do you believe that legal framework and policies of central and provincial governments are sufficient to facilitate this type of project?</i>	
7	Encourage circular economy principles	<i>Country has sufficient policies to encourage circular economy principles like recycle and reuse of old devices and materials.</i>	<i>Do you believe that country has sufficient policies to encourage circular economy principles?</i>	
8	Discourage corruption	<i>Country and organizations have clear guidelines and practices to discourage corruption for best utilization of fund and resources.</i>	<i>Do you believe that policies and practices discourage corruption in the project?</i>	
9	Consistent PPA policies	<i>Power Purchase Agreement (PPA) policies are consistent and unbiased to foster good business environment.</i>	<i>Do you believe that PPA policies are consistent and unbiased for this type of project?</i>	
10	Supporting Political agenda	<i>National political agenda are in support of the project.</i>	<i>Do you believe that the project and its objectives are supported by national political agenda as well?</i>	

SN	Factors of RE Project Management	Explanation of the Factor	Questions to Respondents	Score (On Likert-Scale from 1-5) 1= Strongly Disagree 5= Strongly Agree
11	Clarity of project purpose and goals	<i>Project purpose and goals are clearly defined and explained such that all the stakeholders can understand easily.</i>	<i>Do you believe that project's purpose and goals are clearly defined and explained to be understood by all the stakeholders?</i>	
12	Transparent & Realistic Project awarding process	<i>Project bidding and awarding process is transparent and based on realistic grounds to give confidence on successful completion and achievement of project goals. Hypothetical considerations, assumptions, dependencies etc. are avoided as much as possible.</i>	<i>Do you believe that project bidding and awarding process is transparent based on realistic grounds?</i>	
13	Consideration for Environment Preservation	<i>Enough consideration is done for preserving the natural environment.</i>	<i>Do the project and operation activities give enough consideration for preserving the natural environment?</i>	
14	Evaluate Project size	<i>Size of the project is evaluated properly so that funding arrangements and other planning are done appropriate for the project. Size may refer to production capacity, area required, input resources required, people and environment affected etc.</i>	<i>Is size of the project evaluated sufficiently so that further planning can be done easily?</i>	
15	Evaluate Project Complexity	<i>Complexity of the project is evaluated properly so that funding arrangements and other planning are done appropriate for the project. Complexity may refer to project size, technology used, stakeholders involved etc.</i>	<i>Is complexity of the project evaluated sufficiently so that further planning can be done easily?</i>	

SN	Factors of RE Project Management	Explanation of the Factor	Questions to Respondents	Score (On Likert-Scale from 1-5) 1= Strongly Disagree 5= Strongly Agree
16	Evaluate Project Uniqueness	<i>Uniqueness of the project is evaluated properly so that funding arrangements and other planning are done appropriate for the project. Uniqueness may refer to the unique objectives, approach, situation, environment, resources, technology etc. applicable for the given project.</i>	<i>Is uniqueness of the project evaluated sufficiently so that further planning can be done easily?</i>	
17	Evaluate Social, Environmental and Economic long-term priorities	<i>A project is sufficiently evaluated for social, environmental and economic long-term priorities and benefits. The project has categorical and specific evaluation for long-term needs and benefits of the larger society fulfilled by the project. Similarly, whether the project contributes in protecting and even rejuvenating the degraded natural environment and ecosystem. And finally, the project serves a long-term economic benefits prioritized over other alternative projects.</i>	<i>Is the project is sufficiently evaluated for social, environmental and long-term priorities?</i>	
18	Stakeholder participation & engagement	<i>All the stakeholders of the project are engaged to participate in different stages of project life-cycle.</i>	<i>Are all the stakeholders of the project identified and engaged in sufficient amount at different stages of project life-cycle?</i>	
19	Address Buyers or customer expectations	<i>The expectations of buyers, customers or beneficiaries are satisfactorily addressed. For example, regular supply is maintained, tariffs are not revised very frequently, power demanded is fulfilled etc.</i>	<i>Do you think expectations of buyers, customers or beneficiaries are satisfactorily addressed?</i>	

SN	Factors of RE Project Management	Explanation of the Factor	Questions to Respondents	Score (On Likert-Scale from 1-5) 1= Strongly Disagree 5= Strongly Agree
20	Level of Stakeholder Satisfaction	<i>Stakeholders are satisfied with the project's objectives, goals, activities, outcome and their involvement.</i>	<i>What is the stakeholder satisfaction level for the projects?</i>	
21	Public acceptance & inclusion	<i>General public or public groups are included at different stages of project life-cycle to gain their acceptance and support for the project.</i>	<i>How do you evaluate the level of public acceptance and inclusion for the project?</i>	
22	Communication with customers	<i>The customers and beneficiaries of the project can easily communicate with project leaders and other major stakeholders.</i>	<i>Do you think that customers and beneficiaries can easily communicate with project leaders and other major stakeholders to share their concerns?</i>	
23	Effective & transparent communication with all stakeholders and team	<i>Project related communication like stakeholder's concerns, suggestions, grievances, needs and updates are effectively and transparently communicated to project team and other stakeholders.</i>	<i>Do you find that all the stakeholders and team members can effectively and transparently communicate with each other?</i>	
24	Adequate Planning & implementation	<i>All the project components are adequately discussed, planned and executed based on agreed upon project management framework.</i>	<i>Do you believe that adequate discussion, planning and implementation efforts are done based on agreed upon project management framework?</i>	
25	Project Cost Management	<i>Project cost estimate, expenses, funding sources, funding milestones, contingencies, monitoring, evaluation and control principles are in place. Cost management is performed within agreed limits of variation.</i>	<i>Do you find the project cost management is done based on agreed upon principles within specified limits of variation?</i>	

SN	Factors of RE Project Management	Explanation of the Factor	Questions to Respondents	Score (On Likert-Scale from 1-5) 1= Strongly Disagree 5= Strongly Agree
26	Project Schedule Management	<i>Project schedule estimate, progress milestones, buffer time, dependencies, assumptions, complexities considerations, monitoring, evaluation and control principles are in place. Schedule management is performed within agreed limits of variation.</i>	<i>Do you find the project schedule management is done based on agreed upon principles within specified limits of variation?</i>	
27	Satisfactory Project Performance	<i>Project performance parameters are well established based on standard practices and stakeholders' expectations.</i>	<i>Do you believe that project performance is satisfactory as per defined parameters?</i>	
28	Realistic cost and time estimates	<i>Project's cost and duration estimates are prepared based on realistic and clear parameters rather than a hypothetical random manner. The estimates are achievable within the agreed range of variations.</i>	<i>Do you believe that cost and duration estimates are realistic?</i>	
29	Sufficient & Timely Financing	<i>Project gets financing in sufficient amount on agreed upon financing milestones.</i>	<i>Does the project receive timely and sufficient financing as per defined financing milestone?</i>	
30	Project Scope Management	<i>Scope of the project is clearly and sufficiently defined. Changes are reviewed by authorized committee. If changes are approved, necessary amendments are done on other components of the project like cost, schedule, risk, quality, resources etc.</i>	<i>Do you believe that project requirements and scope of work are well defined such that major changes don't happen without proper evaluation and approval.</i>	

SN	Factors of RE Project Management	Explanation of the Factor	Questions to Respondents	Score (On Likert-Scale from 1-5) 1= Strongly Disagree 5= Strongly Agree
31	Project Quality Management	<i>The quality standards of materials and other resources and the final output or product are finalized at the beginning of the project. Quality assurance process, quality check mechanisms, tools and techniques, variation limits etc. are also established before starting the execution of project activities. Quality control is done based on defined standards and processes.</i>	<i>Do you believe that quality management principles, standards and processes are well defined and followed as required by the project's final output?</i>	
32	Supportive Organizational culture	<i>Organization(s) associated with the project have a supportive culture and practices to make project successful. Supportive culture refers to team members giving and receiving support from each other, management, suppliers including all stakeholders. Team has a habit of sharing constructive feedback to make the project successful.</i>	<i>Does your and associated organizations have supportive culture to make the project successful?</i>	
33	Top management support	<i>Top management of the associated organization(s) give full support to the agreed processes and to the employees.</i>	<i>Does the top management of your and associated organizations support agreed principles, processes and employees working for the project?</i>	
34	Demonstrate clear Leadership styles	<i>Leaders from associated organizations and stakeholder groups are able to show clear vision, establish trust and facilitate in handling difficult situations.</i>	<i>Can the leaders associated with the project demonstrate clear leadership styles with vision, trust and facilitation?</i>	

SN	Factors of RE Project Management	Explanation of the Factor	Questions to Respondents	Score (On Likert-Scale from 1-5) 1= Strongly Disagree 5= Strongly Agree
35	Competency of project manager	<i>The project manager is competent enough to implement project management framework to lead the project team and activities along with establishing good relationship with all the stakeholders.</i>	<i>Are the project manager(s) competent enough to implement project management framework to lead the project team?</i>	
36	Institutional project management capacity	<i>The associated organizations have a good understanding, experiences, established processes and practices of project management at the institutional level.</i>	<i>Do your and associated organizations have good understanding of project management processes and practices at institutional level?</i>	
37	Transformational Leadership	<i>The leaders at various levels of the project are aware of the upcoming changes to be brought by the project. They are visionary, optimistic, supportive and facilitative in transforming from current state to future state.</i>	<i>Do the project leaders show transformational leadership characteristics?</i>	
38	Adequate resources	<i>The project is equipped with adequate required resources like human, machine, material, technology, method etc.</i>	<i>Is the project equipped with required resources in adequate amount?</i>	
39	Optimization of resources	<i>The resources are utilized to the optimum level minimizing the wastage. For example, materials, machines and human efforts are utilized on right time in right amount.</i>	<i>Are the resources utilized on optimum level minimizing the wastage?</i>	
40	Competent & experienced project team	<i>Project team members have sufficient knowledge and experience required for the project activities. The composition of the project team is right-fit for their responsibilities and deliverables.</i>	<i>Are the project team members competent and experienced enough to perform the project activities?</i>	

SN	Factors of RE Project Management	Explanation of the Factor	Questions to Respondents	Score (On Likert-Scale from 1-5) 1= Strongly Disagree 5= Strongly Agree
41	Required types of skills in project team	<i>Project team members have required set of skills to perform their activities in efficient and effective manner so that the deliverables meet the quality requirements avoiding rework to fix the issues.</i>	<i>Do the project team members have required set of skills to perform assigned activities efficiently meeting the quality requirements?</i>	
42	Efficient supply chain	<i>The supply chain of required materials, machineries, tools and other resources are managed efficiently so that project work is not halted in lack of the required resources.</i>	<i>Is the supply chain system of the project efficient enough for smooth progress?</i>	
43	Knowledge sharing	<i>All the team members have an attitude to share knowledge and experience to establish a good team spirit.</i>	<i>Do you find all team members have an attitude to share knowledge and experience with good team spirit?</i>	
44	Handling of Human factors	<i>Associated organization(s), leaders and managers are able to handle human factors with humanity. Human factors can be personality conflicts, human errors, negligence, ego clash, emotional imbalance, being disrespectful to others etc.</i>	<i>Do you believe that project leaders and managers handle human factors with humanity?</i>	
45	Controlled Change Management	<i>Changes in the project are properly evaluated considering probable risks. All the changes pass through approval process to ensure impacts are under control of the performing team.</i>	<i>Are all the changes evaluated and approved considering probable risks that may arise in future?</i>	
46	Risk Management	<i>There is a set of standard processes to identify, analyze, respond, monitor, evaluate and control the project risks. Responsibilities are distributed among relevant team members or stakeholders who can tackle the risks better.</i>	<i>Do you believe that project risk management is well practiced by all the stakeholders, sponsor(s) and performing teams?</i>	

SN	Factors of RE Project Management	Explanation of the Factor	Questions to Respondents	Score (On Likert-Scale from 1-5) 1= Strongly Disagree 5= Strongly Agree
47	Managing External issues	<i>Stakeholders and project team are always willing to manage external issues beyond their control. Managing external issues may refer to exchanging right information, seeking help, escalating issues to higher authorities etc.</i>	<i>Are the stakeholders and project team(s) always willing to manage external issues beyond their control?</i>	
48	Managing project related factors	<i>The project related factors like scope, cost, quality, resources, procurement, stakeholder satisfaction etc. are well managed so that risks do not arise from ill management of the project itself.</i>	<i>Do you find all the components of project management are well managed so that risks do not arise from ill management of project itself?</i>	
49	Recognize source of risks	<i>Project team is proactive to recognize sources from where probable risks may arise. Early recognition of sources of risks can help for better preparation for risk response strategy.</i>	<i>Do you believe that performing team(s), sponsors and stakeholders are proactive in recognizing sources of risks so that better preparation can be done upfront?</i>	
50	Flexibility	<i>The project constraints are flexible enough to accommodate limited variations. For example, provisioning of contingencies gives flexibility when unknown and unidentified risks appear at any stage of project life-cycle.</i>	<i>Do you believe that project has flexibility to accommodate limited variations arising from unidentified risks?</i>	
51	Integrated management & governance	<i>Project governance structure is based on wholistic and integrated management approach. Project monitoring, performance evaluation, controlling actions, decisions etc. are all done in favor of meeting the project objectives successfully.</i>	<i>Does the project governance structure follow the principles of wholistic and integrated management approach?</i>	

SN	Factors of RE Project Management	Explanation of the Factor	Questions to Respondents	Score (On Likert-Scale from 1-5) 1= Strongly Disagree 5= Strongly Agree
52	Project integration Management	<i>All the components of project like scope, cost, schedule, quality, resources, risks, procurement, communications, stakeholder satisfaction etc, are integrated together so that project initiation, planning, execution, monitoring, evaluation, controlling and closing are performed in coherence to meet the project goals.</i>	<i>Do you believe that all the components of project management are integrated together?</i>	
53	Project supervision	<i>Project supervision mechanism is in place at different levels of governance structure. Elements of governance structure generally comprise of standard operating procedure, process designing, monitoring, audit, ethics and compliances.</i>	<i>Is the project supervised at all the levels of governance structure?</i>	
54	Balance and Control	<i>Project governance structure is designed in such a way that involved stakeholders and organization(s) can balance and control the events which are not in favor of achieving project goals.</i>	<i>Is the project governance structure equipped with mechanism and practices to maintain balance and control on decisions by involved stakeholders and organization(s)?</i>	
55	Technological Knowhow	<i>Technological knowhow of domestic team and stakeholders are improved through the governance structure. Technology knowledge transfer is ensured.</i>	<i>Can the domestic team(s) enhance their technical knowledge by working on the project?</i>	
56	Geographical Knowledge	<i>All the project stakeholders and teams should have sufficient knowledge of project site geography. Governance approach has considered the challenges associated with specific site geography.</i>	<i>Do all the stakeholders and team(s) have sufficient knowledge of project site geography?</i>	

SN	Factors of RE Project Management	Explanation of the Factor	Questions to Respondents	Score (On Likert-Scale from 1-5) 1= Strongly Disagree 5= Strongly Agree
57	Efficient Project Procedures	<i>Project procedures are made efficient. For example, decision on any change request should be made within specified days. If this procedure takes longer than the specified days, it is not efficient.</i>	<i>Do to believe that project procedures are efficient enough for smooth progress of project activities?</i>	
58	Traditional waterfall Method	<i>Project monitoring and governance are tuned to match traditional waterfall method whereby all the details of scope of work is clearly defined before executing project tasks.</i>	<i>Do you believe that project management practices follow traditional waterfall method which is an effective method for the project?</i>	
59	Agile Methodology	<i>Project monitoring and governance are tuned to match agile method whereby details of scope of work are gradually defined as small sets of tasks are executed in progressive manner.</i>	<i>Do you believe that project management practices follow agile method which is an effective method for the project?</i>	
60	Care for future Maintenance challenges	<i>Project governance does not only focus on current execution, but also establishes a good process and practice for future operation and maintenance of the power plant.</i>	<i>Do you find that governance structure also establishes good practices taking care for future operation and maintenance challenges?</i>	
61	Readiness for Unexpected disasters	<i>Governance structure has also provision to handle unexpected disastrous situations if happened. For example floods, earthquake, pandemics, political and economic turmoil etc.</i>	<i>Does the governance structure has provision to keep everyone ready for tackling unexpected disasters in future?</i>	

(B) Item Objective Congruence (IOC) Score

Table 15: IOC Score

SN	Factors of RE Project Management	Questions to Respondents	IOC (Kuaanan)	IOC (Arun)	IOC (Suthirat)	IOC (Srijan)	IOC (Sundar)	IOC (Birendra)	Avg IOC
1	Follow PMI / PRINCE2 Framework	<i>Do the projects follow any globally accepted and practiced Project Management Framework like PMI or PRINCE2?</i>	1	1	0	1	1	1	0.83
2	Project selection & market conditions	<i>Are the projects selected transparently based on specified criteria considering the market conditions?</i>	1	1	1	1	1	1	1
3	Project prioritization	<i>Are the projects prioritized based on specific needs and criteria transparently?</i>	-1	1	1	1	1	1	0.67

SN	Factors of RE Project Management	Questions to Respondents	IOC (Kuaanan)	IOC (Arun)	IOC (Suthirat)	IOC (Srijan)	IOC (Sundar)	IOC (Birendra)	Avg IOC
4	Suitable Financing Strategy	<i>Is the project financing strategy analysis sufficiently done so that it's secured till end of the project?</i>	1	1	1	1	1	1	1
5	Suitable Business Model	<i>Are the business models sufficiently analyzed before finalizing a project?</i>	1	1	1	1	1	1	1
6	Legal framework to facilitate project	<i>Do you believe that legal framework and policies of central and provincial governments are sufficient to facilitate this type of project?</i>	1	1	1	1	1	1	1
7	Encourage circular economy principles	<i>Do you believe that country has sufficient policies to encourage circular economy principles?</i>	-1	1	1	1	0	1	0.5

SN	Factors of RE Project Management	Questions to Respondents	IOC (Kuaanan)	IOC (Arun)	IOC (Suthirat)	IOC (Srijan)	IOC (Sundar)	IOC (Birendra)	Avg IOC
8	Discourage corruption	<i>Do you believe that policies and practices discourage corruption in the project?</i>	1	1	0	1	1	1	0.83
9	Consistent PPA policies	<i>Do you believe that PPA policies are consistent and unbiased for this type of project?</i>	1	1	0	1	1	1	0.83
10	Supporting Political agenda	<i>Do you believe that the project and its objectives are supported by national political agenda as well?</i>	1	1	1	1	1	1	1
11	Clarity of project purpose and goals	<i>Do you believe that project's purpose and goals are clearly defined and explained to be understood by all the stakeholders?</i>	1	1	1	0	1	1	0.83

SN	Factors of RE Project Management	Questions to Respondents	IOC (Kuaanan)	IOC (Arun)	IOC (Suthirat)	IOC (Srijan)	IOC (Sundar)	IOC (Birendra)	Avg IOC
12	Transparent & Realistic Project awarding process	<i>Do you believe that project bidding and awarding process is transparent based on realistic grounds?</i>	1	1	1	1	1	1	1
13	Consideration for Environment Preservation	<i>Do the project and operation activities give enough consideration for preserving the natural environment?</i>	1	1	1	1	1	1	1
14	Evaluate Project size	<i>Is size of the project evaluated sufficiently so that further planning can be done easily?</i>	1	1	1	1	1	1	1
15	Evaluate Project Complexity	<i>Is complexity of the project evaluated sufficiently so that further planning can be done easily?</i>	1	1	1	1	1	1	1

SN	Factors of RE Project Management	Questions to Respondents	IOC (Kuaanan)	IOC (Arun)	IOC (Suthirat)	IOC (Srijan)	IOC (Sundar)	IOC (Birendra)	Avg IOC
16	Evaluate Project Uniqueness	<i>Is uniqueness of the project evaluated sufficiently so that further planning can be done easily?</i>	1	1	1	1	1	1	1
17	Evaluate Social, Environmental and Economic long-term priorities	<i>Is the project is sufficiently evaluated for social, environmental and long-term priorities?</i>	1	1	1	1	1	1	1
18	Stakeholder participation & engagement	<i>Are all the stakeholders of the project identified and engaged in sufficient amount at different stages of project life-cycle?</i>	1	1	1	1	1	1	1
19	Address Buyers or customer expectations	<i>Do you think expectations of buyers, customers or beneficiaries are satisfactorily addressed?</i>	-1	1	1	1	1	1	0.67

SN	Factors of RE Project Management	Questions to Respondents	IOC (Kuaanan)	IOC (Arun)	IOC (Suthirat)	IOC (Srijan)	IOC (Sundar)	IOC (Birendra)	Avg IOC
20	Level of Stakeholder Satisfaction	<i>What is the stakeholder satisfaction level for the projects?</i>	1	1	1	1	1	1	1
21	Public acceptance & inclusion	<i>How do you evaluate the level of public acceptance and inclusion for the project?</i>	1	1	1	1	1	1	1
22	Communication with customers	<i>Do you think that customers and beneficiaries can easily communicate with project leaders and other major stakeholders to share their concerns?</i>	-1	1	1	1	0	1	0.5
23	Effective & transparent communication with all stakeholders and team	<i>Do you find that all the stakeholders and team members can effectively and transparently communicate with each other?</i>	1	1	1	0	0	1	0.67

SN	Factors of RE Project Management	Questions to Respondents	IOC (Kuaanan)	IOC (Arun)	IOC (Suthirat)	IOC (Srijan)	IOC (Sundar)	IOC (Birendra)	Avg IOC
24	Adequate Planning & implementation	<i>Do you believe that adequate discussion, planning and implementation efforts are done based on agreed upon project management framework?</i>	1	1	1	1	1	1	1
25	Project Cost Management	<i>Do you find the project cost management is done based on agreed upon principles within specified limits of variation?</i>	1	1	1	1	1	1	1
26	Project Schedule Management	<i>Do you find the project schedule management is done based on agreed upon principles within specified limits of variation?</i>	1	1	1	1	1	1	1
27	Satisfactory Project Performance	<i>Do you believe that project performance is satisfactory as per</i>	1	1	1	1	1	1	1

SN	Factors of RE Project Management	Questions to Respondents	IOC (Kuaanan)	IOC (Arun)	IOC (Suthirat)	IOC (Srijan)	IOC (Sundar)	IOC (Birendra)	Avg IOC
		<i>defined parameters?</i>							
28	Realistic cost and time estimates	<i>Do you believe that cost and duration estimates are realistic?</i>	1	1	1	1	1	1	1
29	Sufficient & Timely Financing	<i>Does the project receive timely and sufficient financing as per defined financing milestone?</i>	1	1	1	1	1	1	1
30	Project Scope Management	<i>Do you believe that project requirements and scope of work are well defined such that major changes don't happen without proper evaluation and approval.</i>	1	1	1	1	1	1	1

SN	Factors of RE Project Management	Questions to Respondents	IOC (Kuaanan)	IOC (Arun)	IOC (Suthirat)	IOC (Srijan)	IOC (Sundar)	IOC (Birendra)	Avg IOC
31	Project Quality Management	<i>Do you believe that quality management principles, standards and processes are well defined and followed as required by the project's final output?</i>	1	1	1	1	1	1	1
32	Supportive Organizational culture	<i>Does your and associated organizations have supportive culture to make the project successful?</i>	1	1	1	1	1	1	1
33	Top management support	<i>Does the top management of your and associated organizations support agreed principles, processes and employees working for the project?</i>	1	1	1	1	1	1	1

SN	Factors of RE Project Management	Questions to Respondents	IOC (Kuaanan)	IOC (Arun)	IOC (Suthirat)	IOC (Srijan)	IOC (Sundar)	IOC (Birendra)	Avg IOC
34	Demonstrate clear Leadership styles	<i>Can the leaders associated with the project demonstrate clear leadership styles with vision, trust and facilitation?</i>	1	1	1	1	1	1	1
35	Competency of project manager	<i>Are the project manager(s) competent enough to implement project management framework to lead the project team?</i>	1	1	1	1	1	1	1
36	Institutional project management capacity	<i>Do your and associated organizations have good understanding of project management processes and practices at institutional level?</i>	1	1	1	1	1	1	1
37	Transformational Leadership	<i>Do the project leaders show transformational leadership characteristics?</i>	1	1	0	1	1	1	0.83

SN	Factors of RE Project Management	Questions to Respondents	IOC (Kuaanan)	IOC (Arun)	IOC (Suthirat)	IOC (Srijan)	IOC (Sundar)	IOC (Birendra)	Avg IOC
38	Adequate resources	<i>Is the project equipped with required resources in adequate amount?</i>	1	1	1	1	1	1	1
39	Optimization of resources	<i>Are the resources utilized on optimum level minimizing the wastage?</i>	1	1	1	1	1	1	1
40	Competent & experienced project team	<i>Are the project team members competent and experienced enough to perform the project activities?</i>	1	1	1	1	1	1	1
41	Required types of skills in project team	<i>Do the project team members have required set of skills to perform assigned activities efficiently meeting the quality requirements?</i>	1	1	1	1	1	1	1
42	Efficient supply chain	<i>Is the supply chain system of the project efficient enough for smooth progress?</i>	1	1	0	1	1	1	0.83

SN	Factors of RE Project Management	Questions to Respondents	IOC (Kuaanan)	IOC (Arun)	IOC (Suthirat)	IOC (Srijan)	IOC (Sundar)	IOC (Birendra)	Avg IOC
43	Knowledge sharing	<i>Do you find all team members have an attitude to share knowledge and experience with good team spirit?</i>	1	1	1	1	1	1	1
44	Handling of Human factors	<i>Do you believe that project leaders and managers handle human factors with humanity?</i>	1	1	1	0	1	1	0.83
45	Controlled Change Management	<i>Are all the changes evaluated and approved considering probable risks that may arise in future?</i>	1	1	1	1	1	1	1
46	Risk Management	<i>Do you believe that project risk management is well practiced by all the stakeholders, sponsor(s) and performing teams?</i>	1	1	1	1	1	1	1

SN	Factors of RE Project Management	Questions to Respondents	IOC (Kuaanan)	IOC (Arun)	IOC (Suthirat)	IOC (Srijan)	IOC (Sundar)	IOC (Birendra)	Avg IOC
47	Managing External issues	<i>Are the stakeholders and project team(s) always willing to manage external issues beyond their control?</i>	1	1	1	1	1	1	1
48	Managing project related factors	<i>Do you find all the components of project management are well managed so that risks do not arise from ill management of project itself?</i>	1	1	1	1	1	1	1
49	Recognize source of risks	<i>Do you believe that performing team(s), sponsors and stakeholders are proactive in recognizing sources of risks so that better preparation can be done upfront?</i>	1	1	1	1	1	1	1

SN	Factors of RE Project Management	Questions to Respondents	IOC (Kuaanan)	IOC (Arun)	IOC (Suthirat)	IOC (Srijan)	IOC (Sundar)	IOC (Birendra)	Avg IOC
50	Flexibility	<i>Do you believe that project has flexibility to accommodate limited variations arising from unidentified risks?</i>	1	1	1	1	1	1	1
51	Integrated management & governance	<i>Does the project governance structure follow the principles of wholistic and integrated management approach?</i>	1	1	1	1	1	1	1
52	Project integration Management	<i>Do you believe that all the components of project management are integrated together?</i>	1	1	1	1	1	1	1
53	Project supervision	<i>Is the project supervised at all the levels of governance structure?</i>	1	1	1	1	1	1	1

SN	Factors of RE Project Management	Questions to Respondents	IOC (Kuaanan)	IOC (Arun)	IOC (Suthirat)	IOC (Srijan)	IOC (Sundar)	IOC (Birendra)	Avg IOC
54	Balance and Control	<i>Is the project governance structure equipped with mechanism and practices to maintain balance and control on decisions by involved stakeholders and organization(s)?</i>	-1	1	1	1	1	1	0.67
55	Technological Knowhow	<i>Can the domestic team(s) enhance their technical knowledge by working on the project?</i>	1	1	1	1	1	1	1
56	Geographical Knowledge	<i>Do all the stakeholders and team(s) have sufficient knowledge of project site geography?</i>	1	1	1	1	1	1	1
57	Efficient Project Procedures	<i>Do to believe that project procedures are efficient enough for smooth progress of project activities?</i>	1	1	1	1	1	1	1

SN	Factors of RE Project Management	Questions to Respondents	IOC (Kuaanan)	IOC (Arun)	IOC (Suthirat)	IOC (Srijan)	IOC (Sundar)	IOC (Birendra)	Avg IOC
58	Traditional waterfall Method	<i>Do you believe that project management practices follow traditional waterfall method which is an effective method for the project?</i>	1	1	1	1	1	1	1
59	Agile Methodology	<i>Do you believe that project management practices follow agile method which is an effective method for the project?</i>	1	1	1	1	1	1	1
60	Care for future Maintenance challenges	<i>Do you find that governance structure also establishes good practices taking care for future operation and maintenance challenges?</i>	1	1	1	1	1	1	1

SN	Factors of RE Project Management	Questions to Respondents	IOC (Kuaanan)	IOC (Arun)	IOC (Suthirat)	IOC (Srijan)	IOC (Sundar)	IOC (Birendra)	Avg IOC
61	Readiness for Unexpected disasters	<i>Does the governance structure has provision to keep everyone ready for tackling unexpected disasters in future?</i>	1	1	1	1	1	1	1

Appendix C

Exploratory Factor Analysis Settings and Results

EFA settings with screenshots are presented below.

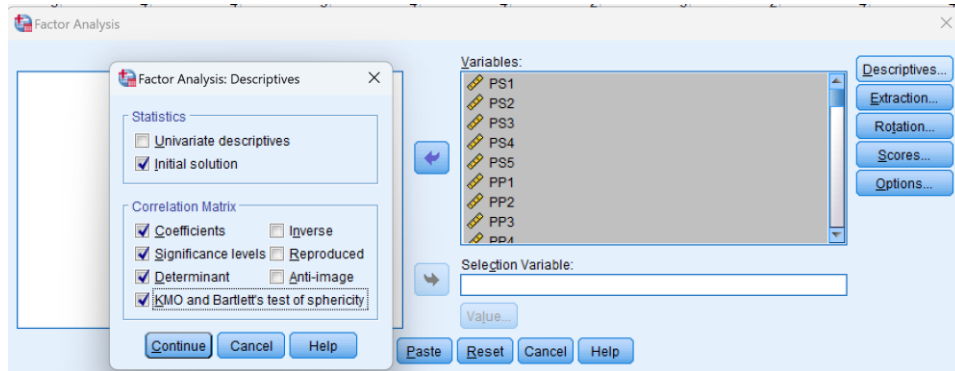


Figure 10: EFA - Factor Analysis: Descriptives

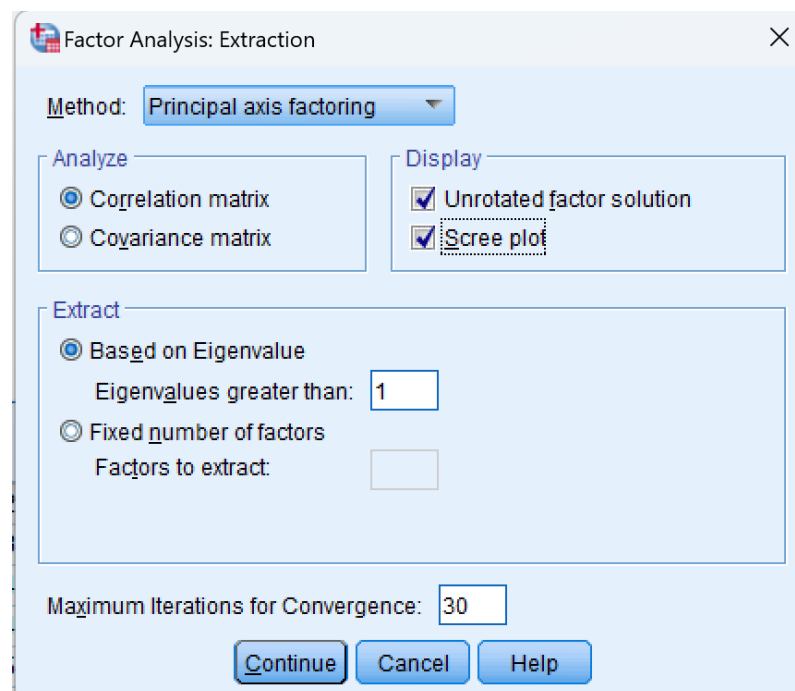


Figure 11: EFA - Factor Analysis: Extraction

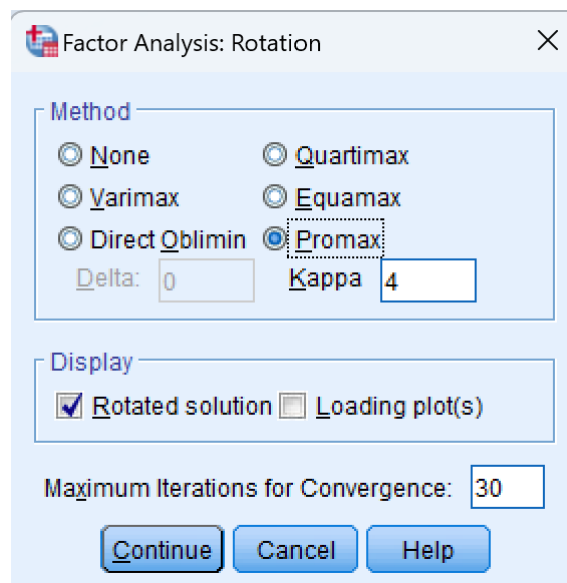


Figure 12: EFA - Factor Analysis: Rotation

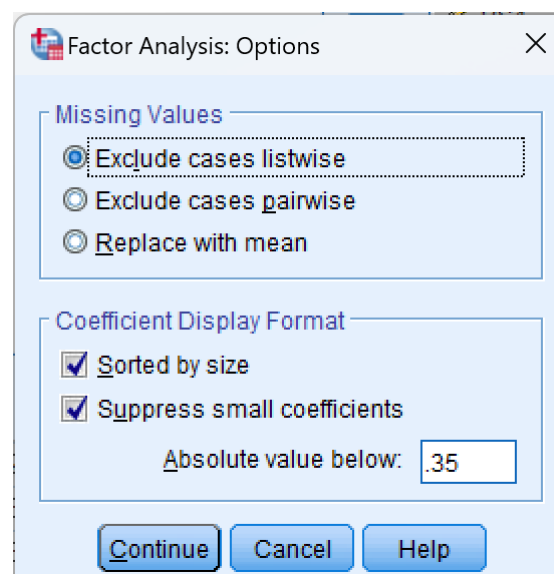


Figure 13: EFA - Factor Analysis: Options

The first iteration results are presented below.

KMO and Bartlett's Test

Table 16 : KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.924
Bartlett's Test of Sphericity	Approx. Chi-Square	12142.021
	df	1830
	Sig.	.000

Communalities

Table 17: Communalities

Communalities		
	Initial	Extraction
PS1	.435	.434
PS2	.615	.616
PS3	.609	.687
PS4	.575	.584
PS5	.574	.556
PP1	.448	.485
PP2	.557	.637
PP3	.523	.523
PP4	.459	.416
PP5	.427	.359
PP6	.540	.594
PP7	.512	.515
PA1	.475	.369
PA2	.615	.623
PA3	.676	.699
PA4	.671	.660
PA5	.574	.506
PI1	.492	.528
PI2	.535	.570
PI3	.579	.622
PI4	.501	.489
PI5	.438	.462
PPar1	.491	.450
PPar2	.570	.579
PPar3	.545	.543
PPar4	.612	.604
PPar5	.559	.564

PPar6	.593	.560
PPar7	.533	.489
PPar8	.549	.520
PPar9	.462	.460
CL1	.573	.563
CL2	.640	.679
CL3	.597	.616
CL4	.525	.580
CL5	.585	.566
CL6	.573	.484
RES1	.558	.518
RES2	.591	.526
RES3	.625	.624
RES4	.649	.630
RES5	.560	.562
RES6	.572	.632
RES7	.604	.627
MR1	.564	.518
MR2	.598	.573
MR3	.561	.547
MR4	.595	.596
MR5	.596	.644
MR6	.441	.459
PG1	.579	.591
PG2	.665	.709
PG3	.610	.570
PG4	.600	.569
PG5	.429	.323
PG6	.494	.464
PG7	.503	.463
PG8	.508	.494
PG9	.476	.432
PG10	.566	.530
PG11	.444	.385
Extraction Method: Principal Axis Factoring.		

Here, four variables are found to possess communality less than 0.4 which need to be addressed by eliminating them in further steps.

Table 18: Total Variance Explained

Total Variance Explained							
Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings ^a
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	18.142	29.741	29.741	17.699	29.014	29.014	11.737
2	3.099	5.081	34.822	2.658	4.357	33.371	8.876
3	2.173	3.562	38.384	1.739	2.850	36.221	11.368
4	2.023	3.317	41.701	1.542	2.527	38.748	9.013
5	1.755	2.876	44.578	1.308	2.145	40.893	12.568
6	1.669	2.736	47.314	1.241	2.034	42.927	5.320
7	1.525	2.500	49.814	1.083	1.776	44.703	9.643
8	1.406	2.304	52.119	.966	1.583	46.287	6.270
9	1.327	2.175	54.294	.869	1.424	47.711	7.677
10	1.267	2.077	56.371	.811	1.330	49.041	2.642
11	1.192	1.954	58.325	.752	1.233	50.274	7.500
12	1.169	1.916	60.240	.696	1.141	51.415	4.451
13	1.110	1.820	62.061	.660	1.083	52.498	4.755
14	1.053	1.725	63.786	.593	.972	53.470	1.444
15	1.020	1.672	65.458	.560	.917	54.388	2.607
16	.968	1.586	67.044				
17	.937	1.536	68.580				
18	.901	1.478	70.058				
19	.849	1.392	71.450				
20	.836	1.370	72.819				
21	.771	1.264	74.083				
22	.741	1.215	75.299				
23	.730	1.197	76.495				
24	.691	1.133	77.628				
25	.661	1.084	78.712				
26	.631	1.034	79.746				
27	.623	1.022	80.767				
28	.583	.955	81.723				
29	.570	.934	82.657				
30	.541	.887	83.544				

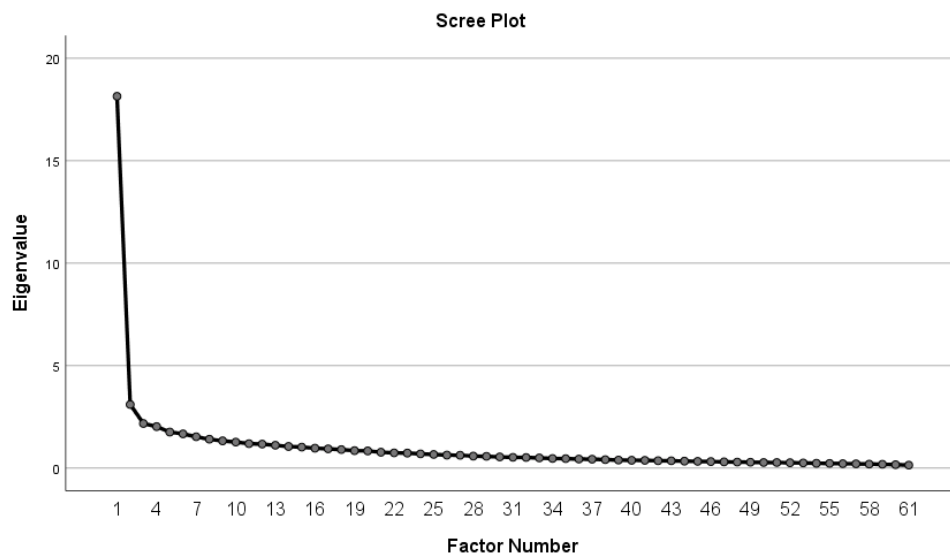


Figure 14: Scree Plot

Total Variance Explained resulted in 15 factors with Eigen Values > 1 .

Pattern Matrix

Pattern Matrix ^a															
	Factor														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MR1	.732														
RES1	.707														
MR2	.606														
RES7	.523														.382
RES2	.488														
PG10															
CL6															
PG11															
MR6		.656													
RES5		.542													
PG8		.503													
RES4		.495		.364											
RES6		.471													.350
PG9		.455													
PG7		.420													
PA3			.810												
PA4			.783												
PA2			.730				.427								
PA5			.538												
PS5			.511			.352									
PA1			.414												
CL2				.826											
CL1				.725											
CL3				.515											
RES3															
PPar5					.838										
PPar6					.814										
PPar4					.723										
PPar7					.536										
PPar3					.404										
PPar9															
PS3						.799									
PS2						.672									
PS4						.539									
PG6							.700								
PG5							.615								
PG4							.497								
CL5							.388								
PG3							.361								
PI2								.644							
PI3								.621							
PI1								.476							
PI4								.360							
PP4									.604						
PP6									.582						
PP5									.573						
PP7									.478						
PP2										.759					
PP1										.744					
PP3										.383					
MR4											.652				
MR5											.578				
MR3											.554				
PPar1												.561			
PPar2												.558			
PPar8															
PG2													.606		
PG1													.578		
PS1														.530	
PI5															
CL4															.484

Extraction Method: Principal Axis Factoring.
 Rotation Method: Promax with Kaiser Normalization.
 a. Rotation converged in 25 iterations.

Figure 15: Pattern Matrix

Table 19: EFA - Variables Eliminated after iterations

Eliminated Variables
Iteration 1
PG10
CL6
PG11
RES3
PPar9
PPar8
PI5
Iteration 2
PG3
CL4
Iteration 3
PS1
CL5

Results after variables reduction

The KMO and Bartlett's Test, Total Variance Explained and Pattern Matrix after eliminating the problematic variables are found to be suitable for performing Confirmatory Factor Analysis (CFA) as shown below.

Table 20: EFA - KMO and Bartlett's Test after variables reduction

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.908
Bartlett's Test of Sphericity	Approx. Chi-Square	9336.687
	df	1225
	Sig.	.000

Table 21: EFA - Total Variance Explained after variables reduction

Total Variance Explained							
Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings ^a
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total

1	14.561	29.122	29.122	14.113	28.226	28.226	7.153
2	2.879	5.757	34.879	2.420	4.840	33.065	8.614
3	2.023	4.045	38.925	1.589	3.178	36.243	8.813
4	1.820	3.640	42.565	1.328	2.655	38.899	5.649
5	1.658	3.316	45.881	1.212	2.424	41.323	6.083
6	1.540	3.079	48.960	1.106	2.213	43.536	8.607
7	1.435	2.870	51.830	.972	1.945	45.480	6.383
8	1.363	2.727	54.557	.917	1.835	47.315	6.770
9	1.191	2.381	56.938	.733	1.466	48.781	6.768
10	1.124	2.248	59.186	.672	1.345	50.126	2.598
11	1.111	2.222	61.408	.645	1.291	51.417	4.766
12	1.026	2.052	63.460	.579	1.158	52.575	4.244
13	1.008	2.016	65.476	.547	1.095	53.670	5.378
14	.953	1.905	67.381				
15	.920	1.840	69.222				
16	.867	1.734	70.955				
17	.790	1.580	72.535				
18	.768	1.536	74.071				
19	.727	1.454	75.525				
20	.700	1.401	76.926				
21	.654	1.309	78.235				
22	.635	1.270	79.504				
23	.627	1.254	80.758				
24	.595	1.190	81.948				
25	.580	1.159	83.108				
26	.558	1.117	84.225				
27	.524	1.048	85.273				
28	.492	.983	86.256				
29	.476	.952	87.208				
30	.453	.907	88.115				
31	.430	.861	88.976				
32	.411	.822	89.798				
33	.403	.805	90.603				
34	.394	.788	91.391				
35	.363	.726	92.117				
36	.357	.714	92.831				
37	.342	.685	93.515				
38	.327	.655	94.170				
39	.304	.608	94.778				
40	.298	.596	95.374				

Pattern Matrix^a

	Factor												
	1	2	3	4	5	6	7	8	9	10	11	12	13
MR6	.581												
PG8	.553												
PG9	.526												
RES6	.523	.433											
RES5	.508												
RES4	.456												
PG7	.433												
MR1		.669											
MR2		.578											
RES7		.578											
RES1		.576											
RES2		.449											
PA3			.809										
PA4			.758										
PA2			.685										
PA5			.531										
PS5			.450	.388									
PA1			.364										
PS3				.850									
PS2				.645									
PS4				.544									
PI2					.752								
PI3					.648								
PI4					.498								
PI1					.422								
PPar5						.788							
PPar6						.679							
PPar4						.678							
PPar3						.394							
PPar7						.382							
CL2							.816						
CL1							.730						
CL3							.437						
PP4								.683					
PP5								.583					
PP6								.571					
PP7								.414					
MR4									.671				
MR5									.638				
MR3									.631				
PP2										.662			
PP1										.653			
PP3										.383			
PG6											.578		
PG5											.575		
PG4											.462		
PPar1												.602	
PPar2												.541	
PG1													.644
PG2													.551

Extraction Method: Principal Axis Factoring.

Rotation Method: Promax with Kaiser Normalization.

a. Rotation converged in 11 iterations.

Figure 16: Pattern Matrix after variables reduction

Appendix D

Confirmatory Factor Analysis Settings and Results

The CFA is performed on IBM's SPSS AMOS 26 software as explained below. The initial SEM diagram is built as shown below.

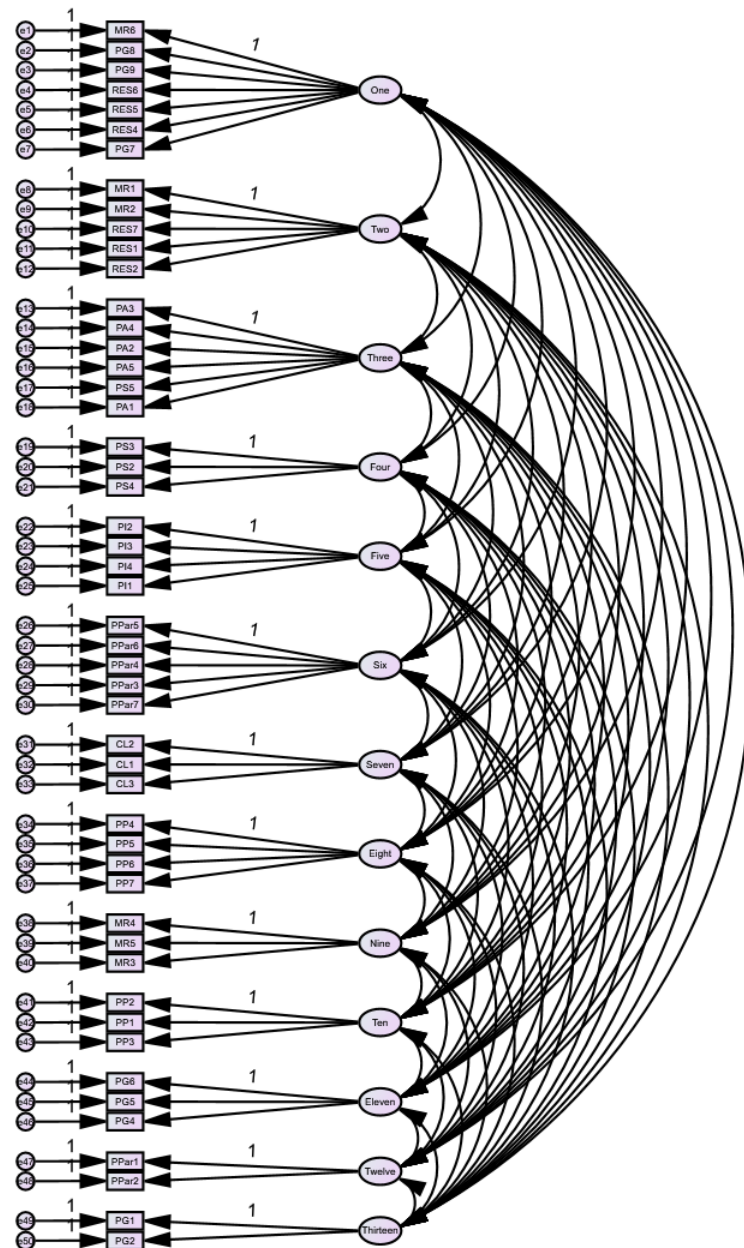


Figure 17: CFA - Initial SEM Diagram

Analysis Properties

Estimation | Numerical | Bias | Output | Bootstrap | Permutations | Random # | Title

☒ Minimization history ☐ Indirect, direct & total effects

☒ Standardized estimates ☐ Factor score weights

☐ Squared multiple correlations ☐ Covariances of estimates

☐ Sample moments ☐ Correlations of estimates

☐ Implied moments ☐ Critical ratios for differences

☐ All implied moments ☒ Tests for normality and outliers

☒ Residual moments ☐ Observed information matrix

☒ Modification indices Threshold for modification indices

☐ D-separation

Figure 18: CFA - Analysis Properties

After running the model, the following fitness indices are observed.

CMIN

Table 22: CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	178	2774.855	1097	.000	2.529
Saturated model	1275	.000	0		
Independence model	50	9778.884	1225	.000	7.983

RMR, GFI

Table 23: RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.057	.782	.746	.673
Saturated model	.000	1.000		

Model	RMR	GFI	AGFI	PGFI
Independence model	.280	.198	.165	.190

Baseline Comparisons

Table 24: Baseline Comparisons , CFI

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.716	.683	.807	.781	.804
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

RMSEA

Table 25: RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.063	.060	.066	.000
Independence model	.134	.132	.137	.000

Observation:

Table 26: CFA - Initial Observations

Fitness Indices	Recommended	Resulted
Chi-Square	>0.05	2774.855
Degree of Freedom		1097
CMIN/DF	Between 1 - 3	2.529
GFI	>=0.90	0.782
AGFI	>=0.8	0.746
CFI	>=0.90	0.804
RMSEA	<0.08	0.063

Covariances: (Group number 1 - Default model)

Table 27: Covariances of the errors within same Group

M.I.	Par Change
------	---------------

e41	<-->	e42	22.244	0.173
e32	<-->	e33	10.901	-0.088
e28	<-->	e30	16.794	-0.148
e27	<-->	e30	11.753	0.134
e14	<-->	e18	19.049	-0.145
e14	<-->	e16	17.117	0.118
e14	<-->	e15	10.312	-0.097
e13	<-->	e14	11.372	0.08
e8	<-->	e9	11.053	0.098
e2	<-->	e7	12.442	0.099

The variables eliminated for good model fit are listed below.

Variables Eliminated	PPar3, PPar6, PI1, PI3, PS4, PA1, PS5, PA2, RES2, PG7, RES5, RES6, PP5, CL1, PI4, PI2, RES1, MR2, PG9, MR6
----------------------	--

Model Fit Summary after reduction is presented below.

CMIN

CMIN value is satisfied as it lies between 1 and 3.

Table 28: CFA - CMIN after variables elimination

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	115	629.404	291	.000	2.163
Saturated model	406	.000	0		
Independence model	28	4393.579	378	.000	11.623

RMR, GFI

RMR does not have recommended value. GFI and AGFI are >0.8 satisfying the goodness-of-fit index.

Table 29: CFA - RMR, GFI, AGFI after variables elimination

Model	RMR	GFI	AGFI	PGFI
Default model	.044	.897	.856	.643
Saturated model	.000	1.000		
Independence model	.286	.295	.242	.274

Baseline Comparisons

Here, the CFI > 0.90 which satisfies the criteria.

Table 30: CFA - Baseline Comparisons, CFI after variables elimination

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.857	.814	.918	.891	.916
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

RMSEA

The RMSEA < 0.07 satisfies the statistical requirements.

Table 31: CFA - RMSEA after variables elimination

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.055	.049	.061	.087
Independence model	.166	.161	.170	.000

Regression Weights: (Group number 1 - Default model)

Table 32: Regression Weights after CFA

			Estimate	S.E.	C.R.	P	Label
MR1	<---	Two	1				
RES7	<---	Two	1.001	0.093	10.742	***	
PA3	<---	Three	1				
PA4	<---	Three	0.936	0.066	14.225	***	
PA5	<---	Three	0.883	0.079	11.176	***	
PS3	<---	Four	1				
PS2	<---	Four	0.964	0.081	11.958	***	
PPar5	<---	Six	1				
PPar4	<---	Six	1.216	0.105	11.596	***	
PPar7	<---	Six	0.877	0.1	8.763	***	
CL2	<---	Seven	1				
CL3	<---	Seven	1.129	0.096	11.803	***	
PP4	<---	Eight	1				
PP6	<---	Eight	1.245	0.132	9.451	***	
PP7	<---	Eight	1.169	0.129	9.085	***	
MR4	<---	Nine	1				
MR5	<---	Nine	1.007	0.073	13.871	***	

MR3	<---	Nine	0.933	0.071	13.092	***
PP2	<---	Ten	1			
PP1	<---	Ten	0.739	0.097	7.64	***
PP3	<---	Ten	1.574	0.186	8.47	***
PG6	<---	Eleven	1			
PG5	<---	Eleven	0.919	0.13	7.094	***
PG4	<---	Eleven	1.529	0.183	8.347	***
PPar1	<---	Twelve	1			
PPar2	<---	Twelve	1.43	0.156	9.141	***
PG1	<---	Thirteen	1			
PG2	<---	Thirteen	1.15	0.084	13.712	***

Table 33: CR and AVE Results

Constructs	CR	AVE	MSV	MaxR(H)
Two	0.642	0.473	0.648	0.644
Three	0.748	0.498	0.516	0.751
Four	0.786	0.647	0.482	0.786
Six	0.734	0.484	0.44	0.759
Seven	0.74	0.588	0.436	0.749
Eight	0.674	0.41	0.516	0.684
Nine	0.789	0.555	0.434	0.791
Ten	0.604	0.351	0.461	0.665
Eleven	0.637	0.378	0.434	0.69
Twelve	0.688	0.531	0.439	0.746
Thirteen	0.775	0.634	0.648	0.788

Table 34: Correlation Matrix after CR, AVE Test

	Two	Three	Four	Six	Seven	Eight	Nine	Ten	Eleven	Twelve	Thirteen
Two	0.688										
Three	0.538***	0.706									
Four	0.456***	0.548***	0.804								
Six	0.590***	0.663***	0.376***	0.696							
Seven	0.660***	0.576***	0.419***	0.557***	0.767						
Eight	0.595***	0.718***	0.694***	0.540***	0.494***	0.641					
Nine	0.606***	0.612***	0.340***	0.621***	0.636***	0.506***	0.745				
Ten	0.346***	0.664***	0.444***	0.587***	0.227**	0.679***	0.502***	0.592			
Eleven	0.638***	0.457***	0.377***	0.454***	0.531***	0.589***	0.659***	0.293***	0.615		
Twelve	0.585***	0.662***	0.458***	0.501***	0.522***	0.573***	0.587***	0.414***	0.519***	0.729	
Thirteen	0.805***	0.553***	0.414***	0.600***	0.567***	0.563***	0.659***	0.409***	0.553***	0.514***	0.796

Appendix E

Abstracts of proceedings

Sustainable Energy Project Management: A Review on Success Factors

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Abstract

Purpose: This paper aims to compile consideration factors for the success of Renewable Energy projects. The chances of completing a renewable energy (RE) project are still an issue. Over the past decade, researchers have sought to identify the barriers to the project and the key success factors for successful projects. But a comprehensive set of success factors is lacking.

Method: A systematic review was conducted using 92 research articles and 45 secondary reports. Literature identification, screening, eligibility and inclusion steps were followed based on Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Flow Diagram.

Findings: As a result, 61 success factors were compiled and classified into nine different categories: Project Strategy, Policies & Politics, Project Attributes, Stakeholder Interactions, Project Parameters, Culture & Leadership Resources, Managing Risks and Project Governance.

Originality: A unique scientific tool has been proposed to calculate project success probability. Each success factor score is based on a Likert scale of 1-5 to calculate weighted average value of each category leading to the success probability. This tool will be beneficial for project management practitioners, project sponsors, government agencies, policy makers and researchers.

Limitation/Implications: The comprehensive set of project success factors is considered for RE projects only. However, a similar approach can be applied to other projects to ensure higher success. It has been recommended that the project team assess each factor score frequently and make every effort to raise each category score to 5 as much as is realistically possible.

Key Words: Renewable and Sustainable Energy, Project Success Factors, Project Management, Systematic Review, Sustainable Development Goal.

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A Review of Contract Types for Sustainable Energy Projects

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Abstract

With reduction in conventional sources of energy like coal and fossil fuels; and their increasing negative impact on environment due to huge amount of carbon dioxide gas emission, world is looking for other sources of energy which are clean as well as sustainable over longer period of time. Hydropower, solar, wind and biogas are some popular choices of clean sustainable sources of energy. In order to make it more attractive from commercially affordability point of view, innovative ideas are being implemented to make such energy projects more cost effective. With this comes the contractual arrangement between producer (seller) and government utility organizations (buyers) who take the energy all the way to end consumers. Qualitative methodology was adopted to review publications from Government of Nepal, Nepal Electricity Authority, World Bank, Government of India, Public Utility Regulatory Policies Act of USA, Project Management Institute of USA and other secondary sources to find and compare prevailing contract types in practice. There are mainly four types of contracts found in practice - avoided cost, fixed-price, cost-reimbursable and time, material and labor contracts. The study tries to review prevailing power purchase agreement (PPA) contracts done in countries Nepal, India and USA to find in which category of contract they belong to. Additionally, the study compares the PPA contracts practiced in those three example countries to find similarity and differences between them. It was found that there is a mix of various concepts in PPA contracts but mainly belonging to Fixed-Price Contract family. In order to understand more about decision factors and impacts of prevailing active PPAs, further way forward is suggested.

Key Words: Renewable energy, Power Purchase Agreement (PPA), Avoided Cost Contract, Fixed-Price Contract.

Determining project success factors of renewable energy initiatives using exploratory and confirmatory factor analyses: empirical evidence from Nepal

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Abstract

The international community is committed to addressing climate change and reducing global emissions. Efforts such as the sustainable development goals (SDGs) and the Paris Agreement on Climate Change demonstrate this commitment. Renewable energy initiatives are being implemented globally to achieve these goals. However, completing these projects on time and within budget is often a challenge. Inadequate planning, lack of investment, and legal and administrative obstacles are some of the main barriers. To understand the factors that contribute to the success of renewable energy projects, a research study was conducted in Nepal. The study involved surveying professionals from government organizations, private companies, researchers, and consultants in the energy sector. The survey used a Likert scale (1-5) and the data was analyzed using factor analysis and structural equation modeling. This analysis helped develop the Project Success Model (PSM) Framework, which provides insights into project success probability (PSP) and areas for improvement. The results showed that the current success probability of renewable energy projects in Nepal is 63%, indicating room for improvement. By addressing issues such as inconsistent policies, corruption, and legal frameworks, the success probability can be significantly increased. This research study contributes to global knowledge on project management by providing a unique approach to predicting project success.

Keywords: Renewable Energy, Project Success, Factor Analysis

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Publications

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