"SUCCESS OR FAILURE ANALYSIS OF HYDROPOWER PROJECTS"

A Thesis

Submitted in partial fulfillment of the requirements for the award of the degree of

MASTER OF TECHNOLOGY

IN

CIVIL ENGINEERING

With specialization in

CONSTRUCTION MANAGEMENT

Under the supervision of

Mr. Santu Kar
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By

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to

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

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CERTIFICATE

This is to certify that the work which is being presented in the thesis title **"SUCCESS OR FAILURE ANALYSIS OF HYDROPOWER PROJECTS"** in partial fulfilment of the requirements for the award of the degree of Master of Technology in Civil Engineering with specialization in "**Construction Management"** and submitted to the Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by Bebhuti (142608) during a period from July 2015 to June 2016 under the supervision of **Mr. Santu Kar,** Assistant Professor, Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of our knowledge.

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Date: …….. Bebhuti

ABSTRACT

The construction projects are dynamic in nature. Project success means different things to different people. Some authors consider time, cost and quality as the main parameters or criteria while some suggests that success is something more complex and they suggest a number of performance measuring parameters or criteria apart from time, cost and quality to call a project successful such as satisfaction of project participants, technical performance of the project number of disputes at the completion of project. The study of success factors are considered to be a means to improve the effectiveness of project. The aim of this project is to identify and analyze those factors which are responsible for success of hydroelectric project. Questionnaire survey has been carried out among twenty respondents representing a mixture of professionals including, construction manager, and engineer and project manager. This study has chosen sixty three factors categorized in thirteen major groups that that the respondents were asked to give the rating. According to RII (Relative Importance Index) method is used to identify the success factors of hydropower project. According to the RII ranking the top five actors were found to be: project manager's experience, contractor experience, leadership skills of project manager, Supervision and site management and design team experience and site location & shortage in material. This paper helps to set a benchmark and provide significant insights into developing a general and comprehensive base for further research.

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ABBREVIATIONS

AHP	Analytical hierarchy process
CSFs	Critical success factors
E&C	Engineering and construction
OSHA	Occupational safety and health administration
IT	Information technology
WWW	World Wide Web
D&B	Design and Build
ANOVA	Analysis of Variance
SEM	Structural Equation Modelling
CCPM	Critical Chain Project Management
AI	Artificial Intelligence
SIPE	System for Interactive Planning & Execution
RII	Relative Importance Index
ASCE	American Society of Civil Engineers
KPI	Key Performance Indicator
IJES	International Journal of Engineering and Science
NHPC	National Hydropower Corporation

CHAPTER-1

INTRODUCTION

1.1 General

Construction projects are dynamic in nature due to uncertainties in budgets, technology and development processes. Major goals in construction industry are budget, schedule and quality. Failure or success of the achievement of these objectives depends upon variety of factors. The concept of project success is a means to improve the effectiveness of the project. There is ambiguity about the concept of project success in the minds of construction professionals. Project success can be defined as meeting the required expectation of stakeholders and achieving its purpose. A successful project is one that is delivered on the time and managed with budget, time, cost and quality. Those measures which results in the organization success are called critical success factors. Therefore the main purpose of this research paper is to recognize the factors which are responsible for the success of the hydropower projects.

1.2 Need of study

Although a lot of researchers have explored this concept, no general agreement is achieved. Success of project means different things to different people. Therefore a systematic approach is needed for measurement of success ofa hydropower project. So this paper will help in finding out the critical success factors which are responsible for success of hydropower projects.

1.3 Objective

The main objectives of this project are:-

1. To investigate different factors affecting success or failure of a hydropower project.
2. To analyze them for identification of critical factors.

1.4 Scope of the project

Identifying and analyzing of different factors affecting success or failure of a Hydropower project in Indian scenario.

1.5 Research methodology

The research methodology is schematically presented in figure 1.1. In the study, a discussion is made on the topic and research starts with literature review in order to provide the theoretical context about the project. The collection of data is based on the questionnaire survey of twenty respondents, representing a mixture of professionals, including engineer, project manager and construction manager in hydropower projects. The results from questionnaire survey are presented to show the success factors. The various success or failure factors are identified and analyzed by ranking. The ranking of factors are based on the RII (Relative Importance Index) values.

In case study part, the results from the questionnaire survey are analyzed by ranking and compared to the theoretical framework. Finally the final recommendations are drawn up in the conclusion section.

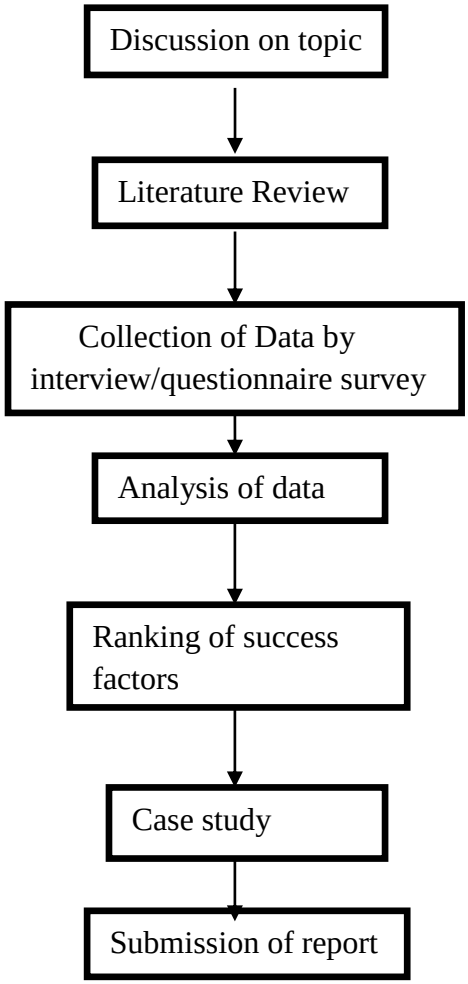

FIG. 1.1 Research methodologies

CHAPTER-2

LITERATURE REVIEW

2.1 General

The literature on success factors reveal several definitions of "Project Success" results much better than expected or normally observed in terms of cost, schedule, quality, safety and participant satisfaction (Ashley, 1947). Having everything turn out as hoped…anticipating all project requirements and have sufficient resources to meet needs in a timely manner (Tuman, 1986). The project is considered as overall success if the project meets the technical performance specifications and/or mission to be performed, and if there is a high level of satisfaction concerning the project outcome among: key people in the parent organization, key people in the project team, and key users or clientele of the project efforts (de Wit, 1986).

The factors which determine the success of construction project are time, safety, participant's satisfaction, user expectation, environmental performance, quality, cost etc.This concept of project success has remained ambiguously in the minds of construction professionals. The selection of literature is based mainly on the following sources:-

- ASCE Journals of Construction Engineering and Management.
- ASCE Journals of Management in Engineering(US)
- International Journals of Project Management(UK)

2.2 Summary of Literature

The literature on success factors reveal several definitions of "Project Success" results much better than expected or normally observed in terms of cost, schedule, quality, safety and participant satisfaction (Ashley, 1947). Having everything turn out as hoped…anticipating all project requirements and have sufficient resources to meet needs in a timely manner (Tuman, 1986). The project is considered as overall success if the project meets the technical performance specifications and/or mission to be performed, and if there is a high level of satisfaction concerning the project outcome among: key people in the parent organization, key people in the project team, and key users or clientele of the project efforts (de Wit, 1986). Some of the previous work done by various authors in the field of success of construction projects:-

[1]Refer to the paper by Nabil A. Kartam and Raymond E. Levitt on "Intelligent Planning of Construction Projects" published in the Journal of Computing in Civil Engineering, 1990 which conclude experience modeling of a multistory office building project for construction planning. This paper demonstrates the utility of AI (Artificial Intelligence) techniques for generating construction project plans by presenting experience implementing SIPE (System for interactive planning and execution) to plan a multistory office building project. The research was conducted using SIPE, which is a domain-independent planner with some distinctive features (Wilkins 1988).

In general, contribution activities results in the accumulation of project components e.g. removing formwork after pouring concrete, removing scaffolding etc. This generally additive nature of construction planning easily handled by an AI planner since it is natural to represent operators in this formation. SIPE was regarded as the most advanced domain- independent AI planner built on the basis of knowledge. The construction of a five-story or a ten-story building could be planned with the same operator information. Much of the information can be reused from project to project. This demonstrates the power of using a small numbers of generic operators in conjunction with constraints and the project specific component data stored in frame hierarchies.

[2]Refer to the paper by Victor Sanvido, François Grobler, Kelvin parfitt, MorisGuvenis, and Michaela Coyle on "Critical Success Factors for Construction Projects" published in the Journal of Construction Engineering and Management, 1992 which conclude a set of conditions or factors that, when thoroughly and completely satisfied on a project, ensures the successful completion of facility. Success on a project means that certain expectations for a given participant were met, whether owner, planner, engineer, contractor, or operator. These expectations may be different for different people. Finally, the four factors most critical to success are presented.

Certain factors which are more critical than others are called critical success factors (CSF). The term "critical success factors", in the context of projects and the management of projects, was first used by Rockart (1982). The objective of this research is to define the critical factors that lead to project success and provide a forecasting tool. The definition of success is results much better than expected or normally observed in terms of cost, schedule, quality, safety and participant satisfaction (Ashley, 1987). The project is considered an overall success if the project meets the technical performance specifications. According to Morris (1983) "any

study of success and failure in projects must before long decide what is meant by success: for whom? Using what criteria? And over what time period?" Success criteria or a person's definition of success as it relates to a building often changes from project to project depending on participants, scope of services, project size and a variety of other factors.

The results of research indicated that there were seven success factors. Of these seven, four were found to be critical:

1. A well-organized cohesive facility team to manager plan, design, contract and operate facility.
2. A series of contracts that allows and encourages the various specialists.
3. Experience in the management, planning, design and construction.
4. Timely, valuable optimization, user, design etc.

[3]Refer to the paper by Walid Belassi and OyaIcmeli Tukel on "A New Framework for Determining Critical Success/Failure Factors in Project" published in the International Journal of Project Management, 1996 Elsevier Science Ltd and IPMA which conclude a new scheme that classifies the critical factors, and describes the impacts of these factors on project performance. Emphasis is given to the grouping of success factors and explaining the interaction between them, rather than the identification of individual factors. An empirical study is conducted to test the practicality of using such a scheme. The statistical analysis of results demonstrate the differences between the critical success factors identified in a previous study from literature and factors identified with the use of scheme. Many critical factors, such as factor related to project managers, performance, factors related to team members and environmental factors, became apparent with this study.

There are many factors outside the control of management which could determine the success or failure of a project. These factors are referred as critical success or failure factors. Most of the studies in the area focused on the reason for project failure rather than project success. In their book, Morris and Hough studied eight large, complex projects which had great potential economic impact but poorly managed and generally failed. The framework suggested here not only brings advantage by grouping critical factors, but also helps project managers understand the intra-relationships between the factors in different groups. The framework has divided the factors into four areas as:

1. Factors related to the project.

2. Factors related to the project manager.
3. Factors related to the organization.
4. Factors related to the external environment.

[4]Refer to the paper by D.K.H. Chua, Y.C. Kog, and P.K. Lohon "Critical Success Factors for Different Project Objectives" published in the Journal of Construction Engineering and Management, 1999 which adopted the AHP approach to identify CSFs for construction projects. A hierarchical model for construction project success is presented. Sixty seven success related factors are considered. These factors are grouped under four main project aspects, namely, project characteristics, contractual arrangements, project participants, and interactive processes in the model for project success. Results of study revealed that experts do agree that there are different sets of CSFs for different project objectives. The major goals in a construction projects are budget, schedule and quality, although there are other more specific objectives, such as safety consideration and market entry. A variety of factors determine the success or failure of projects in terms of these objectives.

Some researchers have been conducted to identify CSFs for the project success using quantitative measures of various factors (Jaselskis and Ashley 1991). CSFs can also be identified based on expert opinions. The impact of experience possessed by project key personnel toward project outcomes has been widely recognized (Jaselskin and Ashley 1991). By using AHP approach, the contribution of the factors towards the main three objectives of budget, schedule and quality can be determined and separate lists of CSFs can be identified. The AHPs systematic approach as soliciting an expert's judgment and a consistency check have also made it a reliable way to determine the priorities to a set of factors which may then be incorporated into other evaluation system. The CSFs identified in this study were found to be consistent with those determine the priorities to a set o factors which may then be incorporated into other evaluation system. The CSFs identified in this study uses found to be consistent with those determined in previous study using a neural network with quantitative data. Top five critical success factors are:

1. Adequacy of plans and specification.
2. Constructability
3. Economic risk
4. Adequacy of funding
5. Budget update

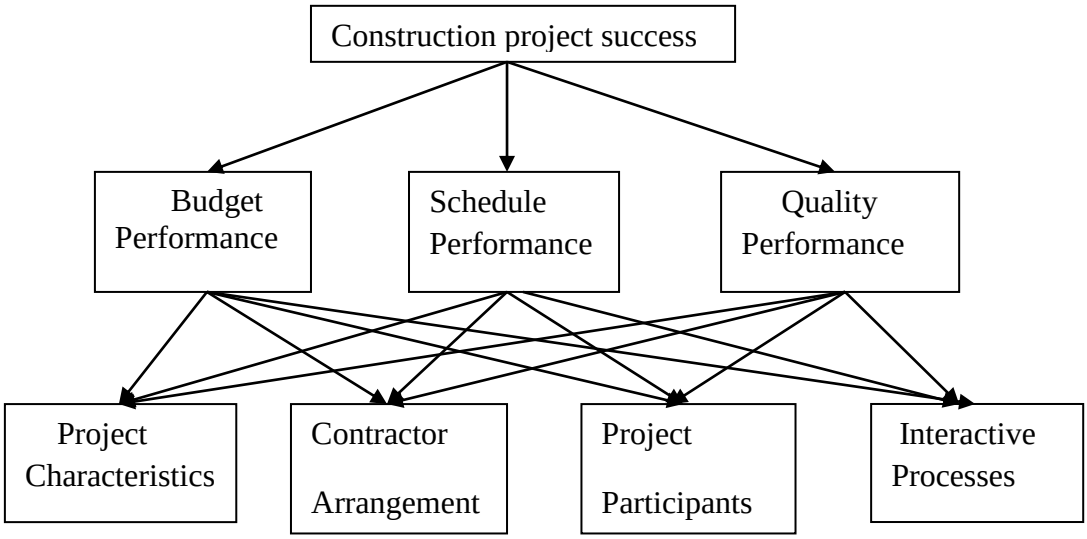

FIG. 2.1 Hierarchical Model for Construction Project Success[4]

[5]Refer to the paper by Janet K Yates and Edward E. Lockley on "Documenting and Analyzing Construction Failures" published in the journal of Construction Engineering & Management, February 1, 2002 which provides the information about the construction failures and investigation techniques. Data was collected on failures and failure investigation techniques from surveying 115 members of the engineering and construction industry. Construction failure case studies were created using documentation provided by the federal Occupational Safety and Health Administration, state offices of safety and health, and forensic engineers. It gives an idea of results and discusses the techniques of investigation. This paper provides the background influence on construction failures and investigation techniques. It describes the results obtained from a survey of 115 engineering and construction (E&C) industry professionals. It provides an analysis of the results and discusses E&C industry and discusses a new procedure for investigating, documenting and reporting construction failures.

Bell (1985) discussed the type and levels of failure information that are required and how the data should be disseminated. Bell divides failures into two major categories-technical and procedural. Thornton (1985) claims that failures can be classified into three categories-safeties, functional and ancillary and causes of failures fall into five general areas: design deficiencies, construction deficiencies, material deficiencies, administrative deficiencies and maintenance deficiencies. Dov Kaminetzky defines failure as a …a human act; omission of occurrence or performance; lack of success; non-performance; insufficiency; loss of strength; and cessation of proper functioning or performance (Kaminetzky, 1991). This study did not

focus on the cause of construction failures or on the methods for preventing failures. The research was conducted to determine:

- The most frequent causes of failures in construction.
- What can be done to improve the methods of investigating and documenting failures?
- What can be learned from a study of failure investigations conducted by OSHA (Occupational Safety and Health Administration).

This paper provides:

1. Description of the methods for the research.
2. Results obtained from the industry survey.
3. Summary of the results of an investigation into case studies on construction failures.
4. Analysis of results.
5. Discussion on construction failure.
6. Guidelines developed during the research project.
7. Recommended format for reporting the findings of failure investigation.

[6]Refer to the paper by Albert P.C. Chan; David Scott; and Ada P.L. Chan on "Factors Affecting the Success of a Construction Project" published in the Journal of Construction Engineering and Management, ASCE, 2004 which conclude a new framework that includes and regroups the identified variables affecting project success. This paper focuses on the CSFs and not on the measurement of project success, i.e. the key performance indicators (KPIs). Further study should be directed to identify the KPIs, so that the casual relationship between CSFs and KPIs can be a useful piece of information to implement a project team members, identifying the development needs of the project team members, and most important for forecasting the performance level of a construction project before it commences. Now days, building projects are becoming much more complex and difficult. The project team is facing various changes. The study of the project success and the critical success factors are considered to be a means to improve the effectiveness of project.

The main aim of this paper is to conduct a thorough review on literature related to CSFs in seven major management journals. The term CSFs in the context of the management o projects was first used by Rockart in 1982 and is defined as those factors predicting success on projects (Sanvido et al. 1992). This paper can help in selecting project team members, identifying the development needs of the project team members, and most important for

forecasting the performance level of a construction project before commences. A careful study of previous literature suggests that CSFs can be grouped under five main categories:

1. Human related factors
2. Project related factors
3. Project procedures
4. Project management actions
5. External environment

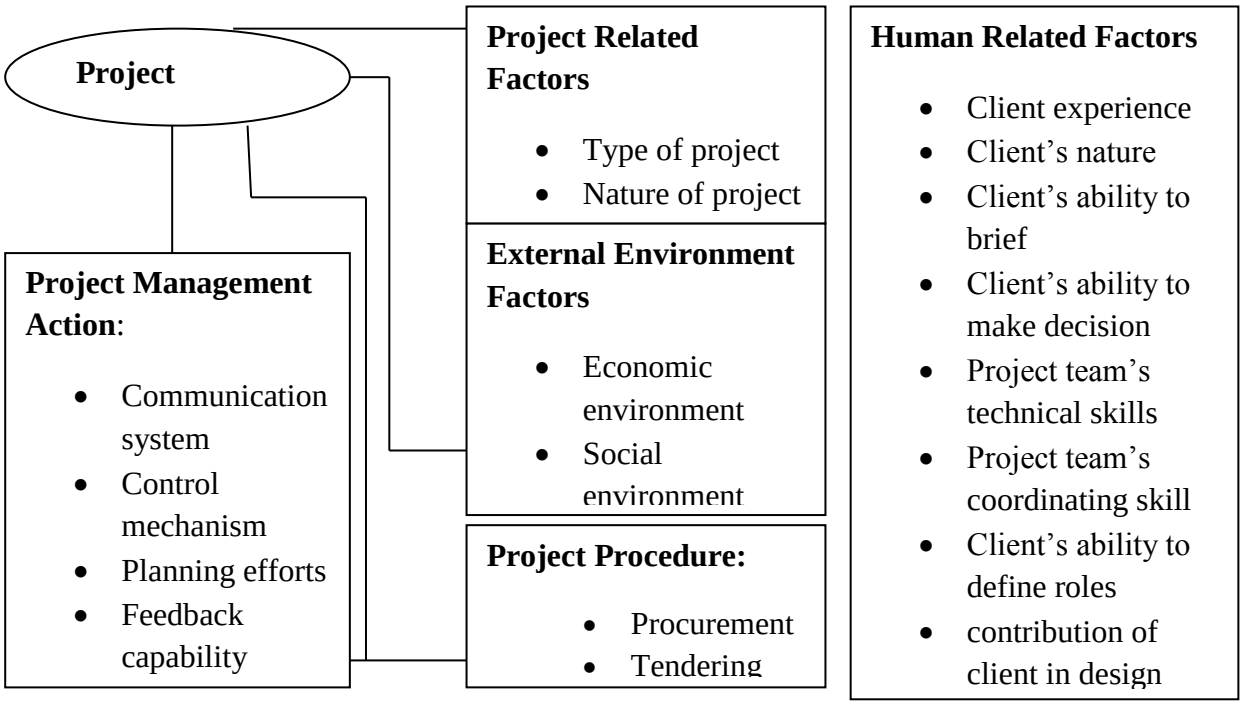

FIG. 2.2 A New Conceptual Framework for Factors Affecting Project Success[6]

[7]Refer to the paper by Pottaphat Nitithamyong and Miroslaw J. Skibniewski on "Web-based Construction Project Management System: How to Make Them Successful" published in the School of Civil Engineering, 2004 Elsevier which determines the success or failures of web-based construction project management system, by the use of application service. Information technology (IT) is now routinely used in the construction industry as a tool to reduce some of the problems generated by fragmentation. Among all IT application the internet is the technology that best facilitate a collaborative working environment in a construction project. Walker and Bell postulated that the internet and more specially the World Wide Web (WWW) will be the key to a change in global construction business in the near future and will impact professions, collaboration and the construction business structure.

[8]Refer to the paper by K.C. Iyer& K.N. Jhaon "Critical Factors Affecting Schedule Performance: Evidence from Indian Construction Projects" published in the Journal of Construction Engineering and Management, 2006 which identifies 55 attributes responsible for impacting the performance of projects. Statistical analysis of responses on the attributes segregated them into distinct set of success attributes and failure attributes. The analysis results are expected to help project professionals to focus on a few factors and get the optimum results rather than giving attention all the factors. When schedule compliance is the prime objective, seven factors are observed which have influence on the schedule outcome. One o the most researched topics in the project management is the concept of project success factors and the criteria to measure the project success (Ashley et al. 1987). In the present study the success of a project is measured in terms of its performance on schedule, cost, quality and non-dispute. Hence the discussion on this paper is limited to schedule performance of the projects. There are many attributes that affect the schedule performance either positively or negatively.

Rowlinson (1999) states that critical success factors are those fundamental issues inherent in the project which must be maintained in order for team working to take place in an efficient and effective manner. Chau et al. (1999) applied a neural network approach and identified eight important project management attributes associated with achieving successful budget performance. Chan et al. (2001b) investigated the project success factors and identified six project success factors. These are project team commitment, client competencies, contractor's competencies, risk and liability assessment, end-users needs and constraints imposed by end-user.

These seven factors are:-

1. Commitment of the project participants
2. Owner's competence
3. Conflict among project participants
4. Co-ordination among project participants
5. Project manager ignorance and lack of knowledge
6. Hostile socionomical environment
7. Indecisiveness of project participants

[9]Refer to the paper by RoshanaTakim, Shah Alam and Hamimah Adnan on "Analysis of Effectiveness Measures of construction, Project success in Malaysia" published in the Asian

Social Science, 2008 which provides an empirical analysis of measure of success in terms of effectiveness performance in the development of construction projects in Malaysia. The finding shows that effectiveness measures are related to the project results achieved in the development of construction projects. First finding revealed that the level of the success criticality with regards to the project efficiency performance in the development of construction projects in Malaysia is according to the specific requirements. The second finding shows that effectiveness measures are related to the project 'results' achieved in the development of construction project. The data were analyzed by means of statically analysis i.e. ranking of variables based on the mean values, ANOVA (Analysis of Variance) and factor analysis techniques. A synonym for success according to Baccarini (1999) is effectiveness i.e. the degree of achievement of objectives. More specially, the concept of success in a construction project according to some researchers is corresponding to the efficiency and effectiveness measures (Brudney and England, 1982).

Maloney (1990) also asserts that the efficiency of construction projects involves the utilization of resources, which may be represented by the ratio of the resources expected to be consumed divided by the utilization of resources. According to Crawford and Bryce (2003) an evaluation of project success is from the efficiency and effectiveness dimensions. Project efficiency is concerned with cost and process management and a wise use of human, financial natural capital. Whilst, project effectiveness is concerned with the development of worthiness or appropriateness o the chosen project goal. Effectiveness measures of project success are:

1. Client and user satisfaction.
2. Level of effectiveness.
3. Project functionality and 'Fitness for purpose'.
4. Free from defects.
5. Value for money.
6. Profitability
7. Absence of any legal claims and proceedings.
8. Learning and exploitation.
9. Generate positive reputation.

[10]Refer to the paper by Syed Zafar Shahid Tabish and Kumar Neeraj Jha on "Success Traits for a Construction Project" published in the Journal of Construction Engineering and Management, ASCE, 2012 which hypothesized that project success is influenced by success

traits. This study finds that human factor play a decisive role in making a project successful. The structural equation modeling technique has been used to test the hypothesized positive interrelationships between success traits and project success. The approach used in this study could be a good addition in the field of construction management. The impact of success traits on project success has been investigated in this study. The study in this research may help managers to identify the variables that may lead to the successful completion of project. It can be concluded that human factors and management factors play a key role in making the project success. The completion of project requires input from a variety of groups, including the client, the project team, the parent organization, the producer and the end user. Jha and Iyer identified 11 project success factors on the basis of a review of the literature and a limited numbers of interviews with construction professionals during the pilot study. In this study, it was hypothesized that project success traits. A success trait was defined as a second order construct composed of two latent constructs, including the human and management actions.

The paper utilizes the structural equation modeling technique to test the hypothesized positive inter relationship between success traits and project success. The hypothesis was tested using structural equation modeling (SEM), a statically tool. The term "critical success factors" has been initially used in the content of information system and project management by Rockart (1982). Rowlinson (1999) concludes that the CSFs are the fundamental issues that are inherent in the project and they must be maintained in an efficient and effective manner. This research paper may help managers to identify the variables that may lead to successful completion of projects. It can be concluded that human factors and management actions play a key role in making the project a success, as such by the direct link between human factors and management actions. Chan et al. (2004) developed a conceptual framework on CSFs and grouped CSFs under five main categories:

1. Human related factors
2. Project related factors
3. Project procedures related factors
4. Project management actions
5. External environment

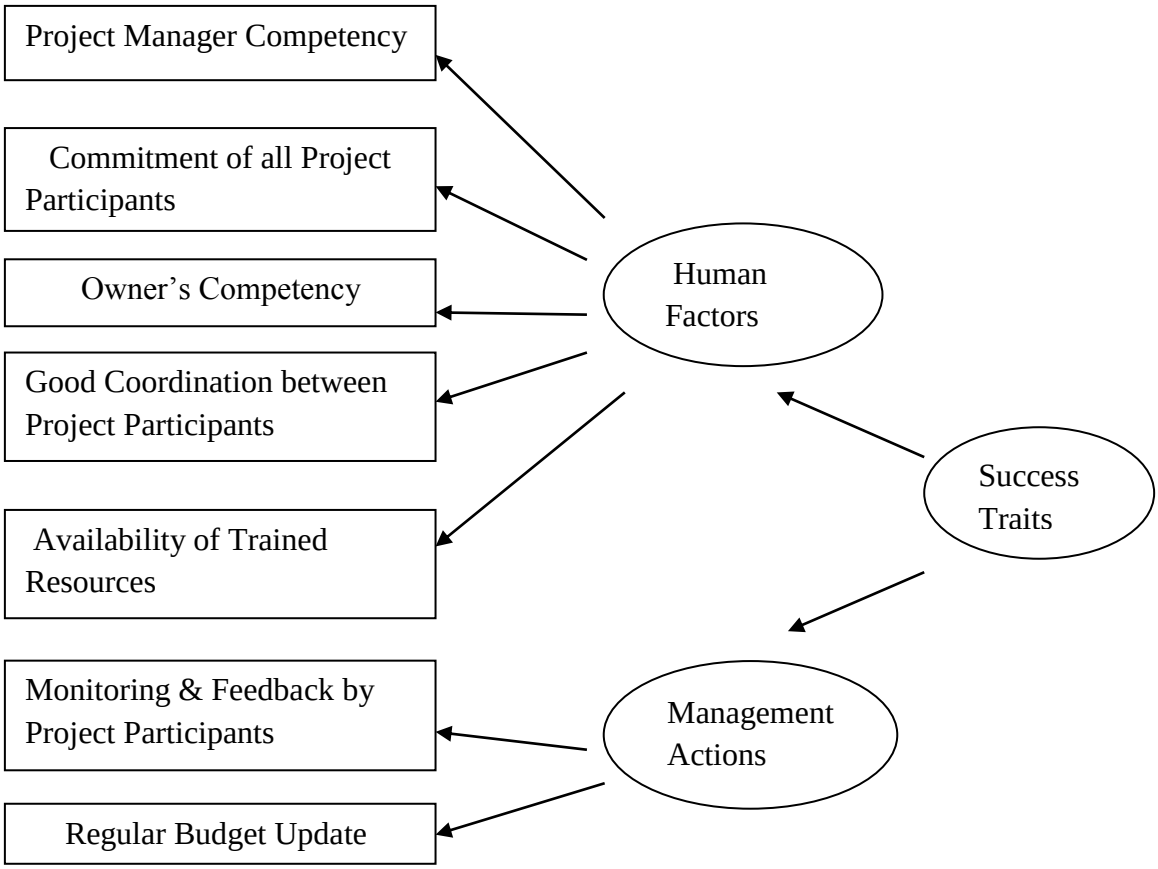

FIG. 2.3 Hypothesized Model of Success Traits[10]

[11]Refer to the paper by Abdelnaser Omran, Mohammed Alnor Abdulbagei and Abdelwahab O. Gebril on "An Evolution of the Critical Success Factors for Construction Projects in Libya" published in the Journal of Economic Behavior, 2012 which conclude the evaluation of critical success factors which are most important in the phases of construction projects. A quantitative approach was selected. This paper identifies ten critical success factors that are important and will impact positively on construction projects if they are focused on by all the stakeholders and it can be concluded that the critical success factors found to be most influential and could be utilized in future work which examine the different situations and environments. This study has also recommended that the methodology used in this paper can also be applied to the other areas or cities in Libya so that more influential factors can be discovered which will improve the industry development. Research on the critical success factors (CSFs) are considered to be a means to improve the effectiveness of project and to achieve project objectives. Critical success factors are identified in such areas as production processes, employee and organization skills, functions, techniques and technologies.

Jaselskis and Ashley (1991) indicated that the applications of management tools would enable the project managers to plan and execute their construction projects to maximize the project's chance of success. According to Chan (2004), these factors and their participation commence from inception till completion of the construction. Pheng and Chaun (2006) categorized working environment related critical success factors in five categories:

1. Personal variables related factors.
2. Job condition related factors.
3. Project characteristics related factors.
4. Environmental related factors.
5. Organizational related factors.

The top ten ranked factors in this paper are:

1. Factors related to project management.
2. Factors related to procurement.
3. Factors related to client.
4. Factors related to contractor.
5. Factors related to design team.
6. Factors related to project manager.
7. Factors related to work environment.
8. Factors related to material.
9. Factors related to labor and productivity.
10. Factors related to externals factors.

[12]Refer to the paper by Yue Choong Kog and Ping Kit Lohon "Critical Success Factors for Different Components of Construction Projects" published in the Journal of Construction Engineering and Management, 2012 which reveals that the respective top 10 CSFs for the schedule, budget and quality performance of architectural works, civil and structural works and mechanical and electrical engineering works are markedly different. This paper shows that adequacy of plans and specifications and project manager competency are two of the success- related factors. This study also reveals that for architectural works, the human factors, particularly the quality of the consultant and contractor, are crucial to achieving project success. Baker et al. (1983) conducted a survey of successful and unsuccessful projects involving manufacturing, construction, government, services, transportation and other projects and concluded that these are seven critical factors for project success. Pinto and

Cavin (1989) investigated the differences in the opinion of project managers about factors critical to the implementation of R&D and construction projects. Holt (1989) conducted a case study of a highly successful construction project to demonstrate how many of the management principles promoted by Peters & Waterman (1982) and Goldsmith & Clutterbuck (1984) are applicable.

Alarcon & Ashley (1996) proposed a methodology for project performance. Chau et al. (1997) and Kog et al. (1999) used a neural network approach to identify CSFs using data of 75 construction projects. Iyer and Jha (2005) conducted a study to identify the CSFs affecting cost performance of Indian construction projects. They reported coordination among project participant as the most significant CSFs for cost performance. The full details of methodology of study were reported in Chau et al. (1999). A brief summary of the methodology is as follows. In this study, a hierarchical model for construction project success with respect to the different components of work is presented.

[13]Refer to the paper by Afshin Pakseresht and Dr. Gholamreza Asgarion"Determining the Critical Success Factors in Construction Projects: AHP Approach" published in the Interdisciplinary Journal of Business, 2012 which identifying and ranking the critical success factors in construction projects of Pars Garma Company. The research findings indicate that the critical success factors in construction projects have different properties and weights. Also, considering the importance, the critical success factors are respectively: Technical and Economical assessment of project required resources, experience and executive record of project manager, project strategic planning and executive experiences of contractor team about the project subject. Those measures which results in the organization success are called the critical success factors. So, by identified and ranking the critical success factors, this research purpose to give a solution for the executive planning of the project of Pars Garma construction and industrial company. The critical success factors are indicative of the subjects which could make the organization successful.

The main purpose of this research is recognizing the effective factors in the success of Pars Garma Company and also weighing the CSFs of construction projects. Ronald Daniel was among the first expert who offered the CSFs as the business guidance for the first time in 1961. In 1986 Ashley identified these seven factors as success factors:

1. Construction activities programming
2. Design planning

3. Project manager commitment to the goals
4. Project team motivation
5. Project manager technical capabilities
6. Control systems
7. Definition of work and its fields

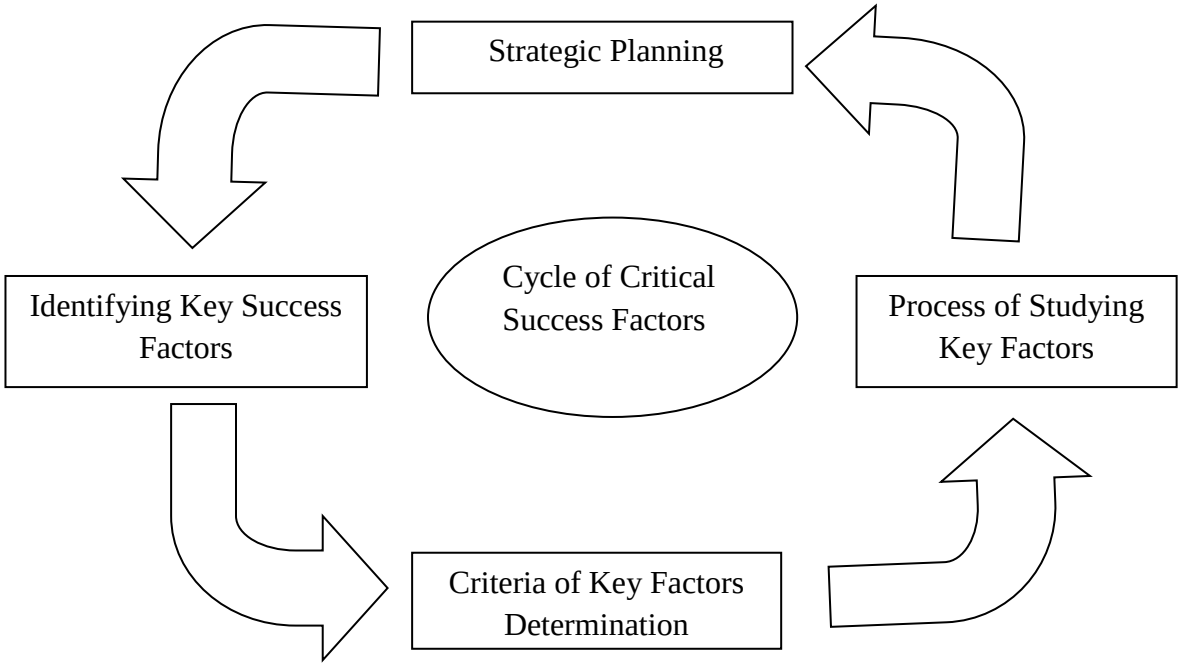

FIG. 2.4 Cycle of Critical Success Factors[13]

In 1996 Walid Bclassi and Tukel Oya Icmeli also divided the critical success factors into four main groups in a new format:

1. Project dependent factors
2. Team members and project manager dependent factors
3. Organizational structure dependent factors
4. External environment dependent factors

[14]Refer to the paper by Arti J Jari, Pankaj and P. Bhangale on"To Study Critical Factors Necessary for a Successful Construction Project" published in the International Journal of Innovative Technology and Exploring Engineering (IJITEE), 2013 which define success criteria, clarify their difference with success factor and analyze their importance in project management methodology. This study provides a forecasting tool to enable parties to rapidly assess the possibility of a successful project from their point of view. The main aim of this paper is to systematically investigate the cause of project failure and how these can be prevented, managed and controlled. Project management is a task derived from an

organization that enables professional project managers to use their skills. Project success can be defined as meeting the required expectation of the stakeholders and achieving its intended purpose. Success criteria or a person's definition of success as it relates to a building often changes from project to project depending on participants, scope of services, Project size and a variety of factors.

Certain factors are more critical to a project's success than others. These factors are called critical project success factors. Various project success factors have been identified by different researchers in different projects around the world. Success has been the ultimate goal of every business activity. It is highly important for the organizations to be successful in their businesses in order to survive in competitive business environments such as construction. For a project to be successful, it is essential to understand the project requirements right from the start and go for project planning which provides the right direction to project managers or their teams and execute the project accordingly. This paper shows that critical success factors perceived as most influential in avoiding or preventing the delay factors. It will also helpful to identify that which factors from followings affect the project success.

1. Factor related to project manager's performance
2. Factor related to organization
3. Factor related to project
4. Factor related to external environment

[15]Refer to the paper by Tan Phat Nguyen and Nicholas Chileshe on "Revisiting the Critical Factors Causing Failure of Construction Projects in Vietnam" published in the Association of Researchers in Construction Management, 2013, U.K which provides an overview of the construction professionals in Vietnam on the critical factors causing failure of construction projects. A triangulated data collection approach was administered to construction stakeholders to elicit their perceptions on the factors causing the failure of construction project. Generally, the major or critical factors were associated with knowledge and technical issues. According to Uygen (2003), the construction industry has been one of the main sectors contributing to the growth of the Vietnam economy in recent years. The Vietnam's construction industry has been confronted by many complicated issues in management. Number of studies has argued that the adoption of risk assessment and management practices are closely aligned with overall project performance.

Nguyen et al. (2004) states that construction projects are often confronted with many complexities which involve a range of uncertainties including deadline. Nguyen et al. (2007) also refers to the ineffectiveness of the Vietnamese construction projects as a result of poor management and inefficient risk management application, with many projects failing to meet the deadline. This study aims to seek the perceptions of construction professionals by revisiting some of these critical factors causing the failure of projects in Vietnam. This paper will give an overview and status of construction project management in Vietnam. It also outlines significant issues that allow justification for revisiting critical and discuss methodological approach and findings. The ten most critical factors causing the failure of construction projects were as follows:

1. Disregard of the significance of project planning process and poor planning process.
2. Lack of experience in executing complicated projects.
3. Poor design capacity and frequent design changes.
4. Lack of knowledge and ability in managing construction projects.
5. Lack of financial capacity of owner.
6. Poor performance of contractors.
7. Lack of a systematic approach for managing the project.
8. Corruption and bribery in construction projects.
9. The delay in projects.
10. Economical volatility and high inflation.

[16]Refer to the paper by Abhijeet Gadekar and Dr. S.S. Pimplikar on "Success and Failure Factors of Indian Construction Companies" published in The International Journal of Engineering and Science (IJES), 2014 which presented the survey carried out among Indian construction companies. The critical factors leading to construction company success have been investigated through interviews among top-level managers and owners of the companies. According to the results cash flow management characteristics with rating 9.1 was identified as the most important main factors to success among large size firms. The findings in the study should be interpreted with caution since the research was limited with only 30 firms.

The Indian construction industry has been a vital contributor to the Indian economy. It plays an important role in building up the Indian national economy in terms of absorption high number of labors and affecting various economic, social, educational sectors. The aim of this paper is to explore the cause of contractor business success and failure and to investigate the

impact level of these causes from contractor's viewpoint. In this project a survey was carried out among 30 Indian constructions companies which are located in Aurangabad district of Maharashtra region of India. The companies were divided into three categories-large, medium and small size firms. The ranking of the CSFs has been determined by using the point rating technique. So the top ten factors are:

1. Cash flow management
2. Poor accounting system
3. Industry weakness
4. Insufficient capital
5. Estimating practices
6. Fluctuation in material cost
7. Use of documentation system
8. Over expansion
9. High employee turn over
10. Heavy operating expenses

[17]Refer to the paper by Dubem I. Ikediashi, Stephen O. Ogunlana and Abdulaziz Alotaibi on "Analysis of Project Failure Factors for Infrastructure Projects in Saudi Arabia: A Multivariate Approach" publishing in the Journals of Construction in Developing Countries, 2014 which provide a framework for identify and classify the cause of project failure in Saudi construction industry. This paper reveal that poor management was the main factor for failure of infrastructure projects, while budget overruns and poor communication by management followed closely at second and third, respectively. A quantitative questionnaire survey was used to solicit responses from 67 respondents in the city of Jeddah. Findings reveals that poor risk management was rated the most critical failure factors for infrastructure project. The contribution of Saudi Arabian construction industry to the growth of the Saudi economy has been unprecedented over the past three decades. Various studies have largely identified several factors that may be associated with project success. This study attempts to fill gap by developing a framework for identifying and classifying the causes of project failures in Saudi Arabia.

According to Al-Seldiry (2001) as the emphasis by government shifted from complex construction project to more basic building projects, concerns about technical expertise and joint venture partnerships between local and multinational companies began to come up,

putting pressure on the Saudi private sector to become more involved in construction projects. The construction boom is also boosted by the development of king Ahdulluh. Economic city, which covers approximately 180 million square meters north of Jeddah and is comprised of an industrial zone (Business week, 2007) Toor and Ogunlana (2008) examined the problems causing delays and failures in major construction projects in Thialand using a questionnaire survey and interviews. According to Ebeid (2009) a shortage of professional and adequately skilled personnel at all levels of management and field operations amongst clients, contractors and consultants in the construction industry was identified as a cause of project failures.

Followings are the failure factors:

1. Management deficiencies
2. Risk challenge
3. Schedule delay
4. Poor estimation practices
5. Cash flow difficulties
6. Design discrepancies
7. Lack of efficient change management
8. Lack of teamwork

[18]Refer to the paper by Guofeng Ma, Aimin Wang, Nan Li, M.A SCE, lingyun Gu and Qi Ai on "Improved Critical Chain Project Management Framework for Scheduling Construction Projects" published in the Journal of Construction Engineering and Management, 2014 which propose an improved critical chain project management framework to enhance the implementation of it in construction project management practices. The CCPM develops a sound schedule using buffer management to avoid to project over runs (Cohenet al. 2009) The main advantage of the CCPM include its simplicity, its variation and a set of reasonable control guide lines it provides. Zhao et al. (2010) developed a genetic algorithm to identify the critical chain and obtain the optimal start time of each activity under the most optimistic duration of each activity and resource constraints.

CHAPTER-3

DATA COLLECTION & QUESTIONNAIRE SURVEY

3.1 General

Various factors determine the success or failure of hydroelectric projects, but the identification of factors is not easy task.

3.2 Questionnaire survey

A Questionnaire survey is one of the most effective ways to involve a large number of people in order to achieve better results. The method adopted for this research was based on questionnaire survey of twenty respondents in the hydropower projects. The data collection exercises were held over a period of three months. The questionnaire was distributed to the twenty targeted respondents, representing a mixture of professionals, including engineer, project manager, and construction manager.

The questionnaire survey consists of three sections namely company's status, respondent status and ranking of factors. These factors are discussed below:

3.2.1Company's status

The first part of the questionnaire was the status of company. It includes the company name, phone number, nature of company and the age of the company.

Questionnaire survey for Success or Failure of Hydroelectric Project

(Please fill the appropriate boxes with blue colour as shown)

Company Status

1. Company Name

2. Phone no.

3. Nature of company

	Client
	Contractor
	Designer
	Consultant
	Other(specify name)

4.Age of company

	<5 year
	5-10 years
	10-15 years
	>15 years

3.2.2 Respondent status

The second part of questionnaire was designed for the purpose of electing the information of respondent background. It consist name of respondent, position in company and experience.

Respondent Status

1.Name(optional)

2. Position in the Company:

- ☐ Engineer
- ☐ Construction manager
- ☐ Project manager
- ☐ Contract officer
- ☐ Business head
- ☐ Site co-ordinator
- ☐ Any Other

3. Experience

- ☐ <2 years
- ☐ 2-4 years
- ☐ 4-6 years
- ☐ 6-8 years
- ☐ 8-10 years
- ☐ >10 years

3.2.3 Rating of factors

The questionnaire survey includes thirteen major factors. These major factors are further divided into sub-factors. Factors were ranked from 1-5,

1-Not affecting,

2-Less affecting,

3- Moderately affecting,

4- Strongly affecting and

5- Very strongly affecting.

Difference respondent had given responses on the basis of their experience in the hydropower projects. Then the RII (Relative Importance Index) of these factors were determined and conclusion was made.

In table below, NA- not affecting, LA- less affecting, MA- moderately affecting, SA- strongly affecting, VSA- very strongly affecting

Success or Failure Analysis of Hydroelectric Projects

Which of the following factors affecting the success or failure of Hydroelectric projects.

Table 3.1 :Rating of factors

S.No	Factors	Rating given to factors				
	Options	**NA**	**LA**	**MA**	**SA**	**VSA**
A	**Factors related to project**					
a	Type of project	1	2	3	4	5
b	Size of the project	1	2	3	4	5
c	Value of the project	1	2	3	4	5
d	Uniqueness of the project	1	2	3	4	5
e	Urgency of the project	1	2	3	4	5

Table 3.2: Rating of factors:-

	Options	NA	LA	MA	SA	VSA
B	**Factors related to management**					
a	Communication system	1	2	3	4	5
b	Developing an appropriate organization structure	1	2	3	4	5
c	Implementing an effective safety program	1	2	3	4	5
d	Implementing an effective quality assurance program	1	2	3	4	5
e	Control of sub-contractor's works	1	2	3	4	5
f	Overall managerial actions	1	2	3	4	5
g	Control mechanism	1	2	3	4	5
h	Feedback capabilities	1	2	3	4	5
i	Planning efforts	1	2	3	4	5
C	**Factors related to project manager**					
a	Leadership skills of project manager	1	2	3	4	5
b	Project manager's efficiency	1	2	3	4	5
c	Project manager's experience	1	2	3	4	5
d	Project manager's commitment to meet quality, cost & time	1	2	3	4	5
D	**Factors related to client**					
a	Client's experience	1	2	3	4	5
b	Size of client's organization	1	2	3	4	5
c	Client's ability to make decision	1	2	3	4	5
d	Client's ability to define roles	1	2	3	4	5

Table 3.3: Rating of factors

	Options	**NA**	**LA**	**MA**	**SA**	**VSA**
e	Client's contribution to design	1	2	3	4	5
f	Client's emphasis on high quality of construction	1	2	3	4	5
E	**Factors related to contractor**					
a	Contractor experience	1	2	3	4	5
b	Supervision	1	2	3	4	5
c	Effectiveness of cost control system	1	2	3	4	5
d	Speed of information flow	1	2	3	4	5
e	Site management	1	2	3	4	5
F	**Factors related to design team**					
a	Quality of relation between team	1	2	3	4	5
b	Design team experience	1	2	3	4	5
c	Mistake & delay in producing design documents	1	2	3	4	5
d	Project design complexity	1	2	3	4	5
G	**Factors related to project team**					
a	Commitment & competence	1	2	3	4	5
b	Technical skills	1	2	3	4	5
c	Planning, organizing & coordinating skills of project team	1	2	3	4	5

Table 3.4: Rating of factors

	Options	NA	LA	MA	SA	VSA
H	**Factors related to work environment**					
a	Adequacy of funding	1	2	3	4	5
b	Commitment of all parties to project	1	2	3	4	5
c	Political environment	1	2	3	4	5
d	Human skill availability	1	2	3	4	5
e	Technology availability	1	2	3	4	5
I	**Factors related to material**					
a	Shortage in material	1	2	3	4	5
b	Quality of material	1	2	3	4	5
J	**Factors related to labour & productivity**					
a	Labour productivity	1	2	3	4	5
b	Labour supply	1	2	3	4	5
c	Equipment availability & failure	1	2	3	4	5
K	**Factors related to external environment**					
a	Economic environment	1	2	3	4	5
b	Social environment	1	2	3	4	5
c	Political environment	1	2	3	4	5
d	Physical environment	1	2	3	4	5
e	Industrial relation environment	1	2	3	4	5
f	Technology advanced	1	2	3	4	5
L	**Technical factors**					
a	Resource allocation	1	2	3	4	5
b	Resource quality	1	2	3	4	5
c	Site location	1	2	3	4	5

Table 3.5: Rating of factors

	Options	**NA**	**LA**	**MA**	**SA**	**VSA**
d	Skilled manpower	1	2	3	4	5
e	Infrastructure	1	2	3	4	5
f	Local repair facilities	1	2	3	4	5
M	**Financial factors**					
a	Ability to pay	1	2	3	4	5
b	Investment availability	1	2	3	4	5
c	Cost of energy	1	2	3	4	5
d	End uses	1	2	3	4	5

CHAPTER-4

RESULT AND ANALYSIS

4.1 General

The data used for analysis of success factors were obtained from the questionnaire survey. Thirteen main categories of factors were included in the questionnaire survey. The analysis of survey is done by Relative Importance Index (RII) method. Therefore the data received in the questionnaire survey was analyzed by Relative Importance Index to determine the success factors for hydropower projects.

4.2 Calculation of Relative Importance Index (RII):-

$$RII = \frac{\sum R}{A \times N}$$

Where,

R= ratings given to the factor by the respondents and will range from 1 to 5.

Where '1' is not affecting and '5' is very strongly affecting

A= highest rating of rating scale (i.e. 5 in this case)

N=Total no. of respondents

Sample calculation:

RII values for:

Type of project= $\frac{5+4}{5\times2}$ = 0.9

Size of project= $\frac{5+3}{5\times2}$ = 0.8

Factors with higher RII values will have more impact on the project and they will be ranked accordingly.

Table 4.1: showing RII (Relative Importance Index) values

S.No	Factors	RII= $\frac{\sum R}{A \times N}$
A	**Factors related to project**	
a	Type of project	0.82
b	Size of the project	0.73
c	Value of the project	0.79
d	Uniqueness of the project	0.65
e	Urgency of the project	0.74
f	Project life cycle	0.7
B	**Factors related to management**	
a	Communication system	0.81
b	Developing an appropriate organization structure	0.72
c	Implementing an effective safety program	0.73
d	Implementing an effective quality assurance program	0.72
e	Control of sub-contractor's works	0.77
f	Overall managerial actions	0.78
g	Control mechanism	0.77
h	Feedback capabilities	0.65
i	Planning efforts	0.81
C	**Factors related to project manager**	
a	Leadership skills of project manager	0.89
b	Project manager's efficiency	0.81
c	Project manager's experience	0.91
d	Project manager's commitment to meet quality, cost & time	0.79
D	**Factors related to client**	
a	Client's experience	0.74
b	Size of client's organization	0.61
c	Client's ability to make decision	0.77

Table 4.2: showing RII (Relative Importance Index) values

S.No	Factors	RII= $\frac{\sum R}{A \times N}$
d	Client's ability to define roles	0.74
e	Client's contribution to design	0.66
f	Client's emphasis on high quality of construction	0.71
E	**Factors related to contractor**	
a	Contractor experience	0.9
b	Supervision	0.87
c	Effectiveness of cost control system	0.78
d	Speed of information flow	0.72
e	Site management	0.87
F	**Factors related to design team**	
a	Quality of relation between team	0.74
b	Design team experience	0.86
c	Mistake & delay in producing design documents	0.72
d	Project design complexity	0.81
G	**Factors related to project team**	
a	Commitment & competence	0.79
b	Technical skills	0.76
c	Planning, organizing & coordinating skills of project team	0.73
H	**Factors related to work environment**	
a	Adequacy of funding	0.76
b	Commitment of all parties to project	0.77
c	Political environment	0.68
d	Human skill availability	0.69
e	Technology availability	0.83
I	**Factors related to material**	
a	Shortage in material	0.86

Table 4.3: showing RII (Relative Importance Index) values

S.No	Factors	RII= $\frac{\sum R}{A \times N}$
b	Quality of material	0.79
J	**Factors related to labour & productivity**	
a	Labour productivity	0.81
b	Labour supply	0.8
c	Equipment availability & failure	0.84
K	**Factors related to external environment**	
a	Economic environment	0.61
b	Social environment	0.66
c	Political environment	0.57
d	Physical environment	0.73
e	Industrial relation environment	0.67
f	Technology advanced	0.71
L	**Technical factors**	
a	Resource allocation	0.78
b	Resource quality	0.74
c	Site location	0.86
d	Skilled manpower	0.78
e	Infrastructure	0.77
f	Local repair facilities	0.69
M	**Financial factors**	
a	Ability to pay	0.77
b	Investment availability	0.78
c	Cost of energy	0.78
d	End uses	0.71

Ranking of factors:-

Table 4.4: showing the ranking of factors

Ranking	Factors	RII
1	Project manager's experience	0.91
2	Contractor experience	0.9
3	Leadership skills of project manager	0.89
4	Supervision	0.87
5	Site management	0.87
6	Design team experience	0.86
7	Shortage in material	0.86
8	Site location	0.86
9	Equipment availability & failure	0.84
10	Technology availability	0.83
11	Type of project	0.82
12	Communication system	0.81
13	Planning efforts	0.81
14	Project manager's efficiency	0.81
15	Project design complexity	0.81
16	Labour productivity	0.81
17	Labour supply	0.8
18	Value of the project	0.79
19	Project manager's commitment to meet quality, cost & time	0.79
20	Commitment & competence	0.79
21	Quality of material	0.79
22	Overall managerial actions	0.78
23	Effectiveness of cost control system	0.78
24	Resource allocation	0.78
25	Skilled manpower	0.78

Table 4.5: showing the ranking of factors

Ranking	Factors	RII
26	Investment availability	0.78
27	Cost of energy	0.78
28	Control of sub-contractor's works	0.77
29	Control mechanism	0.77
30	Client's ability to make decision	0.77
31	Commitment of all parties to project	0.77
32	Infrastructure	0.77
33	Ability to pay	0.77
34	Technical skills	0.76
35	Adequacy of funding	0.76
36	Urgency of the project	0.74
37	Client's experience	0.74
38	Client's ability to define roles	0.74
39	Quality of relation between team	0.74
40	Resource quality	0.74
41	Size of the project	0.73
42	Implementing an effective safety program	0.73
43	Planning, organizing & coordinating skills of project team	0.73
44	Physical environment	0.73
45	Developing an appropriate organization structure	0.72
46	Implementing an effective quality assurance program	0.72
47	Speed of information flow	0.72
48	Mistake & delay in producing design documents	0.72
49	Client's emphasis on high quality of construction	0.71
50	Technology advanced	0.71
51	End uses	0.71
52	Project life cycle	0.7
53	Human skill availability	0.69
54	Local repair facilities	0.69

Table 4.6: showing the ranking of factors

Ranking	Factors	RII
55	Political environment	0.68
56	Industrial relation environment	0.67
57	Client's contribution to design	0.66
58	Social environment	0.66
59	Uniqueness of the project	0.65
60	Feedback capabilities	0.65
61	Size of client's organization	0.61
62	Economic environment	0.61
63	Political environment	0.57

The survey carried out on various hydropower projects reveals the results that the top ten factors are the most important factors which affect the success or failure of hydropower projects. If these factors are followed properly will cause the success of project and if not properly cause failure. The other factors will also affect the project's performance but the probabilities of top ten factors are more in the project.

According the results of RII, project manager's experience is ranked first with 0.91, followed by contractor experience which is ranked second with 0.90. Leadership skills of project manager are ranked third with 0.89. Supervision and site management are ranked fourth with 0.87. Design team experience, site location and shortage in material are ranked fifth with 0.86. Sixth success factor is related to equipment availability and failure with 0.84. Technology availability is ranked seventh with 0.83. Type of project is ranked eighth with 0.82. Communication system, planning efforts, project manager's efficiency, project design complexity and labor productivity are ranked ninth with 0.81.Tenth factor is the labour supply with 0.80. These factors have more probability to affect the success or failure of hydropower projects

CHAPTER-5

CASE STUDIES

5.1 Case studies of some hydropower projects

Here are some of the case studies which show the practical performance of hydropower projects.

5.1.1 Case study I- Rattle hydropower project (850 MW)

5.1.1.1 Introduction

The proposed Rattle hydroelectric project, in Kishtwar tehsil of Doda district of Jammu and Kashmir, is located downstream of the Dulhsti power house which is in advance stage of construction on Chenab river. The Chenab River originates at Chandra flows westerly till it meets Bichlari on right bank and flows continuously up to Akhnoor travels 584 km.

A concrete gravity dam is proposed across the river just downstream of the Rattle village and an underground power house with an installed capacity of 4× 140 MW is proposed near Juddi village both in Doda district. The nearest rail head to the project site is Jammu which is about 260 Km from dam site is 15km south west of Kishtwar. Kishtwar is an important tehsil head quarter of Doda district of Jammu province and is connected to Jammu.

FIG.5.1 Location of Rattle dam in India

Table 5.1: Details of Rattle Hydropower

Country	India
Location	Rattle, Doda District Jammu & Kashmir
Purpose	Power
Status	Under construction
Construction begun	2013
Opening date	February 2018
Owner(s)	GVK Rattle Hydroelectric plan
Type of dam	Gravity
Height	133 m
Installed capacity	850 MW

5.1.1.2 Features of the project

It consists of:

- A 58 m high concrete gravity dam across river Chenab
- Two numbers 11080m long, 9.8m diameter modified horse shoe tunnel terminating in a surge shat.
- Two numbers 25m diameter, restricted orifice type surge shaft.
- Four numbers 6m diameter pressure shaft.
- Underground power house having installation four Francis turbines each of 140MW capacity.
- 300m long tail race tunnel to carry the power house release back to the river.

5.1.1.3 Factors causing failure of the project

- Sub-contractor related issues (demand of higher item rate).
- Non-cooperation of local administration.
- Ambiguity in contract (percentage of local employee was not clear in contract).
- Wages of labors (demand of higher labor wages).
- Factor related to finance (delay in payment by the client).

5.1.2 Case Study II-KarchamWangtoo (1000 MW)

5.1.2.1 Introduction

Karcham Wangtoo hydropower project is a 1000 MW run-of –the river hydroelectric power station on the Sutlej River in Kinnaur district of Himachal Pradesh, India. The dam and power station are located between the villages of Karcham and Wangtoo where the plant also gains its name. Jaypee Karcham Hydro Corporation Limited of Jaypee group signed a memorandum of understanding to develop the dam in 1993 and after years of delay, construction on the power station begun on 8 November, 2005. In 2015, Jaypee group sold out Karcham Wangtoo project to JSW group.

The first generator was commissioned in May 2011, the second in June and the final two in September. The 48m tall dam at Karcham diverse a substantial portion of the Sutlej into a 10.4m diameter and 17.2 Km long headrace tunnel to the underground power station downstream at Wangtoo. At the station, the powers 4×250 MW Francis turbine generators before it is sent back into the Sutlej via a 1.2Km long tail race tunnel. The difference in elevation between the dam and the power station affords a gross hydraulic head of 298m water not diverted by the dam sent over the spillway and down the normal course of river.

FIG.5.2 Location of KarchamWangtoo hydropower in India

Table 5.2: Details of Karcham Wangtoo Hydropower

Country	India
Location	Karcham Wangtoo District Kinnaur
Purpose	Power
Status	Operational
Construction begun	2005
Opening date	2011
Owner(s)	JSW group
Type of dam	Gravity
Height	98 m
Length	177.8m
Installed capacity	1000 MW
Turbines	4×250 MW Francis Type

5.1.2.2 Factors causing failure of the project

- Strikes of workers regarding wages, public consultation
- Violation of techno economic clearances conditions

5.1.3 Case Study III-Lower Subansiri hydropower project (2000 MW)

5.1.3.1 Introduction

The 2000 MW hydroelectric power project is located on Subansiri River, which is located on the border of India's two north-eastern states, Arunachal Pradesh and Assam. The project is being developed by state-run National Hydropower Corporation (NHPC). The construction of Subansiri started in 2005 and was due to be completed in 2010. However, the project has been plagued by delays due to stiff opposition over its potential environment impact.

It is an under construction gravity dam located 2.3 Km upstream of Giruaamukh village in Dhemaji district and lower state. The concrete gravity dam is designed to be 116m fall, measured from the river bed and 130m from foundation. Its length will be 284m. There will be eight horse shoe shaped headrace tunnel each being 9.5 m in diameter and heaving length from 908-1168m. There will be eight horse shoe shaped surge tunnel each being 9.8m in diameter and heaving length 400-485m. The project has experienced several problems during the construction to include landslides, redesign and opposition.

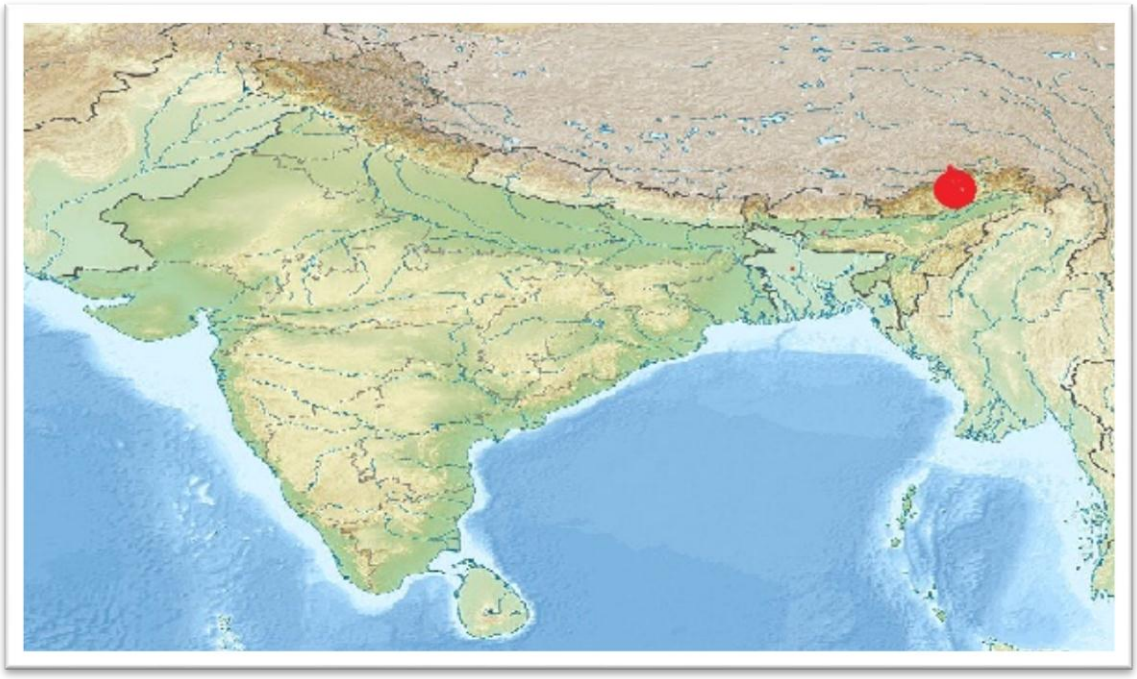

FIG.5.3 Location of Lower Subansiri hydropower in India

Table 5.3: Details of Lower Subansiri Hydropower

Country	India
Location	Lower Subansiri, district Dhemaji Assam
Purpose	Power
Status	Under construction
Construction begun	2007
Opening date	2016
Owner(s)	NHPC Limited
Type of dam	Gravity
Height	116 m
Length	284m
Installed capacity	2000 MW
Turbines	8×250 MW Francis Type

5.1.3.2 Factors causing failure of the project

- Incorrectly designed spillways
- Environment Impact Assessment (EIA) related issues

- Political issues (non-cooperation of the local administration)
- Non availability of labor suppliers

5.1.4 Case Study IV-Nathpa Jhakri hydropower project (2000 MW)

5.1.4.1 Introduction

The Nathpa Jhakri hydroelectric power project is one of the largest run-off-the –river schemes in the world. It is designed to generate 1500 MW of power. The project is located at a distance of 150 Km from Shimla and it is approachable by NH-22 Hindustan-Tibet road. The project is over a distance of 50 Km along the highway between Nathpa village in Kinnaur district and Jhakri in Shimla district of Himanchal Pradesh. Geological survey of India has been associated with the Nathpa Jhakri hydroelectric project since 1967 when reconnaissance for the project was carried out. Twenty two officers and thirteen supervisory officers remained associated with the geotechnical studies during different stages of project till its commissioning in 2004. Construction of the project commenced in March 1993 and was commissioned in 18th May 2004.

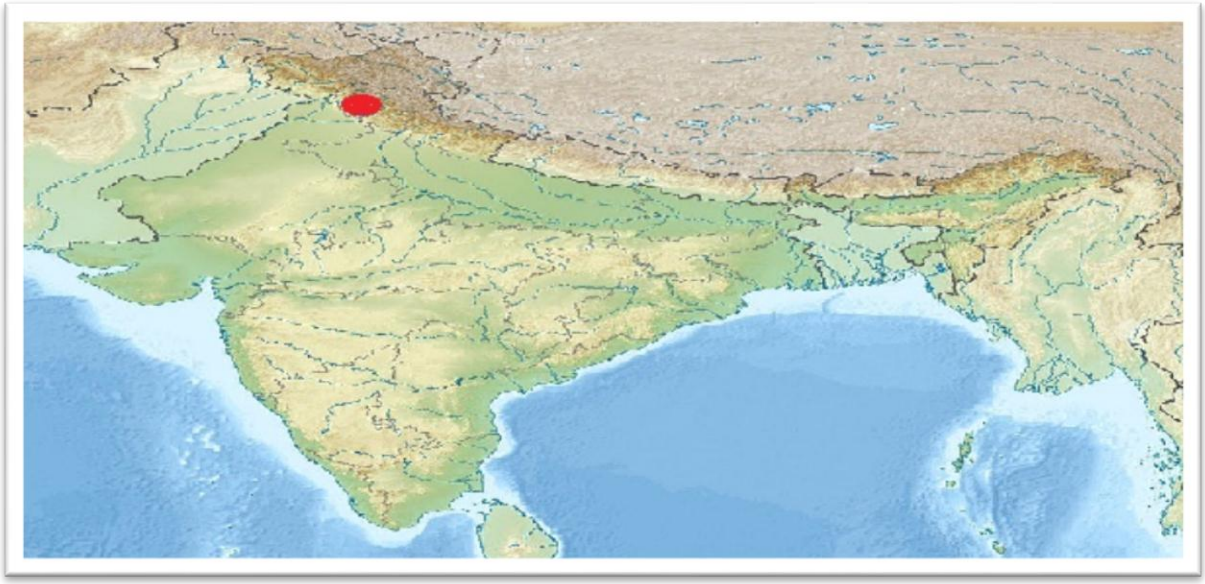

FIG.5.4 Location of Nathpa Jhakri hydropower in India

Table 5.4: Details of Nathpa Jhakri Hydropower

Country	India
Location	Himachal Pradesh, District Shimla& Kinnaure
Purpose	Power
Status	Under construction

Table. 5.4 Details of Nathpa Jhakri Hydropower

Construction begun	1993
Opening date	2004
Owner(s)	SJVN Limited
Length	185m
Height	62.5 m
Installed capacity	1500 MW
Turbines	6×250 MW Francis Type

5.1.4.2 Features of the project

- 62.5m high concrete gravity dam.
- Four numbers, egg shaped desilting chambers to remove particles down to 0.2 mm.
- A 10.15m diameter, 29.37 Km long, circular headrace tunnel.
- A 21.5m diameter, 301m deep surge shaft.
- Three numbers steel lined pressure shafts, each 4.9m diameter, and 571-622m long.
- Six numbers Francis turbine, each of 250 MW capacities.
- A 10.15m diameter tail race tunnel, 982m long.

5.1.4.3 Factors causing failure of the project

- Issues related to the wages of labor
- Political issues

5.1.5 Case Study V-Tehri Dam (Hydropower Project)

5.1.5.1 Introduction

The Tehri Dam on India's Bhagirathi River, the main tributary of Ganges, is one of the world largest and most controversial hydroelectric projects. Under construction since 1978, the final phase of the reservoir filling is scheduled to start by December 2002.Within six months the homes and lands of around 100,000 people would be submerged. Power production is planned to start in August 2003.tehri is located 200 miles north east of Delhi, in the state of Uttaranchal. With a height of 260m, the dam will be the fifth tallest in the world. Its reservoir will completely submerge Tehri town, 40 villages and partially submerge 72 villages.

The two lower tunnels of dam were closed in December 2001 submerging the main bridge leading to tehri town and other areas. The last two tunnels, which are at a higher level, are scheduled to be closed by December 2002. This will results in complete submergence of Tehri town and surrounding areas. From interception, Tehri dam has been opposed due to concerns over its environmental and social impacts and its ability to withstand earthquake damage. Tehri dam officials also been implicated in several cases of corruption.

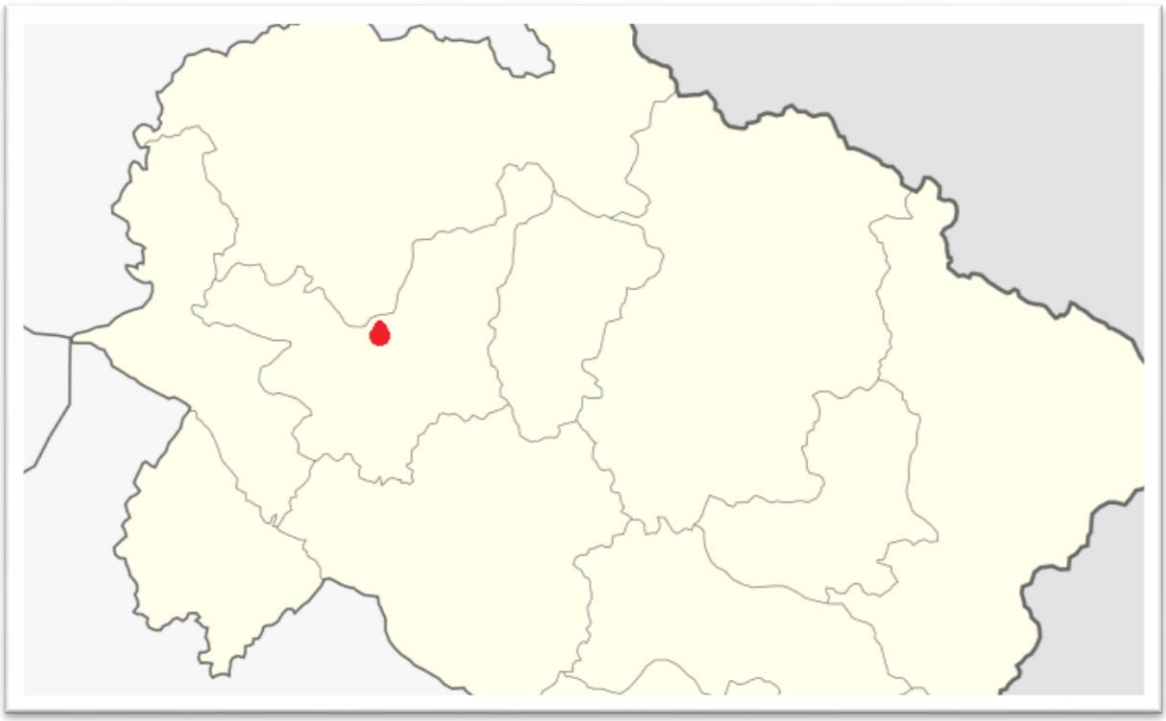

FIG.5.5 Location of Tehri Dam hydropower in India

Table 5.5: Details of Tehri dam

Country	India
Location	Uttrakhand
Purpose	Power
Status	Operational
Construction begun	1978
Opening date	2006
Length	575m
Height	260.5 m
Installed capacity	1000 MW
Turbines	Vertical Francis Type

5.1.5.2 Factors causing failure of the project

- Issues related to environment
- Social issues

CHAPTER- 6

CONCLUSION

6.1 Conclusion

The questionnaire survey was carried out to know the influence of various success or failure factors. The top ten factors rated by the various respondents are responsible for the success of hydropower projects. Rating given by the different respondents is not same as the respondents from different organizations have different point of view on the factors causing the success or failure of hydropower projects. The results of questionnaire survey were obtained on the basis of responses from questionnaire survey. The top ten factors which significantly affect the success or failure of hydropower projects are listed as: (1) project manager's experience, (2)contractor experience, (3) leadership skills of project manager, (4) supervision, (5) site management(6) design team experience,(7) shortage in material,(8) site location,(9) equipment availability & failure,(10) technology availability. The other factors will also affect the success or failure of projects but the probability of top ten factors are more.

6.2 Future scope

More investigation is required to identify factors attributes to the success or failure of the project. Further the analysis of success factors can be done by various other methods such as SAPP software, SEM software and other quantitative analysis approach.

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APPENDIX

Table: Rating given by different respondents

S. No	Factors	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20
A	**Factors related to project**																				
a	Type of project	5	4	3	3	4	4	4	5	5	5	1	5	5	4	4	3	4	4	4	5
b	Size of the project	5	3	4	3	4	3	5	4	4	3	4	3	5	2	5	5	4	4	3	3
c	Value of the project	3	5	5	3	4	5	4	4	3	4	1	4	4	5	4	5	4	5	3	4
d	Uniqueness of the project	4	3	3	2	4	4	4	3	3	4	1	2	3	4	2	5	3	4	4	3
e	Urgency of the project	4	2	4	1	5	5	2	4	4	4	4	4	5	2	3	4	4	5	4	4
f	Project life cycle	3	3	5	5	4	5	3	3	3	5	2	4	3	2	3	3	3	3	3	5
B	**Factors related to management**																				
a	Communication system	4	4	1	5	4	4	4	5	5	4	5	3	5	3	3	4	5	5	3	5
b	Developing an appropriate organization structure	3	4	2	4	4	4	5	4	4	3	4	4	4	2	2	5	4	4	3	3
c	Implementing an effective safety program	4	3	3	4	4	5	3	4	4	4	4	4	3	2	2	4	4	4	3	5
d	Implementing an effective quality assurance program	3	2	2	4	5	5	4	3	4	3	4	5	4	2	3	4	3	4	4	4
e	Control of sub-contractor's works	4	3	4	3	4	4	4	4	4	3	4	4	5	3	4	5	4	5	3	3

Table: Rating given by different respondents

S. No	Factors	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20
f	Overall managerial actions	4	5	3	4	4	4	1	5	5	3	4	4	5	4	2	5	5	4	3	4
g	Control mechanism	4	3	2	4	4	5	3	4	4	4	4	4	4	4	3	5	3	4	4	5
h	Feedback capabilities	3	3	3	5	4	3	3	3	3	3	4	4	3	4	2	4	4	4	2	3
i	Planning efforts	4	4	4	5	4	4	4	4	4	4	4	5	4	4	3	5	3	5	3	4
C	**Factors related to project manager**																				
a	Leadership skills of project manager	5	4	2	5	4	5	5	5	5	4	4	5	5	5	4	3	5	5	4	5
b	Project manager's efficiency	5	5	3	4	4	4	4	4	4	4	4	5	4	3	3	5	4	4	4	4
c	Project manager's experience	5	5	4	4	4	5	3	4	4	4	4	5	5	3	5	4	4	4	5	5
d	Project manager's commitment to meet quality, cost & time	5	4	3	3	4	4	3	4	4	4	4	5	4	4	4	5	4	5	3	3
D	**Factors related to client**																				
a	Client's experience	4	5	2	3	5	2	5	3	4	4	4	3	4	4	5	3	3	3	4	4
b	Size of client's organization	3	3	1	4	5	4	4	3	3	3	4	3	3	2	3	1	4	2	3	3
c	Client's ability to make decision	5	4	2	5	5	3	4	4	4	4	4	3	4	4	3	4	4	3	3	5

Table: Rating given by different respondents

S. No	Factors	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20
d	Client's ability to define roles	4	4	2	5	5	3	5	4	4	4	1	3	4	4	3	3	4	3	4	3
e	Client's contribution to design	5	2	3	5	5	4	3	3	3	3	1	3	2	4	3	3	3	4	4	5
f	Client's emphasis on high quality of construction	3	4	3	5	5	4	4	4	4	4	1	3	4	3	4	2	4	3	3	4
E	**Factors related to contractor**																				
a	Contractor experience	5	5	2	4	5	5	5	5	4	4	4	5	5	4	5	5	5	4	4	4
b	Supervision	5	4	3	5	5	4	4	5	5	4	4	5	5	4	3	5	5	5	2	5
c	Effectiveness of cost control system	4	3	3	5	5	3	2	4	4	4	4	4	4	4	4	5	4	4	3	5
d	Speed of information flow	4	3	2	5	5	5	1	4	4	4	4	4	4	3	3	3	4	4	2	4
e	Site management	5	4	4	5	5	4	4	5	4	4	4	5	4	4	3	5	5	4	4	5
F	**Factors related to design team**																				
a	Quality of relation between team	4	3	2	5	4	4	4	4	4	4	1	5	5	4	3	4	4	4	2	4
b	Design team experience	5	4	4	5	4	5	5	5	5	3	1	4	5	5	4	4	5	5	4	4
c	Mistake & delay in producing design documents	4	3	1	4	4	3	5	4	3	4	4	4	4	3	4	3	4	3	5	3
d	Project design complexity	5	5	2	4	4	4	4	4	4	4	4	5	4	4	4	5	4	4	3	4

Table: Rating given by different respondents

S. No	Factors	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20
G	**Factors related to project team**																				
a	Commitment & competence	4	3	1	3	4	4	3	5	5	4	4	4	5	4	4	5	5	4	3	5
b	Technical skills	4	2	2	4	4	4	5	4	4	4	4	5	4	4	4	4	4	3	4	3
c	Planning, organizing & coordinating skills of project team	5	3	3	5	4	3	5	4	4	4	4	5	5	4	3	5	4	4	4	5
H	**Factors related to work environment**																				
a	Adequacy of funding	4	2	4	5	4	2	4	4	4	4	4	5	4	4	5	5	4	3	2	3
b	Commitment of all parties to project	5	3	3	3	4	3	3	4	4	5	4	4	5	4	3	5	4	4	3	4
c	Political environment	5	4	4	4	4	2	4	3	3	4	1	5	3	1	5	3	3	1	4	5
d	Human skill availability	4	3	2	4	5	2	4	4	4	4	1	4	4	3	4	3	4	3	3	4
e	Technology availability	4	3	4	5	5	3	5	4	4	4	4	5	4	4	5	4	4	4	3	5
I	**Factors related to material**																				
a	Shortage in material	5	3	5	4	5	1	5	5	5	5	4	3	5	5	4	4	5	4	4	5
b	Quality of material	3	3	4	4	3	4	5	4	4	5	3	5	4	4	3	4	4	5	3	5
J	**Factors related to labour & productivity**																				
a	Labour productivity	5	3	3	4	4	3	5	4	5	4	4	4	5	5	3	4	4	5	3	4

Table: Rating given by different respondents

S. No	Factors	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20
b	Labour supply	5	2	2	4	5	4	5	4	4	4	4	3	4	5	3	5	4	5	3	5
c	Equipment availability & failure	5	3	3	4	4	4	4	5	5	4	4	4	5	5	4	4	5	5	3	4
K	**Factors related to external environment**																				
a	Economic environment	4	2	4	3	3	2	1	3	3	4	1	5	3	4	3	3	3	4	3	3
b	Social environment	5	3	5	4	3	1	2	3	4	3	1	5	4	3	4	3	3	3	3	4
c	Political environment	5	4	4	4	3	2	4	2	2	4	1	3	2	1	4	3	2	1	3	3
d	Physical environment	4	1	4	4	3	2	4	5	5	4	1	4	4	3	3	5	5	3	5	4
e	Industrial relation environment	5	2	4	3	3	3	4	3	3	4	1	4	3	4	3	3	3	4	3	5
f	Technology advanced	4	2	2	4	3	3	4	4	4	4	1	5	4	4	4	4	4	4	3	4
L	**Technical factors**																				
a	Resource allocation	4	3	4	3	3	4	5	5	5	4	1	4	5	4	3	5	5	4	3	4
b	Resource quality	4	2	5	3	3	4	4	4	4	4	1	4	4	4	3	5	4	4	3	5
c	Site location	4	3	5	4	3	3	4	5	5	4	4	5	5	5	4	5	5	5	4	4
d	Skilled manpower	4	4	4	4	4	3	1	4	4	4	4	4	4	5	3	4	4	5	4	5
e	Infrastructure	4	3	4	4	4	3	2	4	4	4	5	4	4	4	3	5	4	4	3	5
f	Local repair facilities	5	2	3	4	4	1	3	4	4	4	4	3	4	3	3	3	4	3	3	5
M	**Financial factors**																				
a	Ability to pay	4	3	4	5	4	2	4	4	4	4	4	5	4	5	4	3	4	4	3	3

Table: Rating given by different respondents

S. No	Factors	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20
b	Investment availability	3	5	5	4	4	3	3	4	4	5	4	4	5	3	4	4	4	3	3	4
c	Cost of energy	3	4	4	4	4	3	4	5	5	4	4	2	5	4	4	3	5	4	3	4
d	End uses	4	2	3	5	4	4	3	4	3	4	1	5	3	3	3	4	4	3	4	5