

Investigation of Critical Success Factors for Construction Companies' Human Resource Management



Jemal Kedir Shuka

**A Thesis Submitted to the Department of Civil Engineering
School of Civil Engineering and Architecture**

**Presented in Partial Fulfillment of the Requirement for the Degree of Master's in Civil
Engineering (Specialization in Construction Engineering and Management)**

**Office of Graduate Studies
Adama Science and Technology University**

September 2023
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Advisor: Fikreyesus Demeke (PhD)

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Dedicated to my beloved families, friends & Teachers

CERTIFICATE

I declare that the thesis entitled “**Investigation of Critical Success Factors for Construction Companies’ Human Resource Management**” is my original work and it has not been submitted to any university for similar purposes. Proper citations duly recognize the references used in this thesis.

Jemal Kedir Shuka

Signature

Date

RECOMMENDATION OF ADVISOR

I, the major advisor/supervisor of this research proposal, hereby certify that I have closely advised/supervised the student while developing this thesis and read the draft thesis entitled **“Investigation of Critical Success Factors for Construction Companies’ Human Resource Management”** prepared under my guidance by Jemal Kedir Shuka. Therefore, I recommend the submission of revised version of the thesis to the department following the applicable procedures.

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APPROVAL PAGE

I, the advisor of the thesis entitled, “**Investigation of Critical Success Factors for Construction Companies’ Human Resource Management**” and developed by Jemal Kedir Shuka; hereby certify that the recommendations and suggestions given by the thesis review Committee are appropriately incorporated into the final thesis.

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APPROVAL OF BOARD OF REVIEWERS

We, the undersigned, members of the Board of Examiners of the thesis presented by Jemal Kedir Shuka have read and evaluated the thesis entitled “**Investigation of Critical Success Factors for Construction Companies’ Human Resource Management**” and examined the candidate the open defense. This is, therefore, to certify that the thesis is accepted for the partial fulfillment of the requirement of the degree of Master of Science in Construction Engineering and Management.

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LIST OF ACRONYMS

AHP	Analytic Hierarchy Process
CSF	Critical Success Factors
HRM	Human Resource Management
HRP	Human Resource Planning
HRMCSFs	Human Resource Management Critical Success Factors
CCHRMCSFs	Construction Companies Human Resource Management Critical Success Factors
ISM	Interpretive Structural Modeling

ABSTRACT

The performance of construction projects is highly affected by human capital-related factors. The research of human capital-related critical success factors will substantially contribute to the success of construction projects. However, this field has not been thoroughly studied before and past studies lack consideration for identifying interrelationships between human capital-related critical success factors, even it is crucial to understand how other less critical ones may affect the criticality of certain factors. Based on a survey of the literature and recommendations from experts, 23 human capital-related factors were identified. Subsequently, expert elicitation was used to ascertain the importance of each factor and the interrelationship among them using an integrated methodology made up of the Analytic Hierarchy Process (AHP), Interpretive Structural Modeling (ISM), and Quadrant Analysis. The findings indicate that performance management factors and human resource planning factors have been more inclined to be at lower levels of a ten-layer structure that represents the relationships among human resource management factors, with health and safety factors and human resource planning factors getting the highest importance weights. The results of the quadrant analysis showed that determining of the project goal, regular human resource planning, selecting experienced and skill-full project manager, providing sufficient and structured training and development program, and creating of job security in the field of health and safety are among the key factors that hold significant and influential importance for the success of construction projects. These factors directly affect the human resource management activities of construction companies, and their prioritization can contribute to the overall success of construction projects. By giving attention to these important and influential factors, construction companies can ensure that their human resource management practices align with project goals and objectives, leading to improved project outcomes.

Keywords: Human Resource Management, Project success, Critical Success Factors, Analytical Hierarchy process. Interpretive Structural Modeling

CHAPTER ONE

INTRODUCTION

1.1 General Background

Human Resource Management (HRM) is a system of actions and techniques used to coordinate and manage human capitals in businesses in order to accomplish organizational goals(YEE, 2015). S.Sharmila and Nilmarkumar (2015) defined HRM as the process of attracting, developing and maintaining the talented and energetic workforce to support organizational mission, objectives and strategies. HRM is the most greatest and valuable asset for an efficient outcome of any organization especially in labor-intensive sectors and industries such as construction (Sagar & C.Aher, 2021; Z.A.K & A.R., 2013).

Project Management Body of Knowledge (PMBOK) regards HRM to be one of the six fundamental basic functions of project management. Moreover, it has been found to be one of the three crucial elements that are needed for effective operation of an organization (Keat, 2012). Human resources management is a significant asset for any association and satisfactory administration of Human Resources can enable an association to achieve its objectives and targets. Human Resources Management involves management decisions related to policies and practices that together shape the employment relationship and are aimed for achieving some certain goals which is set by organization (En, Sarpin, Wee, & Shafii, 2022).

HRM in construction companies refers to the management of human resources in the construction industry. The workforce of the construction sector is distinctive since it consists of a variety of skilled and unskilled people from various backgrounds and educational backgrounds. So, for construction enterprises to succeed, good human resource management is essential. Human Resource is one of the four major resources of construction projects. It is required for an organization to conduct different business activities. Organizations cannot exist and operate effectively in absence of human resource. Hence any organizations' success is dependent on the effective usage of human capital (Pitorda, Makwana, & prajapati, 2016).

Human capital plays a very significant role in organizational success(Tabassi, Ramli, & Bakar, 2012). For the purpose of achieving its goals and objectives whether it be public or private (organization) it needs adequate and appropriate human resource and the concern of HRM will be enhancing the contribution of employees toward the effectiveness of the organization.

HRM has a core role in assuring employee satisfaction, improving performance and productivity which directly contributes for success of any given organization(Alemu, 2017).The majority of construction projects are complicated and challenging to manage, and HRM procedures are frequently utilized in businesses to ensure efficient operations, which may have an impact on the success or failure of projects(YEE, 2015). One of the issues that construction projects deal with on a daily basis in their operations while building a sustainable development project is human resource management. Although the construction industry employs more people than other industries do, its human resource management is still deficient and insufficient (I.Othman, A.Idrus, & M.Napiah, 2012).

Organizational performance can be increased by having human resource policies that satisfies employees. HR strategies such as human resources follow-up strategy and training and development strategy can improve the worker's performance from aspects of competencies of workers or level of knowledge of work requirement and consequently can improve the productivity of workers in construction project(En et al., 2022). Construction industry often experiences complexities in meeting project completion schedule and finance due to non-availability of sufficient number of skilled labors and staff to carry out the planned work which can be managed and efficiently possible to handle with proper utilization of human resource management techniques.

Though literature reports that concern of construction human resources management (HRM) is increasing day by day along with greater emphasis on human resource and human relation, construction industry is generally criticized due to lack of appropriate approach towards HRM policies and many researchers are suggesting formal methods of managing human resources in construction field (Z.A.K & A.R., 2013). As to Sarwar, Khan, Nadeem, & Aftab (2016), Human capital and HRM practices have a positive association with organizational performance. They are the success factors for bringing increment in the performance of the organization. As compared to other industries, construction industry's human resource is mostly non-permanent which makes it difficult and risky to manage. There is no good-developed framework for factors affecting HRM in the construction industry.

Therefore, it is necessary to analyze the Human Resource Management (HRM) in the construction industry (Prajapati, Pitorda, & M.Vyas, 2015). It was observed from literature review that the kind of HRM structure applicable in the construction field is not reported satisfactory (Z.A.K & A.R., 2013). The body of research on HRM in the context of project management is still developing. Publications are quite infrequent, and the majority of studies just use case studies, which indicates a dearth of quantitative research (Belout & Gauvreau, 2004). The construction projects have the general characteristics of limited budget, schedule, and quality standards with a series of complex and interrelated activities. It requires the cooperation of all project participants that includes clients, directors, designers, contractors, constructors, project managers, project team and consultants (Abbasbhai & Patel, 2020). Even though Ethiopia's construction industry is expanding quickly, it is still difficult to deliver projects efficiently in terms of time, money, and quality. Construction project success comes from the application of knowledge based, critically essential factors (Hailemarkos, 2020).

Investigation of critical success factors is method of enhancing adequacy and productivity of projects (Kalwane & P.Waghmare, 2016). According to Loosemore, Dainty, and Lingard (2003), a significant share of the expenditures of construction projects are attributable to human resources. Planning and implementing HRM procedures among the workforce is necessary to boost project effectiveness, productivity, and performance in the construction sector (YEE, 2015). This study will fill this research gap by identifying factors influencing effective utilization of human resources in construction industry's HRM. Therefore, leveraging more on human capital through the use of Critical success factors for human resource management (HRM) will help in increasing the performance of construction projects.

1.2 Statement of the Problem

The construction industry is multibillion businesses, which brings an immense value to many aspects of an economy. However, this industry had largely been neglected by Strategic Human Resource Management (SHRM) research. The people factor has drawn less attention in project management in the context of construction industry. Shortage of human capital and low productivity are the key people related challenges in the construction industry today and continue to be in future (Silva, 2018).

Even though Ethiopia's construction industry is expanding quickly, it is still difficult to deliver projects efficiently in terms of time, money, and quality. Construction project success comes from the application of knowledge based, critically essential factors (Hailemarkos, 2020). The success of construction projects depends on numerous variables. In addition, one of the deciding calculates for construction projects' success is human asset administration. The increase in human resource management activities results in increase of construction projects performance (Israr, 2017). It requires the participation of entirety extend members that incorporates clients, directors, designers, temporary workers, constructors, project managers, project team and consultants.

There are numerous human asset issues that will welcome to hopeless completion of construction projects such as poor project work design and structure, deficit of qualified skilled employees, changing manpower demography, a high rate of employee turnover and high rate of burnout among construction workers(YEE, 2015). Investigating of critical success factors is used for enhancing adequacy and productivity of projects (Kalwane & P.Waghmare, 2016). HRM is the most important, the critical and complex issue that has significant influence on the construction industry in other aspects such as cost, time and quality of construction project. As a result, project managers need to pay more attention for people management (S.Sharmila & Nilmarkumar, 2015).

The study of project success and critical success factors (CSFs) are considered to be a means to improve the effectiveness of projects (P.C.Chan, Albert, Scott, David, & P.L.Chan, Ada.,2004). Similarly, it is very essential and crucial to identify and act on critical success factors for human resource management of construction projects, to hit the goal of construction projects success. Construction projects are facing many problems from day to day in their business. One of the problems that has to be taken into consideration is human resource management in the construction of a sustainable development project(I.Othman et al., 2012).

Overall quality of HRM can affect a range of issues, and in the context of construction, poor employment relations may have an impact upon levels of work quality, innovation, project delays, and corporate reputation. If project managers are not aware of the criteria that would influence their goals set from the inception to the cessation phase then the project will not be successful.

Human capital and HRM practices have a positive association with organizational performance (Simarmata, 2020). Moreover, a universal HRM practice would directly influence organizational performance(Safari, Karimian, & Khosravi, 2014).

Identification and prioritization of the identified critical success factors for human resource management in construction companies is very essential and fruitful for achieving both HRM and construction projects goals.

Hence, this study has identified and structured construction companies' CSFs for HRM of construction projects that affect the level of project success through a project management practice and have developed hierarchal structure for those CSFs that will enable construction companies to evaluate the project outcome and increase their organizational performance. This research differs in terms of its research area, methods used, and analysis from the literature reviewed. The results will add to the scarcely available data about construction companies' human resource management critical success factors and establish a basis for future researchers who would like to pursue a study in this area for Ethiopian context.

1.3 Objective of the Study

1.3.1 General Objective

The general objective of this study is to investigate Critical Success Factors for construction companies' Human Resource Management (HRM).

1.3.2 Specific Objectives

- ❖ To formulate hierarchical structure of construction companies' Human Resource Management Critical Success factors based on the relative importance
- ❖ To develop interpretive structure model for construction companies' Human Resource Management Critical Success factors based on the influence of one factor on other.
- ❖ To hierarchically structure construction companies' Human Resource Management Critical Success factors based on the combined effect of importance and influence.

1.4 Significance of the Study

There are several valuable benefits expected by implementing this study. The study has identified HRM critical success factors in selected construction firms found in Addis Ababa city. Therefore, the result of this research can be used as initial information in prioritizing, planning improvement action and in giving corresponding attentions for these very significant HRM Critical success factors.

Human resource department or human resource managers can also use the results of this research as reference to improve their knowledge for Human Resource management in construction sector. Moreover, the identified critical factors can be prioritized in order to enhance construction projects success. It can also be used as secondary data source by researchers and academicians.

1.5 Scope of the Study

The research focused in identifying Human Resource Management Critical Success Factors for construction firms found in Addis Ababa City. 15 Construction firms of grade 1 GC (general contractors) found in Addis Ababa City administration those registered on contructionproxy.com page are considered.

1.6 Limitation of the study

It is very difficult and time consuming to collect data and make analysis using undertaken methodology from all grade one contractors of each category. Hence, this study is limited to only grade one GC found in Addis Ababa city administration, the findings of this study can't represent all other construction firms' human resource management critical success factors.

1.7 Organization of the Thesis proposal

The thesis paper contained five parts. Chapter one is an introductory part containing discussions on background, research problems, objectives of the research, significance of the research, scope, operational definition and organization or layout of the research. Chapter two contains literature review with general descriptions by different researchers on construction, construction success factors, Human resource management and practices in construction projects, CSFs and HRMCSFs. Chapter three discusses about research design and methodology. Chapter four presents and discusses about results of the study. The last Chapter, Chapter five presents conclusions and recommendations.

1.8 Summary

In this chapter, the background and statement of the problem have been presented. Further, the study objectives, scope of the study, significance of the study and the organization of the thesis to achieve these objectives have briefly been presented. In the next chapter, the literature review and the gaps in the prior research have been presented.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Literature review as a part of this research aims to clarify different aspects of study in terms of concepts and reflect what has been already published on a topic by other researchers and scholars. This part of the thesis focuses on theoretical approaches to examine the meaning and interrelationship between critical success factors for human resource management in construction projects. Furthermore, worldwide-related studies and their experience related to construction industry will be viewed. To develop a better understanding of the research objective, a comprehensive literature review has been conducted to identify critical factors of human resource management for construction projects.

2.2 Conceptual Bases of Human Resource (HR) and Human Resource Management (HRM)

The most valuable resource for any firm is its human resources (HR), which also provide a source of competitive advantage. Additionally, the success of any firm depends on its human resources, which are regarded as its most valuable resource (Tayeb, 2005). Any successful company must have the ability to find, train, and keep talented personnel. The most significant resource in a firm is its people, and this is particularly true in a sector that requires a lot of labor, like construction (Z.A.K & A.R., 2013). Buller and McEvoy (2012) as cited in H.Sarwar et al., (2016) stated that human capital is a crucial success factor for the growth of every organization and for the efficient operation of business.

Human resource plays important role in the organization in achieving organizations' goal, mission and vision (S.Zainon et al., 2020). Moreover, it has been found to be one of the three crucial elements that are needed for effective operation of an organization (C. W. Keat, 2012). Management process consists of five basic functions that is planning, organizing, staffing, leading, and controlling. HRM refers to the practices and policies you need to carry out the people or personnel aspects of your management job. The scope or an activity of the HRM refers to the practices and policies needed to carry out the people and personnel aspects of your management job.

These include, conducting job analyses (determining the nature of each employee's job), planning labor needs and recruiting job candidates, selecting job candidates, orientating and training new employees, managing wages and salaries (determining how to compensate employees), Providing incentives and benefits, appraisal performance, communicating (interviewing, counseling, disciplining), Training and developing, building employees commitment and also the consideration of equal opportunity and affirmative action, employee health and safety, Grievances and labor relation (Dessler, 2000).

There are countless ways to define human resource management. Here, a definition that is more pertinent to the subject matter of the research is mentioned. Human resource management (HRM) refers to a set of guidelines and procedures that cover things like job analysis, hiring and selection, orientation, remuneration, performance evaluation, training and development, and labor relations. It includes determining human resource needs, recruiting, screening, training, rewarding, appraising and also attending to labor relations, health and safety and fairness concerns. The goal of HRM is to develop the policies and procedures needed to carry out management tasks that depend on certain aspects of employee activities, particularly with regard to hiring, training, performance reviews, rewarding, and fostering an environment that is fair and healthy for employees (Dessler, 2007).

2.3 Human Resource Management Practices in the Construction Industry

Rules, resources, and human action all contribute to the creation of organizations, and people's actions determine the character of organizations. People have a huge role in organizations since they plan, develop, implement, sustain, and end an organization's existence. This shows that one of the most crucial roles in an organization is the administration of the human resource function from this fairly elementary but essential point (Senyucel.Z, 2009). Similar to this, HR procedures are made to increase workers' knowledge, abilities, and skills as well as to motivate them, reduce or completely eradicate workplace idling, and promote retention of key personnel. Human Resource Planning, recruitment and selection, training and development, performance appraisal, compensation and reward, motivation and labor relation and health and safety are all thoroughly explored.

2.3.1 Human Resource Planning (HRP)

A comprehensive strategy for accomplishing a goal meaning is how the word "planning" is defined. A detailed system, however, comprises the procedure, the tasks to be performed, the timing of those tasks, and resources, including financial resources (A.R.J. Dainty et al.,2000) as cited in the work of Ashiru and Ashiru (2019). Human resources planning in a company is a crucial task, and the employer needs to be able to specify the needs and how they might be met. Project Human Resource Planning and development is an essential portion in managing human resource within a diversifying construction nature(LENG, 2005). Human resource planning (HRP) in construction is the process of planning ahead to ensure that the human resource requirements of the organization are able to meet the demand of the project pipeline. HRP also ensures the best fit employees are being assigned to the right projects at the right time and helps to optimize capacity planning by avoiding workforce shortages or surpluses.

Planning for HR has been identified as a crucial tool for helping the function build a stronger focus on the organization's business and for pinpointing the areas where it must excel to be successful. Establishing clear objectives, choosing proper organizational tactics, and looking for any cutting-edge HR applications are among them (Leng, 2005). According to Ashiru & Ashiru (2009), human resource planning for construction projects is a means to manage human resources in the context of the construction industry's expanding nature. Managing human resources is a very interesting work. However, despite the significant resources devoted to construction planning, there are growing worries about its inability to meet its objectives and the inconsistent use of planning methodologies.

The findings of the study conducted by Ashiru and Ashiru (2019) showed that by making Project HR planning more useful for construction firms, performance at both the organizational and project levels are greatly improved. In addition to providing support for implementing its policies and processes, their findings advised guidelines for enhancing the visibility and adaptability of sustainable HR planning for construction projects. Leng (2005) proposed; evaluation of current resources, job analysis and design, internal availability analysis, and employee turnover analysis as HR planning approaches that could use to ease HR problems. The HRP is very important for the organization as the employees are constantly changing so management needs to respond to the changes and update the plans accordingly.

A further point is that the HRP practice starts from making a plan which is an assessment of the future development and their possible impact on the employee issues. It is required to make an action plan according to the forecasts which can include training, promotions or external recruitment (Armstrong, 2006). Furthermore, it is management's responsibility to forecast and plan the HR practices accordingly. The possible problems with HR planning can be avoided with planning techniques that are used to identify the problems with the manpower.

However, the main aim of the HRP is to reduce waste in employing people, reduce uncertainty about current manpower levels and future needs, and eliminate mistakes in staffing. Its purposes also include avoiding worker and skills shortages, stopping the profit eroding effects of being over or under staffed, preparing succession plans and shaping the optimum future workforce by hiring the right managers, technical specialists and skilled workers in appropriate numbers (Farnham, 2006). Therefore, the purpose of having a HRP either in the short run or in the long run, is to have an accurate estimate of the number of employees required with matching skill requirements to accomplish the organization's goals and objectives.

2.3.2 Recruitment and Selection in Construction Companies

Recruitment and selection is a process that consists of four different stages, which are defining requirements, planning recruitment, attracting candidates and selecting candidates. This is part of the actionable HRP and all these steps should be taken according to the demands of the organization (Armstrong, 2006). Armstrong suggests that the behavioral and technical competencies, qualifications and experiences are part of job roles. Recruitment is defined as a process of hiring the right people having the potential to make a positive contribution to a particular organization, whether in the short or long term (Bratton and Gold, 2007). Recruiting involves searching and enticing a group of individuals to choose from, with the aim of appointing competent individuals for unoccupied positions in the establishment (Gusdorf, 2008). According to Siew (2014), recruitment can be promoted by the following reasons:

- An employee decides to leave a company because of retirement
- Organizational expansion due to a better job offer that prompts immediate workforce
- Changes in a global environment requires, which requires different qualified employees.

The definition of the requirements starts with the organizational strategy and the HRP, which determine what types of employees are needed and what type of activities they should perform. It comes down to analyzing and defining the competencies and characters required for the specific job role (Bratton & Gold, 2007). According to Compton and Morrissey (2014), recruitment is a process of searching for potential employees and encouraging them to apply for a job. Recruitment can be internal or external.

Internal recruitment

Internal recruitment is a process of searching for candidates from among employees who are already working in the organization. This is the hiring of employees within an organization, which could have potential benefits. Internal recruitment saves considerable advertising costs and serves as a source of motivation for employees who see the opportunity of internal recruitment for professional development within the company (Siew, 2014). These are techniques such as job posting, job posting, promotions and Transfer. Using internal recruitment method, decreases labor turnover, increases performance, saves time and keeps corporate culture, though there is limited choice and innovation (Adu-Darkoh, 2014).

The recruitment process provides the organization with a pool of qualified applicants. A job analysis is a systematic approach to determine what a person actually does in a job. This process might involve a questionnaire to all employees. Based on this analysis, an accurate job description and job specifications can be written. A job description lists the components of the job, while job specifications list the requirements to perform the job.

External recruitment

External recruitment sources are the acquisition of applicants from outside a specific organization to fill vacancies. Like internal sources, they are useful for attracting competent applicants for the advertised positions in various organizations. Various methods are available for external recruiting. Organizations should fully evaluate the types of positions they wish to fill and select the recruitment methods likely to produce the best results. External sources of recruitment include advertising, e-recruiting, employment agencies, labor offices, and education and training institutions (Beardwell, 2007; Cober & Brown, 2006) as reported in the work of Adu-Darkoh (2014).

According to Mondy (2010), the process of selecting the best candidate for the open position or a future role from among those applying internally or externally is known as selection. Every firm has a unique hiring procedure. The act of choosing is the decision-making process. The process of picking the candidates who best meet the selection criteria for a post from a pool of applications is known as selection (Byars & Rue, 2006). The completion of the application form by the applicants typically marks the beginning of the organization selection process. Selection process includes screening, selection test, reference and background check, interview, physical examination and the last phase or step is job offer (Adu-Darkoh,2014).

2.3.3 Construction Companies Performance Management

Performance management processes have gained prominence in recent years as a means of providing a more integrated and continuous approach to performance management compared to previous isolated and often inadequate performance reviews and rating systems. Performance management is based on the principle of consensual or contractual leadership rather than command leadership. The focus is on the development and initiation of self-directed learning plans and the integration of individual and organizational goals. In fact, they can play a very key role in providing an integrated and consistent human resources management process that supports each other and improves the effectiveness of given organization as a whole(Armstrong, 2006).

Performance management is about performance, and it is a necessary part of HRM. Armstrong (2006), defined performance management as a systematic process for improving organizational performance by developing the performance of individuals and teams. It is a means of getting better results by understanding and managing performance within an agreed framework of planned goals, standards and competency requirements. Processes exist for establishing shared understanding about what is to be achieved, and for managing and developing people in a way that increases the probability that it will be achieved in the short and longer term. It focuses people on doing the right things by clarifying their goals. It is owned and driven by line management. Furthermore, performance management is the process by which leaders, managers, and supervisors align performance with organizational goals. This is an activity used to determine how effectively an employee is doing their job.

In other words, performance management includes performance appraisal, performance review, employee appraisal, employee appraisal, performance. This creates an environment for ongoing discussion between managers and team members to define expectations and share information about the organization's mission, values and goals. Performance management involves setting goals, evaluating results, and providing feedback to improve the future performance of the organization as employees, teams, or the organization as a whole. It aims to motivate people by guiding their behavior in the desired direction through the ability to modify their behavior based on clear goals and feedback (Abebe, 2019). The following are the aims of performance management as expressed by a variety of organizations (Armstrong, 2006):

- ❖ Empowering, motivating and rewarding employees to do their best.
- ❖ Focusing employee's tasks on the right things and doing them right.
- ❖ Aligning everyone's individual goals to the goals of the organization.
- ❖ Proactively managing and resourcing performance against agreed and objectives.
- ❖ The process and behaviors by which managers manage the performance of their people to deliver a high-achieving organization.
- ❖ Maximizing the potential of individuals and teams to benefit themselves and the organization, focusing on achievement of their objectives.

An effective performance appraisal system involves two way communications between the supervisor and the subordinate about performance. Evaluation should not be viewed simply as a once a year completion of rating forms, it should be a continuing process. Therefore, a good performance plan can give a sense of direction and utilize human potential and enhance individual and organizational performance. Supervisors should work hard by helping employees to meet their expectations on the other hand, conducting periodic performance appraisal is very important by comparing the last period with the current period.

In addition, supervisors should identify the employee's strength and weakness, and may plan ways of avoiding their weakness and develop their skills, knowledge and experiences to fully apply their strength toward improving the work performance effectively and efficiently. It was reported that PRP is the most popular evaluation technique in the construction sector. PRP focuses wholly on output and process criteria and employees are rewarded based on the achievement of goals (Loosemore et al., 2003).

2.3.4 Training and Development in Construction companies

According to the Oxford English Dictionary, Training is the act of imparting to a person a practical skill or manner of conduct in any trade, fine art, or craft. The HRM literature contains a wide variety of definitions and analyses of training and development. For instance, training and development were described by Swanson and Holton (2001) as a process of methodically enhancing employees' "work-related knowledge" and "expertise" in order to enhance job assignments. Additionally, Akdere (2003) described training and development procedures as standards for enhancing employees' levels of self-awareness and competence in carrying out their duties. As a result, various practitioners have viewed training as a systematic procedure to enhance both individual and organizational work performances.

Additionally, training is necessary if employers want to develop their workforce and enhance customer satisfaction. As a result, firms should view training and development as crucial components of staff development processes (Huemann, 2010). Consequently, it appears essential for all businesses, but especially for those in the construction industry, to view staff training and development as a component of both the company's HRM policies and practices. It is also acknowledged that construction enterprises have numerous challenges in developing their labor force and personnel due to the dynamics and complexity of the industry's environment (Loosemore et al., 2003).

Training and development is an ongoing process in any organization and part of HRM practices in the construction industry. Additionally, teaching and training includes three main activities: Training, education and development. Companies that provide training and employee development are visibly investing in their employees. Positive outcomes of this investment include increased employability of individual workers (Cheng & Li, 2002). An organization's human resource training and development system is a key mechanism for ensuring that it has the knowledge, skills and attitudes necessary to achieve organizational goals and create competitive advantage (Quartey, 2012).

Training is a planned activity that promotes the acquisition of work-related knowledge, the updating of skills, and influences employee behavior. "Training is formal and systematic behavioral change through learning resulting from education, development and planned experience (Armstrong, 2006).

On the other hand, due to the nature of the construction industry, most construction companies face many obstacles and difficulties in implementing effective training and development practices for their staff and workforce (Loosemore et al., 2003, Tabassi et al., 2012). The training of personnel contributes directly to the development of HRs within construction organizations. Training also plays a critical role in increasing workers' adaptability and flexibility, which employers have found is becoming increasingly important. It is therefore important for organizations to maintain the necessary competencies of their employees through appropriate training (Tai, 2006). Training has to start with the recognition of training needs through job analysis, performance assessment and organizational analysis. Once the training needs of extension personnel have been identified, the next step is to organize training programs. Methods such as role-playing, simulation exercises, case study, on-the-job training, off-the-job training, and distance education can be used in construction industry to create learning situations based on experience.

2.3.5 Compensation (Reward) Management in Construction Companies

Compensation is a Human Resources function that handles all kinds of rewards that individuals receive in exchange for accomplishing organizational tasks such as: Wages, Salaries and Bonuses. The purpose of the Compensation function is to build a compensation system that is fair to employers and employees. Green, Felstead, Mayhew, and Pack (2000) argue that compensation systems are perceived as employee performance and are highly correlated with organizational performance. Compensation is defined as all cash payments and all goods used in lieu of funds to compensate an employee. Compensation systems are designed to attract, motivate and retain employees.

Reward system refers to all the monetary, non-monetary and psychological payments that an organization provides for its employees in exchange for the work they perform. 'To complement financial rewards, there are different tools of non-financial rewards. Those focus on the needs that people have for recognition, achievement, responsibility, influence and personal growth. Money alone cannot be relied on motivating employees to work, so it should be reinforced with these non-financial rewards. Nani and Apraku (2016) made study on Effects of Reward Systems on Performance of Construction Workers in Ghana and the result of their findings indicate that non-financial rewards were as important as financial rewards to improve the performance of employees.

According to Bratton and Gold (2007), compensation refers to monetary, non-monetary, and psychological payments that organizations make to employees in exchange for their work. Regardless of what other compensation they offer their employees, organizations must make three main decisions: what monetary compensation to pay, who to pay, and how much to pay. Financial compensation should be a focus as part of the overall employment relationship. Mulolli, Islami, and Skenderi (2015) suggest that compensation and rewards can be effective tools to motivate employees to achieve organizational goals. Reward management is closely related to performance management, as rewards are usually given after successful performance.

Rewards can be divided into monetary and non-monetary rewards, and different strategies can be used to allocate rewards (Armstrong 2006). In practice, the demand and supply of labor increasingly influence remuneration, but remuneration should be based on the type of work an individual does and how they do it. Compensation is seen as a leadership tool that supports organizational success and motivates employees to act in accordance with the organization's values and goals. The rewarding has many different systems to follow. The financial rewards can be base pay, and performance related pay. Base pay is determined with internal and external rates that are the form of job evaluation and market rates and it is expressed with relation to a certain time period i.e. year, month, and week. The levels of pay are agreed with individual agreements or with collective agreements/with labor unions (Armstrong 2006).

2.3.6 Motivation and Labor Relation Practices in Construction Companies

Motivation is the force that energizes, directs and sustains behavior. Well-motivated people who are prepared to exercise discretionary effort, i.e. independently do more than is expected of them achieve high performance. As described in Armstrong's Handbook of Human Resource Management Practice (2014), the term 'motivation' derives from the Latin word for movement (movere). A motive is a reason for doing something. Motivation is the strength and direction of behavior and the factors that influence people to behave in certain ways. People are motivated when they expect that a course of action is likely to lead to the attainment of a goal and a valued reward – one that satisfies their needs and wants. The term 'motivation' can refer variously to the goals that individuals have, the ways in which individuals chose their goals and the ways in which others try to change their behavior.

Pink (2009) cited in Armstrong and Taylor (2014) stated that there are three steps that managers can take to improve motivation:

1. Autonomy – encourage people to set their own schedule and focus on getting work done not how it is done.
2. Mastery – help people to identify the steps they can take to improve and ask them to identify how they know they are making progress.
3. Purpose – when giving instructions explain the why as well as the how.

Motivation begins with good work ethics, the mental attitude of employees towards employers and their jobs. High morale is evidence that an organization is running well. However, poor work ethic manifests itself in many ways, including absenteeism, turnover, and strikes, reduced productivity, and increased employee dissatisfaction (Ameh & Daniel, 2017). Additionally, Akpala(1982) states that industrial relations or industrial relations mean the relationship between workers and employers as collective identities rather than as individuals. The concept of industrial relations is narrower in scope than industrial relations as it is an internal agreement between employers and trade unions in a bilateral relationship. Their activities seem to rule out the possibility of state intervention as a mediator in industrial relations regulation. When it comes to such third-party government intervention, the relationship becomes even more complex and is known as industrial relations.

2.3.7 Health and Safety Managements in Construction Companies

Health and safety at construction sites deals with both physical and psychological wellbeing of workers on construction sites and other persons whose health is likely to be adversely affected by construction activities. It is of primary concern to employers, employees, governments and project participants. According to Muiruri and Mulinge(2014) Health and safety management system is a crucial system in ensuring the wellbeing of every individual in a company. Construction workers are exposed to risky workplaces so the execution of HSMS in construction projects can save millions of lives of workers. In developing countries like Ethiopia where there is a high unemployment and illiterate rate, it is not easy to save a life of one educated, skilled or experienced labor. Saving the working man power is saving the lives of many others living by them (Alemu, 2020).

According to Dukpa and Dendup (2017) pertinent issues existing in the construction sector in developing countries included: no proper safety net or system to protect workers, use of poor quality hand tools (which increases the risk of injury), failure to include safety mechanisms at the time of design and planning, unclear or undefined roles and responsibilities of all the parties involved, and the lack of participation of workers in the health and safety issues. Similarly, lack of safety awareness, insufficient safety regulations, poor technical knowledge and capability, ineffective implementation or enforcement of safety standards, and poor attitudes towards safety and health are also common in developing countries (Gutierrez-Gutierrez, Barrales-Molina, & Kaynak, 2018).

Agwu (2012) argued that the construction industry needs to see construction safety not only as a new step to avoid unwanted accidents and costs, but also as a strategic tool to maximize competitiveness and profitability. In this context, there is a need to propose comprehensive safety management as a performance-based approach to construction safety that provides organizations with a sustainable competitive advantage in the global marketplace by creating a safe working environment. This is consistent with excellence and continuous improvement through the integration of all aspects of construction safety: intent, behavior, culture and process.

In Ethiopia, however, the perspectives of most industries and organizations show that the stage of occupational health and safety is still at infancy in the country due to employer/employee attitudinal behavior, lack of safety culture and non-implementation of OHS policies. In addition, only big multinationals recognize occupational health and safety and run the policies as constituted in their parent countries of origin (Argaw, 2017). Meanwhile a typically effective safety management system should encapsulate the actions managers at all levels take in order to create an organizational setting in which workers will be trained and motivated to perform safe and productive construction jobs.

According to Fekete, Quezon, and Macarubbo (2016) the construction industry has been seen as one of the hazardous industries. This is because the industry has a poor health and safety performance record compared to other industries all over the world. Labor law in every nation provides that it is the duty of an employer to ensure that every worker employed works under satisfactory, safe and healthy conditions.

2.4 Overview of Critical Success Factors

Critical Success Factors are the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization. CSF are few key areas where things must go right for the business. If results in this area are not adequate, the organizational effort for the period will be less than desired. They are areas of activities that should receive constant and careful attention from management. CSF method is basically a top-down managerial approach which identifies strategies and goals (Weldegebriel, 2018). Ghazzawi et al., (2014) States that, Human resource management is defined as a strategic and coherent approach to the management of an organization's most valued assets – the people working there who individually and collectively contribute to the achievement of its objectives.

Human resources are the human labor, the physical abilities, and mental abilities that produce the goods and services of businesses. Human Resource Management Critical Success Factors are also the limited number of areas in which results, if they are satisfactory, will help in ensuring successful competitive performance for the given organization. Chang et al.,(2016), Gan et al.,(2016), Zhang et al., (2015, state that governments of developing countries have distributed generous measures of capital budget plans to the framework, transport, and private undertakings in late decades. Human resource is required for an organization to conduct different business activities. Without the support of human resource, the organization cannot exist or operate effectively. The success of any organization depends on the effective use of human resources.

Gudienė et al.,(2014) made study on identification and evaluation of critical success factors for Lithuanian construction projects . They reported a hierarchical model composed of 71 CSFs for construction industry. The identified CSFs were grouped in to seven categories, namely; External factors, institutional factors, project related factors, project management/team related factors, project manager related factors, contractor related factors and client related factors. The findings of their work revealed that the top CSFs for Lithuania construction projects are clear and realistic goals, project planning, project manager's competence, relevant past experience of project management/team, and competence of project management /team. The critical success factors reported (Chehrehpak & Alizadeh, 2015) were analyzed using Rough test theory and expert judgment which found top four construction projects success factors.

The factors were on-time financing by employee, an updated schedule, commitment of employees to schedule, preliminary studies and detailed designs by employer and consultant team. A comprehensive investigation of CSFs undertaken by (Alshami, 2018) has identified CSFs of construction projects based on project size and general aspects. Top five critical success factors were found for general projects, namely: project team motivation and commitment, project manager experience and leadership, communication among all project participants, project manager commitment to project goals, and having good control over time, cost and quality. Top management support and project manager experience and leadership skill were top significant success factors for construction projects depending on the project size.

Didenko and Konovets (2009) studied Success Factors in Construction Projects for the case of Housing Projects in Ukraine. Their study revealed that the most important success factors were economic environment, project manager's experience and qualification of project team.

2.5 Human Resource Management Critical Success Factors (HRMCSFs) for Construction Companies.

The overall purpose of human resource management department is to ensure that the organization is able to achieve success through people, and the good human management is essential if organizations want to attract and retain good staff. Zainon et al.(2020), studied on factors of human resource management practices affecting organizational performance in Malaysia using questionnaire and analyzed those factors using inferential statistics. The results of multiple regression showed that staff training, performance appraisal and rewards, and recognition to be significant factors of human resource management affecting organizational performance.

Similarly, Keat (2012) had made study on regarding the role of human resource management for construction projects with the aim of reviewing human resource management activities, identifying the challenges of human resource management and critical success factors of human resource management. Through his investigation he has identified top management support to be the most critical factor in human resource management. Leilaee and Rezaeian (2021) have studied Critical success factors for human resource management of Iranian construction projects. After extracting 27 key success factors in human resource management in development projects from literature review, they divided those factors into seven categories. Those categories were named, organization, and business relationship, supply of resources, performance management, human resource development, reward management and staff relations.

Using ANP and TOPSIS analysis method the result of their study revealed that increasing trust and certainty between employees and project team managers is the most significant factor. Herath and Chong (2021) have made literature review to identify Key Components and Critical Success Factors for Project Management Success. From their review they have found project human resource management to be one of the key project components. The research done by (Prajapati et al., 2015) have identified factors affecting human resource management of construction firms using RII method. Accordingly, they have identified top ten ranked factors i.e.: life security, working experience of candidates, paying competitive wages, systematically structured training process, competitive salaries, improper crew design, and accurate job description, quality of program provided, and technical knowledge of candidates, clearly defined duties, and regular performance appraisal.

(Fekele et al., 2016) have studied health and safety management practice in building construction for the case of Addis Ababa and they have reported non availability of a clear company Health and safety policy; inadequate enforcement of the existing building rules and regulations; and Safety awareness of the company's top management to be the top three factors affecting health and safety performance of labors. The main problems of human resource management in the construction of a sustainable project have been identified from the undertaken research. There were project managers' roles, communication between team members and insufficient teamwork. The main methods for improvement have also been discovered; namely, more communication among team members, the appointment of a more experienced project manager and the assignment of more skilled workers(I. Othman et al., 2012).

Dosumu et al. (2021) have made study on recruitment and selection practices of construction companies' employers in Rwanda using descriptive survey research design. Their findings indicated that request for curriculum vitae, cover letter, face-to-face interview, submission of information applications with key information of education/work experience and knowledge test to measure job specific knowledge are prevalent strategies of recruiting and selecting staff in construction industry. The research an overview undertaken by (Sagar & C.Aher, 2021) on evaluation of construction firms using human performance factors.

The findings have revealed adaptability, job knowledge, judgment, motivation, and productivity to be the most important factor, which is preferred by all construction firms. Kundu, Malhan, and Kumar (2007) have studied human resource management practices in shipping companies.

According to their result, training and performance appraisal and hiring and compensation system are strongly practiced. The third human resource management practice, which was practiced well, was career development. ‘Job analysis and HR planning’ was moderately practiced in shipping companies. ‘Workforce diversity and flexi-work system’ also showed presence but did not emerge as strong.

2.6 Summary

According to previous studies, HRM aims for developing the policies and procedures needed to carry out management tasks that depend on certain aspects of employee activities, particularly with regard to hiring, training, performance reviews, rewarding, and fostering an environment that is fair and healthy for employees. HRM refers to a set of guidelines and procedures that cover things like job analysis, hiring and selection, orientation, remuneration, performance evaluation, training and development, and labor relations. It was obtained that there were many fields and topics which are related to human resource management such as, human resource management in construction projects, the practice of HRM in construction Industry, factors affecting labors productivity, HRM critical factors, the impact of HRM on projects success and key determinants of HRM.

Most of the scholars agree on that there is a strong link between HRM and the success of projects. CSFs and the criticality of a factor for the success of a project vary with respect to its type. Hence there are scarce source of publications regarding critical success factors of human resource management as whole and specifically as construction sector. All project success factors that are related to human factors found in publications are considered in this research regardless of the project type.

The reason for this generalization lies in the fact that projects do not operate in isolation, but are surrounded by common environments, procedures, policies and tools. After making comprehensive literature reviews of previous studies and with the help of experts, 23 HRM CSFs related to construction companies categorized under six categories were used in the present study as shown below in table 2. It has to be stressed here that the given name is totally subjective and other readers might give a different name(Sawacha, Naoum, & Fong, 1999).

Table 1 Critical Success Factors of HRM for construction companies

Category	CSFs	References
Human Resource Planning(HRP)	Determining of the project goal/Clear goals and objectives	Leilae & Rezaeian (2021), Didenko & Konovets (2009), Singh.M & Sharma.S.K., (2020)
	Regular Human Resource Planning	Kundu et al., (2007), Prajapati et al., (2015), Alzahrani & Emsley, (2013)
	Number of employees	Didenko & Konovets (2009), Singh.M & Sharma.S.K., (2020), Prajapati et al., (2015), Alzahrani & Emsley, (2013), Zakari Tsiga.et.al., (2016), P.C.Chan et al., (2004)
	Proper Human Information system	Kundu et al., (2007), Prajapati et al., (2015), Babu (2015)
Recruitment and Selection(RAS)	Selection of candidate having good technical knowledge	Prajapati et al., (2015), Zakari Tsiga.et.al., (2016), I.Othman et al., (2012)
	Selecting experienced and skill-full project team	Leilae & Rezaeian (2021), Didenko & Konovets (2009), Zakari Tsiga.et.al., (2016), P.C.Chan et al., (2004), Alshami (2018)
	Selecting experienced and skill-full project manager	Leilae & Rezaeian (2021), Singh.M & Sharma.S.K., (2020), Prajapati et al., (2015), Zakari.Tsiga.et.al., (2016), Babu (2015), Alshami (2018)
	Volume of work	Didenko & Konovets (2009), Prajapati et al., (2015), Zakari Tsiga.et.al., (2016), Alyew, Bassa, Reta, & Tora, (2020), Mahamid, Al-Ghonamy, & Aichouni (2013), P.C.Chan et al., (2004)

Performance Management (PM)	Regular performance appraisal	Kundu et al., (2007), Prajapati et al., (2015), Nirmala & Faisal, (2016), Zainon et al., (2020)
	Top management support	Leilae & Rezaeian (2021), Didenko & Konovets (2009), Zakar .Tsigal.et.al., (2016), P.C.Chan et al., (2004), Alshami (2018)
	Paying for performance	Leilae & Rezaeian (2021), Kundu et al., (2007), Prajapati et al., (2015), I.Othman et al., (2012), Zainon et al., (2020)
	Staff involvement in decision making	Leilae & Rezaeian (2021), Didenko & Konovets (2009), Prajapati et al., (2015), ZakariTsigal.et.al., (2016), Nirmala & Faisal, (2016)
	Rework	Didenko & Konovets (2009), ZakariTsigal.et.al., (2016), Nirmala & Faisal, (2016)
Training and Development (TAD)	Providing safe and sufficient credit resources	Leilae & Rezaeian (2021), Alzahrani & Emsley, (2013), Mahamid, Al-Ghonamy, & Aichouni (2013)
	Transfer of individual experience between team members	Leilae & Rezaeian (2021), Prajapati et al., (2015), Alzahrani & Emsley, (2013)
	Providing sufficient and structured training and development program	Singh.M &Sharma.S.K.,(2020), Kundu et al., (2007), Prajapati et al., (2015), Zakari Tsigal.et.al., (2016), I.Othman et al., (2012), Zainon et al., (2020), Khaleel & Nassar, (2018)
	Organizational Structure	Didenko & Konovets (2009), Singh.M &Sharma.S.K.,(2020), Alzahrani & Emsley, (2013)

Motivation and Labor Relation (MALR)	Increasing trust and confidence between employees and project team and project manager	Leilae & Rezaeian (2021), Babu (2015), Mahamid, Al-Ghonamy, & Aichouni (2013)
	Effective and comprehensive communication between project team members	Leilae & Rezaeian (2021), Singh.M & Sharma.S.K., (2020), ZakariTsigal et al., (2016), I.Othman et al., (2012), Alshami (2018), Mahamid, Al-Ghonamy, & Aichouni (2013),
	Encouraging teamwork	Leilae & Rezaeian (2021), I.Othman et al., (2012), Alyew, Bassa, Reta, & Tora, (2020)
	Employee motivation	Kundu et al., (2007), Babu (2015), Alshami (2018), Mahamid, Al-Ghonamy, & Aichouni (2013)
Health and Safety(HAS)	Creating good working culture	Leilae & Rezaeian (2021), Prajapati et al., (2015), Alzahrani & Emsley, (2013)
	Creating of job security in the field of health and safety	Leilae & Rezaeian (2021), Singh.M & Sharma.S.K., (2020), Prajapati et al., (2015), P.C.Chan et al., (2004), Babu (2015), Alshami (2018), Alyew, Bassa, Reta, & Tora, (2020)

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

Research methodology is the step by step procedure used to determine a solution to a particular problem. It is specific techniques for collecting and analyzing data in order to uncover new information. In this chapter the specific procedures and techniques that are used to identify, select, process, and analyze the research data are described. Research approach, research design, population and sampling, data collection, and data analysis are topics detailed in this chapter. A brief illustration of the research design is provided to aid in understanding the structural flow of the study.

3.2 Research Approach

A research approach is a procedure chosen by the researcher to gather, examine, and interpret data. There are two basic types of research approaches: qualitative and quantitative(Kothari, 2004). In a quantitative research, numerical data are gathered and analyzed to characterize, explain, forecast, or control relevant occurrences. Quantitative research approaches involve the collection and analysis of numerical data and information that are descriptive and qualified in nature(Sekaran & Bougie, 2016). It is best for investigating cause and effect and testing theories and hypotheses (Muijs, 2010).

The goal of qualitative research is to better understand a particular phenomenon of interest by gathering, analyzing, and interpreting extensive narrative and visual evidence. Qualitative research aims to understand phenomena as they naturally occur by simultaneously examining a variety of its facets. Through the use of both quantitative and qualitative data in a single study, mixed methods research integrates these two methodologies. The relationship and strength between quantitative and qualitative research approaches can be strengthened through the use of mixed methods research. It provides deeper and broader information than a single research (Almalki, 2016).

Qualitative research approach is concerned with subjective assessment of attitudes, opinions and behavior. It is a function of researcher's insights and impressions (Kothari, 2004). AHP is a decision analysis method that considers both qualitative and quantitative information (da Serra Costa, Correia, & de Souza; Liang & Peng, 2017). It adopts both qualitative and quantitative approaches to solve complex decision problems (Cheng & Li, 2002).

Qualitatively, AHP helps to decompose a complex problem into a hierarchical system. Quantitatively, it uses the pair-wise comparison to rate a group of elements and employs the consistency test to drop out inconsistent responses. Additionally, ISM is a methodology that includes qualitative and interpretive approaches (based on expert judgment in industry and academia) to solve complex problems based on structural mapping of attribute relationships (Watson, 1978, as cited Renukappa, Suresh, Al Nabt, Sarraikh, & Algahtani, 2020). Hence, mixed research approach was used in this study. Mathiyazhagan, Govindan, NoorulHaq, and Geng (2013) have used ISM analysis approach for identifying barriers of green supply chain management implementation and they have described ISM as a qualitative analysis method.

3.3 Research Design

According to Kothari (2004), a research design is a blueprint or road map for data collecting, measurement, and analysis. It is used to integrate various study components in a logical and coherent manner in order to effectively handle research challenges. Research design is the arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure. It includes an outline of what the researcher will do from writing the hypothesis and its operational implications to the final analysis of data (Kothari, 2004).

Descriptive research design is a type of research design that aims to obtain information to systematically describe a phenomenon. And it helps to answer the What, When, Where and How questions regarding the research problem, rather the why. Explanatory research focuses on establishing causal relationships between variables and examining situations or problems to explain relationships between variables (Saunders, Lewis, & Thornhill, 2009).

In this study, a descriptive and explanatory research design were used in order to assess the opinions of experts (those working within construction industry and academicians) to describe Critical Success factors for HRM of construction companies and explain the relationship between identified factors. Data collected using surveys at specific time points can be used to determine specific relationships between variables and to model those relationships (Saunders et al., 2009). Figure 1 shows the overall block diagram of research design.

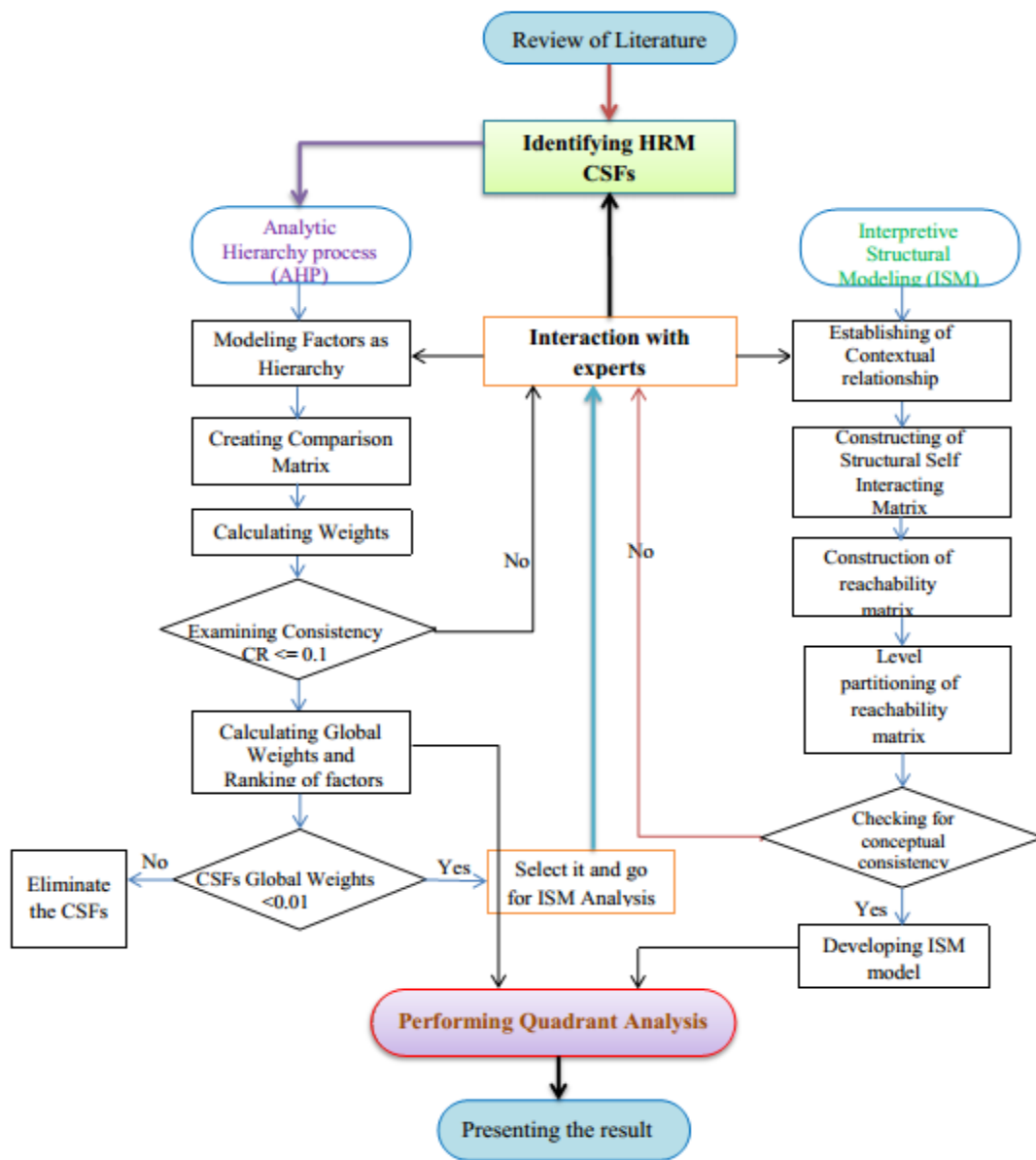


Figure 1 Research design (Research Flow)

3.4 Sampling design

3.4.1 Target Population

The population of this study was 133 grade 1; Building contractors (BC-1), Road contractors (RC-1), Special contractors (SC-1) and General contractors (GC-1) construction companies found in Ethiopia. The number of construction companies is taken from constructionproxy.com page.

3.4.2 Sampling frame

A sampling frame is a list of people, events, source material, or devices from which samples are drawn. It contains a list of all individuals in the population selected as a sample. This includes individuals, companies, organizations and associations (Cassell, Lee, Saunders, Lewis, & Thornhill, 2012). The sampling frame of the study was comprised of 37 grade 1 general contractors (GC-1) construction companies currently found Addis Ababa city Administration. They were selected to be sampling frame of the study as they engage in any civil construction works except water works. These contractors are qualified to undertake a variety of construction works such as buildings, roads, railways, bridges, etc.

The reason for including this sample frame is that top-notch contractors are engaged in many different types of multi-million dollar projects compared to other contractors, thus strengthening the concept of competence in all aspects of management, which involves large number of human resources as compared to others. Project managers, office engineers, human resource managers and foremen were preferred to be the sample elements of this study because they can provide reliable information and clearer understanding about the purpose of the study. Moreover, as these people are in a position to be more expert within their field, they represent the sample population more effectively.

3.4.3 Sampling Technique

According to Bagnasco, Ghirotto, and Sasso (2014) Sampling is a technique used by researchers to systematically choose a representative samples from a pre-defined population to act as a data source. Purposive sampling, also known as judgmental, selective, or subjective sampling, is a form of non-probability sampling in which researchers select members of a population to participate in a study based on their own judgment.

It is a form of non-probability sampling in which decisions concerning the individuals to be included in the sample are taken by the researcher, based upon a variety of criteria which may include specialist knowledge of the research issue, or capacity and willingness to participate in the research (Jupp, 2006). For this research work purposive sampling technique, which is a nonprobability sampling technique, was adopted for data collection. This technique is preferred for the fact that it is less expensive and less time consuming.

3.4.4 Sample Size

Sampling is used as a basis for statistical estimation, or illation from items, about the features of that population (Saunders, et al 2009). According to Sekaran (2003), sample is defined as subgroup or subset of the population. Besides, it also can be defined as a set of respondents selected from a larger population for the purpose of a survey.

Although sample size can affect various aspects of study such as data analysis and interpretation of relevant results, AHP technique does not require a statistically large sample size to yield informed and statistically robust results (Dias Jr & Ioannou, 1996; Doloi, 2008). Because AHP is based on expert judgment, some researchers argue that even one qualified expert judgment is usually representative (Abudayyeh, Zidan, Yehia, & Randolph, 2007; T. Saaty, 1980; Schot & Fischer, 1993). Moreover, it may be unhelpful to use AHP in a study with a large sample size because ‘cold-called’ experts are likely to provide arbitrary answers, which could significantly affect the consistency of the judgments (Cheng & Li, 2002).

Pandey, Bhatnagar, and Ghosh (2021) have used AHP-ISM approach for analyzing critical success factors of sustainable supply chain management in the context of an engine manufacturing industry with a sample size consisting of 5 experts. Salman validated BOT feasibility model for large-scale infrastructure projects using only 12 respondents' inputs. Similarly, Dias Jr and Ioannou (1996) invited only 8 respondents and completed the questionnaires. In Issar (2010), only 25 and 18 companies had respectively accepted the invitation and completed the questionnaires.

Similarly, using purposive sampling method, Dias and Ioannou (1996), invited only 12 respondents and developed company and project evaluation model for privately promoted infrastructure projects with only 8 completed questionnaires. Pholloke, Saenchaiyathon, and Rungruang (2019) have identified human resource management practices affecting employee retention using ISM by collecting data from 8 experts with interview using Delphi method.

In their AHP-ISM approach based research work used for analyzing critical success factors of sustainable supply chain management in the context of an engine manufacturing industry, Pandey et al. (2021) have used a sample size consisting of only 2 experts for ISM analysis. Kusriani, Safitri, and Helia (2019) by collecting a primary data from 4 experts, using ISM, have identified key success factors for small and medium enterprise in Indonesia.

Due to the large number of contractors established in the country and for the feasibility and management of data collection only those contractors that are found in Addis Ababa were selected for the collection of data. Using purposive sampling method 10 first class general contractors (GC-1) construction companies were selected and 3 questionnaires were sent to each firm which makes a total number of 30 questionnaires. There is nothing in the literature regarding exactly how many experts are required for performing Interpretive Structural Modeling. From observing similar issues in publication works 3 to 5 experts could be suitable. Hence, 4 experts; 2 from academician and 2 from construction industry were invited to identify and develop a conceptual relationship between factors under study.

3.5 Data Collection

Collecting data entails compiling information from all pertinent sources to resolve the issues raised by the research. The two categories of data gathering techniques are primary data collection techniques and secondary data collection techniques. The pre-requisite requirement for being chosen as a respondent for this research was to work as a project manager, office engineer, human resource manager, project coordinators or foremen for a grade one construction companies currently found in Addis Ababa.

3.5.1 Primary Data Source

A primary data source is an original data source where the information was gathered by the researcher directly for a particular study goal. Primary data collection can be done in a variety of ways. However, this study used questionnaire surveys followed by in-depth interview.

3.5.1.1 Questionnaire

A questionnaire is a research instrument that consists of a set of questions for gathering information from respondents through survey or statistical study (Wikipedia, the free encyclopedia). To achieve objectives of the study two-survey questionnaires were designed to gather information from construction experts (both academician and practitioners). The first one was for AHP analysis method and the second one was for ISM analysis method.

In this study, AHP is used to rank identified factors based on their importance to the construction companies. Experts were asked to give preference weightage for each factor over another with reference to the Saaty scale as given in Table 2. The feedbacks from different experts were aggregated to assign final ranks to the factors. The first section was about general background of respondents. Respondents were asked their job designation, education level, experience etc. The second section is a nine-point Saaty scale survey on relative importance of identified factors (Appendix-A). To help participants gain a basic understanding, AHP model, HRM categories, AHP comparison matrix example and explanations were included to the undertaken questionnaire survey (Appendix-A). For ISM analysis method, experts were asked to identify and develop a conceptual relationship between factors under study (Appendix-B).

3.5.2 Secondary Data Source

Secondary data is material that has previously been obtained from primary sources and made accessible for use in studies by researchers. The internet, theses, journals, books, and various articles in published publications were used to gather secondary data and to integrate it with primary data for results interpretations and conclusion.

3.6 Data Analysis

3.6.1 Analytic Hierarchy Process (AHP)

Analytic Hierarchy Process (AHP) is a type of multi-criteria assessment (MCA) technique for analyzing complex decisions. It was created in the early 1980s to assist decision-makers in identifying the option that best suits their goal and understanding of the problem. These days, it is employed across a variety of sectors, particularly in the engineering, corporate strategic management, educational, and quality evaluation sectors. Many researches (25.6%) are being undertaken using AHP method (Madzík & Falát, 2022). AHP is a system analysis technique used for solving decision problems, by transforming complex decision problems into elemental issues (clusters) to create hierarchical model.

3.6.1.1 Analytic Hierarchy Process (AHP) Procedures

The model (evaluation structure) is a systematic determination of merit, worth, and significance of something using criteria against standards (Wang, 2015). The following steps are used for the Analytic Hierarchy Process (AHP) (Saaty, 2001 as cited in Tabar, 2013).

Step 1 – Building the decision problem as a hierarchy. The first step in AHP is to decompose the decision problem into its constituent elements and structure these elements in hierarchical order from the broadest to the narrowest (top to bottom, respectively) as shown in figure 2.

Step 2 - Making comparisons/Creating comparison matrix. This step is where pairwise comparison matrices are constructed. A square matrix is created based on the number of CSFs in each category. Six different comparison matrixes are created. Comparisons are made by assigning numerical values representing the strength of preference for one element over another, as shown in Table2.

Table 2 Scale of preference between two parameters in AHP.

Importance Scale	Definition of Importance Scale	Explanation (Assume option A and option B)
1	Equally Important Preferred	Option A and B are equally important
3	Moderately Important Preferred	Option A is moderately more important than option B
5	Strongly Important	Option A is strongly more important than option B
7	Very Strongly Important	Option A is very strongly more important than option B
9	Extremely Important	Option A is extremely more important than option B
2,4,6,8	Intermediate values	Used to represent compromises between the preferences in weights 1, 3, 5, 7 and 9
Reciprocals	Opposites	Used for inverse comparison

Source: Saaty's rating scales

Step 3 - Calculating weights. A weight is a numerical interpretation of a factor's importance to a decision, usually expressed as a decimal number. All elements in a decision sum to 1. Once the hierarchy is established, a series of pairwise comparisons are performed to determine the relative importance value of each element by comparing it to other elements at the same level in terms of their impact on the elements above hierarchy. The priorities obtained from the comparisons are used to weight the priorities in the level immediately below for every factor. The process continues until the normalized principal eigenvectors, which give the weights for each factor, are obtained. Weights of each factors were found using Spice logic AHP software.

Step 4 - Examining consistency of the developed hierarchy, calculating global weights and global rankings. After establishing pairwise matrices, the priorities of each factor in terms of its contribution to the objective were calculated through eigenvalues and eigenvectors of each pairwise comparison matrix. Specifically, the priorities of each factor are obtained from any pairwise comparison matrix A as the solution of the following equation system,

$$A\mathbf{v} = \lambda\mathbf{v}, \sum_{i=1}^n v_i = 1 \quad (1)$$

$$\lambda_{\max} = \sum_{i=1}^n \lambda_i / n \quad (2)$$

where n is the size of the matrix corresponding to the number of pairwise comparison, A is the positive pairwise comparison matrix of order n, λ is principal eigenvector, $\lambda_{\max}$ is the principal eigenvalue of A, and $\mathbf{v}$ is the priority vector(Eigen vector). The consistency ratio (CR) gives a measure of where the judgments in the pairwise comparison matrix lie (between totally consistent and totally random). It is obtained as follows:

$$CR = \frac{CI}{RI} \quad (3)$$

Where $CI = \frac{\lambda_{\max} - n}{n - 1}$ is the consistency index, and RI is the average random consistency index for different matrix order, as shown in Table 3.

Table 3 Random consistency index value (RI).

N(Matrix Size)	1	2	3	4	5	6	7	8	9	10
RI(Random Index)	0	0	0.525	0.882	1.115	1.253	1.341	1.404	1.452	1.484

When the CR is less than 0.1, the matrix is considered consistent. If the CR is greater than 0.1, the comparison matrix is considered inconsistent and it needs to be revised. The consistency the criterion and sub-criteria was examined using Spice Logic AHP Software.

3.6.1.2 Aggregation of respondents responses

The assessments of the 15 experts were added together using the geometric mean method (GMM) by Spice Logic AHP program. All expert opinions are combined into one general opinion using the geometric mean method (T. L. Saaty, 2008). The following equation (Williams & Crawford, 1980) shows how individual judgments made using GMM can be aggregated for n number of members.

$$D_{ij}^G = \sqrt[n]{\prod_{k=1}^n D_{ij}^K} \quad (4)$$

Where D_{ij}^G is the group decision for criterion i with criterion j; D_{ij}^K is the decision of individual k for criterion i with criterion j.

3.6.1.3 Analytic Hierarchy Process (AHP) Model for the current study

The following AHP model, figure 2, was developed based on the following table.

Table 4 Construction Companies Human Resource Management CSFs and used legends

Factors Categories	Construction Companies Human Resource Management Critical Success Factors (CCHRMCSFs)	Legend
Human Resource Planning (HRP)	Determining of the project goal/Clear goals	DPG
	Regular Human Resource Planning	RHRP
	Number of employees	NOE
	Proper Human Information system	PHIS
Recruitment and Selection (RAS)	Selection of candidate having good technical knowledge	SCHGTK
	Selecting experienced and skill-full project team	SEASPT
	Selecting experienced and skill-full project manager	SEASPM
	Volume of work	VOW
Performance Management (PM)	Regular performance appraisal	RPA
	Top management support	TMS
	Paying for performance	PFP
	Staff involvement in decision making	SIIDM
	Rework	RW
Training and Development (TAD)	Providing safe and sufficient credit resources	PSASCR
	Transfer of individual experience between team members	TIEBTM
	Providing sufficient and structured training and development program	PSSTADP
	Organizational Structure	OS
Motivation and Labor Relation (MALR)	Trust and confidence between employees and project team and project manager	TCEPTM
	Effective and comprehensive communication between project team members	ECCPTM
	Encouraging teamwork	ETW
	Employee motivation	EM
Health and Safety (HAS)	Creating good working culture	CGWC
	Creating job security in the field of health and safety	CJSIHAS

Source: self-work

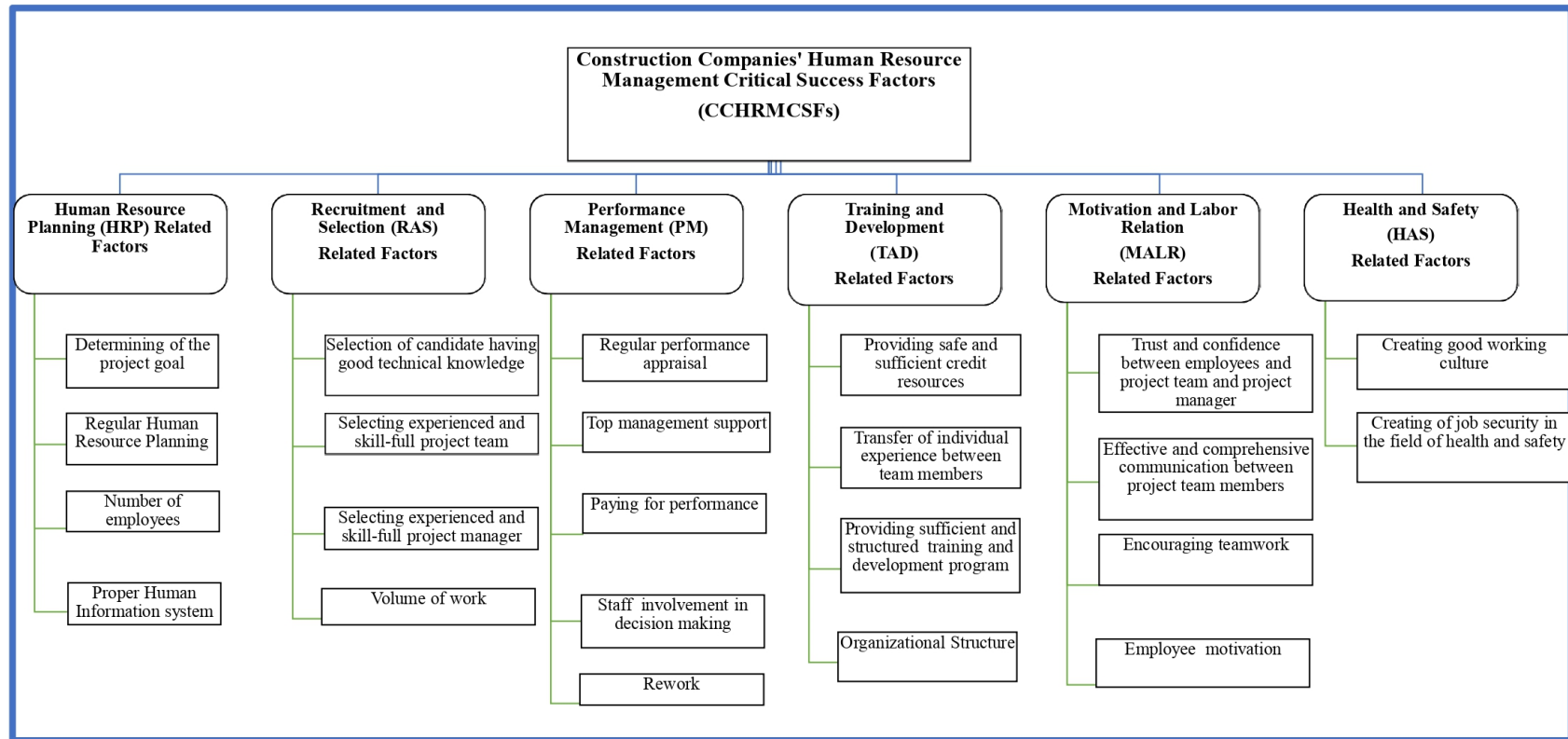


Figure 2 AHP model for the study undertaken

3.6.2 Interpretive Structural Modeling (ISM) Process

Interpretive Structural Modeling (ISM), proposed and developed by Warfield (1973) is a methodology of systemic structural modeling, which has been widely applied in identifying and summarizing relationships among factors. A set of unique, interrelated variables are structured into a comprehensive systemic model presented as a hierarchy graph in an interactive learning process. ISM helps in determining the sequence and purpose of complex relationships between elements in the system. It is used for effective planning, which is effective method because all elements can be processed within a simple matrix (Wang, M., 2015). Additionally, it is utilized to pinpoint the problematic components and examine how they interact with one another.

The factors are further grouped using MICMAC analysis utilizing the output from the ISM analysis. The MICMAC analysis method investigates CSF effect and interdependency. By examining the driver power and dependence power of each CSF, this technique further divides them into distinct clusters (Mandal & Deshmukh, 1994). ISM and MICMAC analyses offer a helpful hierarchy of factors whose individual relationships are clear-cut but whose group relationships are too complex to organize intuitively. This hierarchy can aid practitioners in better understanding factor dependencies and factor prioritization.

3.6.2.1 Interpretive Structural Modeling (ISM) Procedures

ISM helps groups of people structure their collective knowledge. A systematic application of graph theory using theoretical, conceptual, and computational exploits has been employed to efficiently construct directed graphs for reference (Faisal, Banwet, & Shankar, 2006). The general process of ISM development involves seven steps.

Step 1. Listing and Selection of construction companies Human Resource Management (HRM) practices critical success factors. Under this stage a set of factors effecting construction companies HRM practices are identified and listed based on literature review and expert opinions. Based on the result of AHP, 22 factors were selected based their global weight as shown in table 16.

Step 2. Establishing of contextual relationship between selected factors with the help of expert opinions. As shown in Table 5, four different sorts of symbols (V, A, X, and O) are utilized to establish the interaction between the relevant components.

The respondents (experts) of this study were asked to identify the relationship between selected factors and the intended relationship was developed based on the most common opinion of experts (Bag, Kilbourn, Pisa, & Giannakis, 2021; G. Sharma & Kumar, 2021).

Step 3. Construction of Structural Self Interacting Matrix (SSIM) by pairwise comparison from established contextual relationship. For the development of SSIM, the contextual relationship of each variable is considered and the existence of a relation between any two factors (i and j) and the associated direction of the relation was depicted. Accordingly, a Structural Self Interacting Matrix (SSIM) has been created based on these interactions, as illustrated in Table 18.

Table 5 The Symbols used in the development of Structural Self –Interaction Matrix.

Symbol	Interaction among the concerned factors
V	Factor “i” influences factor “j” and factor “j” does not influence factor “i”
A	Factor “j” influences factor “i” and factor “i” does not influence factor “j”
X	Factor “i” and factor “j” influence each other
O	Factor “i” and factor “j” have no relationship

Step 4. Constructing initial Reachability Matrix (RM). After constructing SSIM, Initial reachability matrix (M) is developed by converting the SSIM matrix elements i.e., V, A, X, and O with the binary number (0 and 1) using the following rules:

- “V”: (i,j) and (j,i) become “1” and “0” respectively.
- “A”: (i,j) and (j,i) become “0” and “1” respectively.
- “X”: (i,j) and (j,i) both become “1”.
- “O”: (i,j) and (j,i) both become “0”.

Step 5. Checking for transitivity and generating final Reachability Matrix (FRM). The transitivity of the contextual relationships is a basic assumption made in ISM. It states that if a variable “i” leads to variable “j” and variable “j” leads to variable “k”, then variable “i” should lead to variable “k”.

Step 6. Level Partitioning of Reachability Matrix (M). Level partitioning is done based on the reachability and antecedents of each variable through iterations. This is very similar to the ISM methodology. This assigns a level to all elements.

Leveling is based on the similarity of intersections of reachability sets and antecedents depending up on factors driving and dependency power. After leveling a particular factor, that factor is removed from all sets for the next iteration and the next factor level is searched again.

Step 7. Drawing relationship graph based on SSIM, M, and developing ISM model. Based on final reachability matrix (M) which is generated from SSIM, a relationship graph is drawn. Finally from the given relationship graph, ISM model is developed.

Step 8. Checking for conceptual consistency. The developed ISM model is checked for conceptual consistency. If the developed model is conceptually consistent, conclusion will be made and if not modification of the model follows.

3.6.3 Quadrant Analysis

Quadrant analysis is a method used to categorize factors or variables based on their performance/influence and importance ratings. It involves plotting the factors on a two-dimensional grid, with the x-axis representing influence and the y-axis representing importance. The positioning of the vertical and horizontal axis is based on the grand mean of importance and influence (Bacon, 2003). The four quadrants in a quadrant analysis are:

1. Keep up the good work: This quadrant includes factors that have both high influence and high importance. These factors are considered critical to the success of the project, and efforts should be made to maintain and further improve their performance.
2. Possible overkill: This quadrant includes factors that have high influence but low importance. While these factors may have a strong influence on the project, their low importance suggests that excessive resources may be allocated to them. It is important to reassess their significance and adjust the level of focus accordingly.
3. Priority for improvement: This quadrant includes factors that have low influence but high importance. These factors are identified as areas that need improvement to meet the project's goals. Efforts should be directed towards enhancing their performance to ensure project success.
4. Low priority: This quadrant includes factors that have both low influence and low importance. These factors have minimal impact on the project and may not require immediate attention or allocation of resources. It is important to reassess their significance and prioritize efforts on other critical factors.

By categorizing factors into these quadrants, project managers can prioritize their actions and allocate resources more effectively. This analysis helps in identifying areas of strength and weakness, enabling the team to focus on the factors that will have the greatest impact on project success. This method was applied for the current study to combine the prioritizations based on influence and importance and identify factors that are both important and influential.

3.7 Data Quality Assurance

3.7.1 Validity Test

Validity is defined as how much any measuring instrument measures what it is intended to measure. Bryman & Bell (2003) suggested that the important issue of measurement validity relates to whether measures of concepts really measure the concept. Validity refers to the issue of whether an indicator (or set of indicators) that is devised to gauge a concept really measures that concept.

This phase could be considered as a pre-test, the purpose of which was to ensure that the survey was understandable, relevant, accurate and meaningful to the respondents. Content validity assesses whether a test is representative of all aspects of the construct. Content Validity of questionnaire can be assured by; consulting experts, reviewing literature, and conducting a focus group or an interview with some potential respondents. This study addressed content validity through reviewing the literature and by forwarding the designed questionnaire to subject matter experts in the field of study. Consistency ratio (CR) of pairwise comparison matrix is used to ensure the validity of questionnaires (Haery, Ghorbani, & Farahmand, 2014; Lee, 2015).

3.7.2 Reliability Test

Reliability is one of the test which helps for measuring quality. It refers to the consistency of a measuring instrument. In other words, a research instrument consistently has the same results if it is used in the same situation on repeated occasions to the extent. The reliability of this study is assured by checking the consistency ratio (CR). The consistency ratio (CR) of pair wise comparison matrix indicates the reliability of responses (Doloi, 2008; Haery et al., 2014; Lee, 2015).

3.8 Ethical Consideration

The main ethical issue will be regarding the questionnaires and seeking proper authorization from the respondents in using their responses for analysis and reporting. The researcher has sent a cover letter stating the purpose and usage of the data along with the questionnaire. This was used to seek access for collecting data from respondents and to convey the nature and purpose of the questionnaires. Furthermore, the rights of participants in this study were protected by strict confidentiality of participant identities and responses. The other ethical consideration of this research is in keeping the findings not to be disadvantageous to participants.

Chapter Four

Results and Discussion

4.1 Introduction

In this chapter, results of the data gathered from the desk study and questionnaire survey are discussed. Moreover, the chapter discusses the primary data's analysis, discussion, and interpretation in light of the study's goals. Three main sections make up the chapter: The overall characteristics of the respondents and their response rate are discussed in the first section. The results are analyzed in the second section, factors are ranked based on their importance and finally in the third section interpretive structural model is presented.

4.2 Demographic characteristics of the sample

4.2.1. Response rate

A total of 30 questionnaires were distributed amongst 10 construction companies project managers, project coordinators, office engineers, human resource managers and site engineers. Consequently, 20 replies (66.67% response rate) were obtained from the population of 37 grade 1 GC in Addis Ababa. Working as a project manager, office engineer, human resource manager, project coordinator, or foreman for one of the grade one construction businesses now located in Addis Ababa was a prerequisite for being selected as a responder for this study.

Out of 20 returned responses, 3 responses were invalid and 4 were incomplete and inconsistent. 4 incomplete and inconsistent responses were returned to respondents to revise their presences and complete incomplete questionnaires. Accordingly, only two experts revised their preferences and completed their incomplete responses. Hence the final numbers of questionnaires used for the analysis were 15. The response rate of current study is 66.67%, which means that the response rate is sufficient to draw a very good conclusion and interpretation.

4.2.2 Respondents Designation and Experience Level

Table 6 below provides a tabular depiction of the respondents' designation. According to this table, 20 %(3) of respondents identified as project managers, 26.7%(4) as project coordinators, and 13.3%(2) as human managers. 20% (3) of the 15 respondents that participated in the survey were site engineers, and 20% (3) were office engineers. Project coordinators made up the majority of responders as a result.

Project managers, site engineers, and office engineers made up the second majority of responders. In terms of respondents, human resource managers came in last. This suggests that study participants have adequate previous knowledge and experience in the subject matter.

Table 6 Designation of respondents

Respondents Designation		Frequency	Percent	Cumulative Percent
	Project Manager	3	20.0	20.0
	Project Coordinator	4	26.7	46.7
	Human Resource Manager	2	13.3	60.0
	Office Engineer	3	20.0	80.0
	Site Engineer	3	20.0	100.0
	Total	15	100.0	

Source: SPSS result

4.2.3 Respondents Education Level

The second question of the questionnaire was about participants' education level and the result is shown as in the following figure. As it can be easily understood from the following figure, figure 3, out of 15 respondents, 6(40%) of participants have Bachelor's Degree and the remaining 9(60%) of participants have achieved Master's Degree level. This indicates that information collected from respondents was based on a wider academic knowledge area, which helps in responding the undertaken questionnaires. Moreover, it reflects the high reliability of the participants, which increase the credibility of this research and its results.

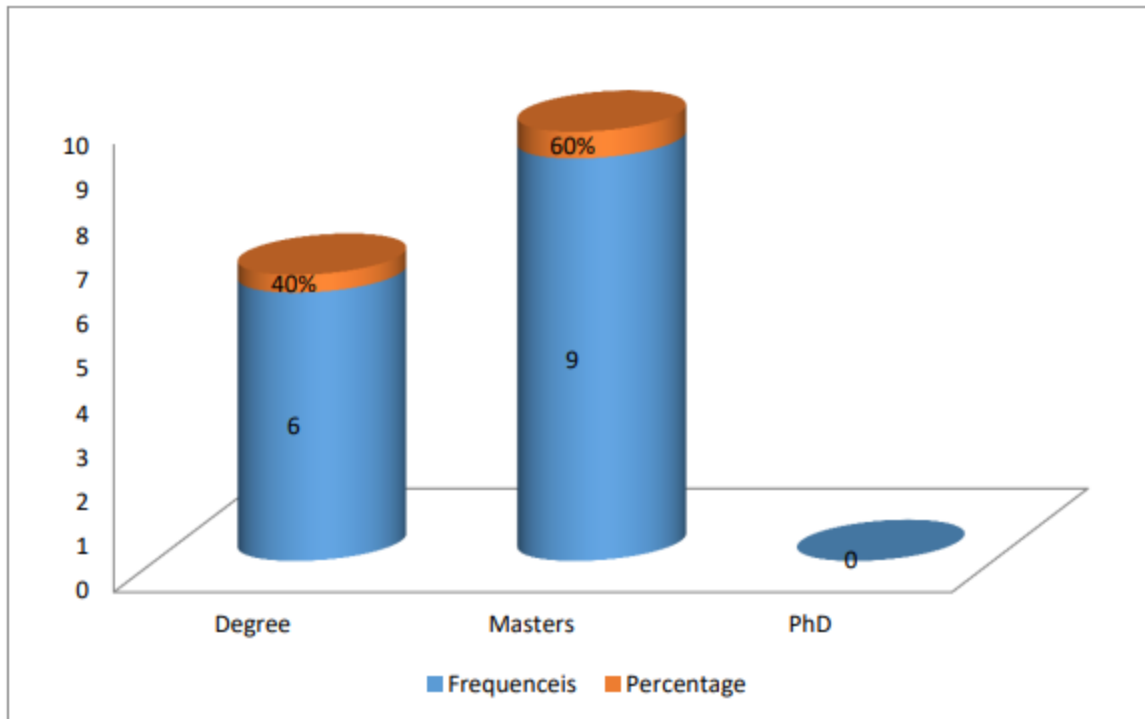


Figure 3 Respondents education level

4.2.4 Respondents Years of Experience

Participants' experience of work is illustrated using the following pie chart. As it can be seen from the pie chart, 13.33% (2) of respondents have less than 5 years of experience, 40% (6) of them have 5-10 years of experience, 33.4%(5) of respondents have 10-15 years of experience, while 13.33% (2) of them have more than 15 years of experience. From this, it can be concluded that experience of majority of respondents lie in between ten to fifteen years. The respondents' average year of experience is 12 years. This indicates that information collected from respondents was based on their experience at different position. It shows that majority of the respondents were professional enough to fill the questionnaires with full understanding.

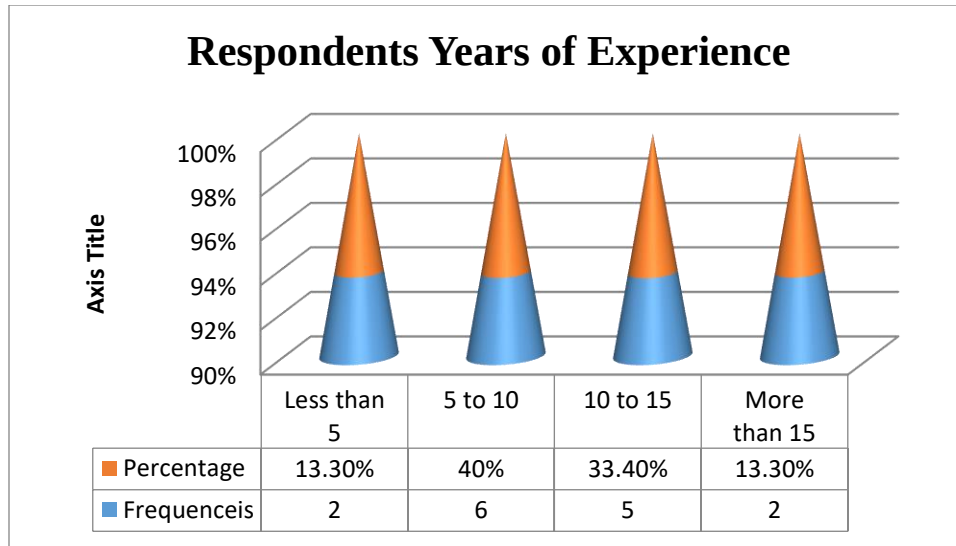


Figure 4 Respondents years of experience

4.2.5 Respondents Company Ages

The ages of respondents' company as shown in the table 7 below varies from 10 to 40 years. The age of most respondents' company is 20 years. The mean age of all companies was 20 years. As contacted companies are older, they have enough experience in construction industry. This reflects the high reliability of the participants and credibility of this research and its results.

Table 7 Age of respondents' company

Company Age	Frequency	Percent	Cumulative Percent
10	1	6.7	6.7
15	5	33.3	40.0
20	7	46.7	86.7
40	2	13.3	100.0
Total	15	100.0	

Source: SPSS result

4.2.6 Respondents Company Employees

From the following bar chart figure, figure 5, it can be seen that: 86.6%(13) of companies have employees greater 200, 6.7%(1) company has employee number 51-100 and the remaining 6.7%(1) company has 21-50 employees. From this it can be seen that majority of the companies have large number of employees with different background and culture.

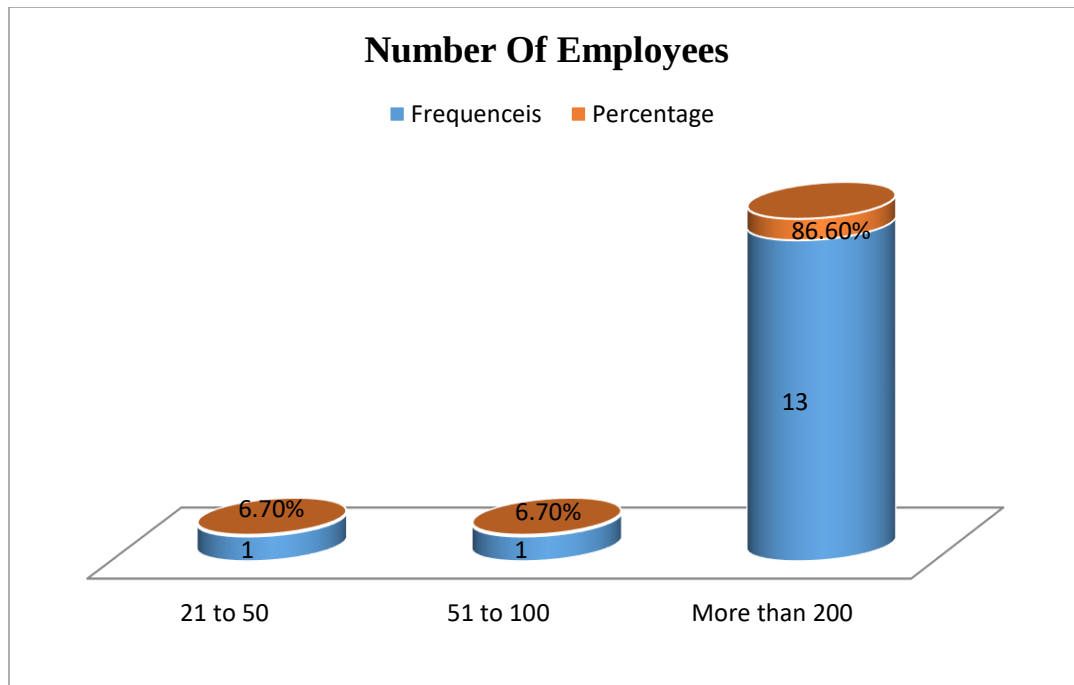


Figure 5 Number of respondents' company employees

4.3 Prioritization of CCHRMCSFs using AHP

4.3.1 Analysis of main groups (Level 1) Factors and Prioritization of HRM Categories

From the collected data (appendix D, table 1) HAS (health and safety) category of HRM activities has been found to be the first ranking having a relative importance of 21.4%.

The second HRM activities that should be given focus in construction companies for the success of construction projects were found to be HRP (17.5%).

Training and development (TAD) and MALR (Motivation and labor relation) activities ranked 3rd and 4th with 16.5% and 16.4% relative importance respectively. Performance management (PM) (15.5%) ranked 5th and recruitment and selection (RAS)(12.9%) ranked last. The result of the analysis shows the inconsistency rate of 0.029 which is less than the maximum permitted value (0.1).

4.3.2 Analysis of Sub-criteria (Level 2) Factors

Under this section the result of the analysis of every factor under study with its corresponding category were presented by following the same procedure used under analysis of main groups. The principal Eigen value (λ max), priorities (weights) (v) of factors, consistency index (CI), and consistency ratio of each category factors were presented in appendix D.

4.3.2.1 Prioritization of Human Resource Planning (HRP) Related Factors

The analysis result revealed that HRP (Human Resource Planning) category was the second ranking category among all other categories. This shows that this category's factors were given higher priority as compared to others. As it can be seen from table 2 of appendix D, DPG (Determining Project Goal) was the most important factor under HRP related factors category with a weight of 0.338. The second, third and fourth important factors were RHRP(Regular Human Resource Planning), NOE(Number of Employees) and PHIS (Proper Human Resource Information) with a weight of 0.285, 0.212 and 0.165 respectively. The result of the analysis undertaken under this category's factors shows the inconsistency rate of 0.063 which was calculated by Spice Logic AHP Software. Hence, it is less than the maximum permitted value (0.1), the performed analysis was OK.

4.3.2.2 Prioritization of Recruitment and Selection (RAS) Related Factors

A total of 6 questions were presented for respondents to make a pairwise comparison among factors identified to be under this category. The analysis undertaken for RAS category shows that Selecting experienced and skill-full project team (SEASPT) (0.371) and Selecting experienced and skill-full project manager (SEASPM) (0.315) are the leading HRM factors of construction of companies which contributes highly for the success of construction projects. Selection of candidate having good technical knowledge(SCHGTK) and VOW (Volume of work) ranked 3rd and 4th having weights of 0.202 and 0.112 respectively. As it can be seen from table 3 of appendix D, the CR of this category was 0.0054 and less than permitted benchmark (0.1).

4.3.2.3 Prioritization of Performance Management (PM) Related Factors

A pairwise comparison matrix for Performance Management (PM) related factors were shown in table 4 of appendix D. This category's most important critical success factor for construction companies' human resource management is Staff involvement in decision making (SIIDM)(0.333).Following that Top Management Support (TMS)(0.237) and Paying for Performance (PFP)(0.203) ranked second and third respectively. Regular Performance Appraisal (RPA)(0.164) factor ranked fourth while Rework(RW)(0.063) factors ranked last in the whole analysis. The consistency ratio (CR) of this category was 0.0112 and which is OK less than 0.1.

4.3.2.4 Prioritization of Motivation and Labor Relation (MALR) Related Factors

Table 5 of appendix D shows the pairwise comparison matrix for the HRM CSFs under motivation and labor relation category. Trust and confidence between employees and project team and project manager(TCEPTM) factor ranked first among all other factors having overall weight of 0.299, while Effective and comprehensive communication between project team members(ECCPTM) ranked second having a weight of 0.257. Encouraging teamwork (ETW)(0.235) and Employee motivation(EM)(0.209) ranked third and fourth respectively. The CR of this category is 0.001 and it is ok!

4.3.2.5 Prioritization of Training and Development (TAD) Related Factors

The pairwise comparison matrix and weights of the CSFs under TAD related factors are presented in table 6 of appendix D. Providing sufficient and structured training and development program (PSSTADP) is the most important factor having overall weightage of 0.301 . Providing safe and sufficient credit resources (PSASCR) and Transfer of individual experience between team members (TIEBTM) ranked second having equal importance with 0.242 weights, while Organizational Structure (OS)(0.215) ranked last. The consistency ratio (CR) of this category was 0.0054 and it is OK as it is less than 0.1.

4.3.2.6 Prioritization of Health and Safety (HAS) Related Factors

This category is the last and the least category as it has less number of factors as compared to other categories. Hence, there was only one question of pairwise comparison matrix. Based on the respondents (experts) response the result of the comparison matrix was presented in table 7 of appendix D. Accordingly, Creating of job security in the field of health and safety (CJSIHAS) ranked first and creating good working culture (CGWC) ranked second with priorities of 0.68 and 0.32 respectively.

4.3.3 Calculating of factors' Local weights, Global weights and Overall Prioritization

In this section the summarized weights of first and second level factors were presented and discussed. There are two comparisons in AHP: local comparison and global comparison. In the first scenario, each factor is exclusively evaluated within its cluster or category. As was seen in the section above, local weights are used to compare each element or category.

AHP's second section includes a global comparison. Only the local weight of the factor and the local weight of its corresponding categories are combined to perform this comparison on factors. In order to calculate the global weight of each sub-factor, the weight of the given sub-factor was multiplied by the weight of its main factor in level 1. For instance, the global weight of sub -factor DPG is equal to the weight DPG(0.338) multiplied by the weight of HRP(0.173). Table 15 illustrates the weight of all factors and sub-factors in addition to the final weights of second level factors.

Table 8 Summarized weights of first and second level factors

HRM Category	Weight of HRM Category	HRM Factors	Local Weight	Local Ranks	Global Weight	Global Ranks
HRP	0.173	DPG	0.338	1	0.0585	3
		RHRP	0.285	2	0.0493	6
		NOE	0.165	4	0.0285	19
		PHIS	0.212	3	0.0367	14
RAS	0.129	SCHGTK	0.202	3	0.0261	20
		SEASPT	0.371	1	0.0479	8
		SEASPM	0.315	2	0.0406	10
		VOW	0.112	4	0.0144	22
PM	0.155	RPA	0.164	4	0.0254	21
		TMS	0.237	2	0.0367	14
		RW	0.063	5	0.0098	23
		PFP	0.203	3	0.0315	18
		SIIDM	0.333	1	0.0516	4
TAD	0.165	PSASCR	0.242	2	0.0400	11
		TIEBTM	0.242	2	0.0400	11
		PSSTADP	0.301	1	0.0497	5
		OS	0.215	3	0.0354	16
MALR	0.164	TCEPTM	0.299	1	0.0490	7
		ECCPTM	0.257	2	0.0421	9
		ETW	0.235	3	0.0386	13
		EM	0.209	4	0.0343	17
HAS	0.214	CGWC	0.320	2	0.0685	2
		CJSIHAS	0.680	1	0.1455	1

According to the multi-criteria decision analysis, the most significant HRM categories that influence the success of construction projects in Ethiopian construction companies' are those linked to Health and Safety (HAS) (0.214). Factors associated with human resource planning (HRP) came in second with a relative weight of 0.173 (17.3%) of the final result. Elements relating to performance management (PM) (15.5%), motivation and labor relations (MALR) (16.4%), training and development (TAD) (16.5%), and recruitment and selection (RAS) (12.9%) filled the remaining positions.

Determine project goal (DPG) was the most important factor under HRP related factors category with a weight of 0.338. The second, third and fourth important factors were Regular Human Resource planning (RHRP), Number of Employees (NOE) and Proper Human Information System (PHIS) with a weight of 0.285, 0.212 and 0.165 respectively. In the TAD related factors category, the most important factor was Providing systematic and structured training and development program (PSSTADP) with weight of 0.301 and the least important factor was organizational structure (OS) having a local weight of 0.215. Providing safe and sufficient credit resource (PSASCR) and transfer of individual experience between members (TIEBTM) factors have equal importance in this category with a local weight of 0.242.

The results show that PSSTADP is a very essential and critical HRM factor contributing for the success of construction projects. Additionally, the analysis undertaken for RAS category shows that selecting experienced and skillful project team (SEASPT) (0.371) and selecting experienced and skillful project manager SEASPM (0.315) are the leading HRM factors of construction of companies, which contributes highly for the success of construction projects.

Selecting candidate having good technical knowledge (SCHGTK) and volume of work (VOW0) ranked 3rd and 4th having weights of 0.202 and 0.112 respectively. For the PM related factors category, staff involvement in decision-making (SIIDM) (0.333) was ranked first and rework (RW) (0.063) ranked last. Others: regular performance appraisal (RPA) (0.164), Paying for performance (PFP) (0.203), and top management support (TMS) (0.237) were in between these factors. The increasing trust and confidence between project team members (TCEPTM) was the most important factor under MALR category having a local weight of 0.299.

The next two important factors were effective and comprehensive communication between project team members (ECCPTM) (0.257) and encouraging teamwork (ETW) (0.235), while the last one was employee motivation (EM) (0.209). In the Health and Safety (HAS) category, creating job in the field of health and safety (CJSIHAS) factor ranked first (0.68) and creating good working culture (CGWC) factor ranked second having a weight of 0.320.

4.4 Discussion on the result of AHP Analysis

The success of construction projects is greatly influenced by HRM in construction businesses. It involves a number of activities, including hiring, training, managing safety, managing employee relations, and paying employees. In construction organizations, good HRM practices can lead to higher output, happier employees, and lower turnover rates. Therefore, it is crucial to pinpoint the success factors that have an impact on construction projects in order to support the project's success. The AHP method and expert advice can be used to accomplish this.

Health and safety related factors were the most important category in category-wise comparison having importance weight of 0.214. Being named employee health and hygiene category, health and safety related factors ranked 8th in the work of (Safari et al., 2014) having importance weightage of 0.0013. It is important to promote a safe nature throughout the group, including supervisors, where discussions play an important role. The construction industry should regularly review its safety training programs and stay up-to-date on health and safety laws through on-site and company safety communications (Sawacha et al., 1999). Human Resource Planning (HRP) related factors are the second most important factors in category-wise comparisons with a weight of 0.173, unlike this (Safari et al., 2014) ranks this category a little higher (first rank).

This may be due to the unique characteristics that a construction companies and construction projects have. This was in line with the work (El-Dash, 2007) that put this category in the first most important groups. It is important to note that different studies may prioritize factors differently due to variations in research methodology, sample size, and industry context. However, the consistent recognition of HRP's importance indicates its critical role in the successful execution of construction projects. Training and development (TAD) (16.5%) and motivation and labor relations (MALR) (16.4%) categories ranked third and fourth respectively by having insignificant importance weightage difference between them.

MALR related factors were ranked fourth in the work of Kokkaew and Koompai (2012), while TAD related factors ranked also fourth as in the work of (Prajapati et al., 2015; Safari et al., 2014). This means that both in the work of Kokkaew and Koompai (2012) and of Prajapati et al. (2015) and Safari et al. (2014), factors related to MALR (Motivation and Working Relationship) and factors related to TAD (Training and Development) ranked 4th in importance or impact. In addition, this shows that Training and development and motivation and labor relations are both important aspects of managing and developing a productive and satisfied workforce with almost equal importance according to undertaken study. Performance management category ranked 5th in this study but 2nd in the work of (Safari et al., 2014).

The difference in rankings between these two studies could be due to a number of factors; the methodology or criteria used to categorize the performance management category, contexts or times in which studies were conducted or it could be the sample size or characteristics of the participants in each study can influence the ranking. Differences in participant demographics or circumstances may lead to differences in the perceived importance or effectiveness of performance management. Hence, it is important to consider these factors and analyze the reasons behind the different rankings to fully understand the meaning and applicability of the results. Although Recruitment and selection (RAS) related factors ranked third in (Safari et al., 2014) works, it has got last rank in current study with having a weightage of 0.129. This indicates that in the present study, recruitment and selection factors were considered the least important compared to other factors considered. A weight of 0.129 indicates that these factors were not considered to have a major influence on the overall outcome of the study.

Based on the comparison of overall factors, it can be concluded that the creation of job security in the field of health and safety is considered the most important factor which underpins with (Safari et al., 2014). This shows that individuals value stability and security in their work in the area of health and safety. In contrast to this study “Creating job security in the field of health and safety” ranked fourth in the work of (Leilaee & Rezaeian, 2021) indicating that it was considered less important compared to three other factors. Contrasted with this, (Abbasbhai & Patel, 2020) ranked creating job security in the field of health and safety among the top 10 most important factors. This implies that the researchers in this study considered job security in the health and safety field as a significant aspect that should be prioritized.

Different study methodology, sample sizes, and the perspectives and priorities of the researchers are just a few of the causes of the disparate rankings. It might also be linked to cultural or contextual variations that affected how people perceived job security in the health and safety sector.

On the other hand, creating a good work culture is considered the second most important factor with overall importance weightage of 0.0685 and it was ranked 12th in (Prajapati et al., 2015). This involves individuals prioritizing a positive and supportive work environment in which they can thrive and feel comfortable. It is important to note that the weight assigned to each factor indicates their relative importance in the overall comparison. However, without knowing the specific context or other factors involved, it is difficult to draw other explanations or conclusions. In both studies, the importance of determining the project goal or having clear objectives was recognized but ranked differently.

Naming it determination of clear objectives and scope, Nguyen & Ogunlana (2004) ranked it 9th overall, while Gudienė, Banaitis, & Banaitienė (2013) ranked it 25th overall but 5th in the category it belonged to. The discrepancy in rankings could be due to variations in the sample, methodology, or other factors. However, it is evident that having a clear project goal is considered a significant factor in project management. The ranking suggests that staff involvement in decision-making plays a significant role in the decision-making process, with overall ranking of four having an importance weightage of 0.0516.

Based on the ranking provided in the statement, it can be inferred that there are at least three other factors that were considered more important. (Safari et al., 2014) ranked it as fifth most important in category wise.

The difference in ranking could be due to the context and specific objectives of the study. According to the result of this study, providing sufficient and structured training and development program (PSSTADP) ranked fifth in contrast to the findings of Prajapati et al. (2015). According to Prajapati et al. (2015), regular human resource planning (RHP) was ranked 17 in their study. However, in this current study, RHP has been ranked 6. This suggests that RHP has become a more valued and prioritized aspect of human resource management compared to the previous study conducted by Prajapati et al. (2015).

The increase in ranking could be attributed to various factors such as the growing recognition of the importance of strategic workforce planning, the increasing complexity of the business environment, and the need for organizations to effectively align their workforce with their goals and objectives. It also indicates that organizations are now recognizing the significance of proactive workforce planning in ensuring their long-term success and competitiveness.

Based on the given information, the factors "Increasing trust and confidence between employees and project team and project manager" (TCEPTM) and "Effective and comprehensive communication between project team members" (ECCBPTM) are ranked 7th and 9th, respectively, in terms of their importance in motivating employees and managing labor relations. It is evident that the rankings of the factors TCEPTM and ECCBPTM vary across different studies. In the mentioned works by Leilae & Rezaeian (2021), TCEPTM was found to be the most important factor in motivating employees and managing labor relations, while in Abbasbhai and Safari's works, ECCBPTM ranked higher in importance. This discrepancy in rankings could be attributed to used research methodologies, research designs and other several factors.

The eighth and tenth ranked factors are factors under Recruitment and Selection (RAS) category: Selecting experienced and skill-full project team (SEASPT), Selecting experienced, and skill-full project manager (SEASPM) which got a relative importance weight of 0.0479 and 0.0406 respectively. These factors were ranked seventh in the work of (Leilae & Rezaeian, 2021). In the current study, both providing safe and sufficient credit resources (PSASCR) and Transfer of individual experience between team members (TIEBTM) have been given equal importance with weight of 0.0400. Both PSASCR and TIEBTM are recognized as key factors for the success of construction companies' HRM and the overall success of construction projects.

However, it is important to note that PSASCR received a higher ranking in the study conducted by (Leilae & Rezaeian, 2021), being placed fifth, while TIEBTM received a lower ranking, being placed ninth in the study conducted by (Abbasbhai & Patel, 2020). This suggests that (Leilae & Rezaeian, 2021), work places slightly greater emphasis on the provision of safe and sufficient credit resources, while (Abbasbhai & Patel, 2020) work gives slightly greater importance to the transfer of individual experience between team members.

Nonetheless, both factors are seen as crucial for the success of HRM in construction companies. The contrasting rankings could be due to several factors, such as variations in the research methodologies, sample sizes, and the perspectives and priorities of the researchers. It could also be attributed to cultural or contextual differences that influenced the perception of job security in the field of health and safety. Accordingly, the overall hierarchal structuring of construction companies HRM critical success factors developed is shown in figure 6.

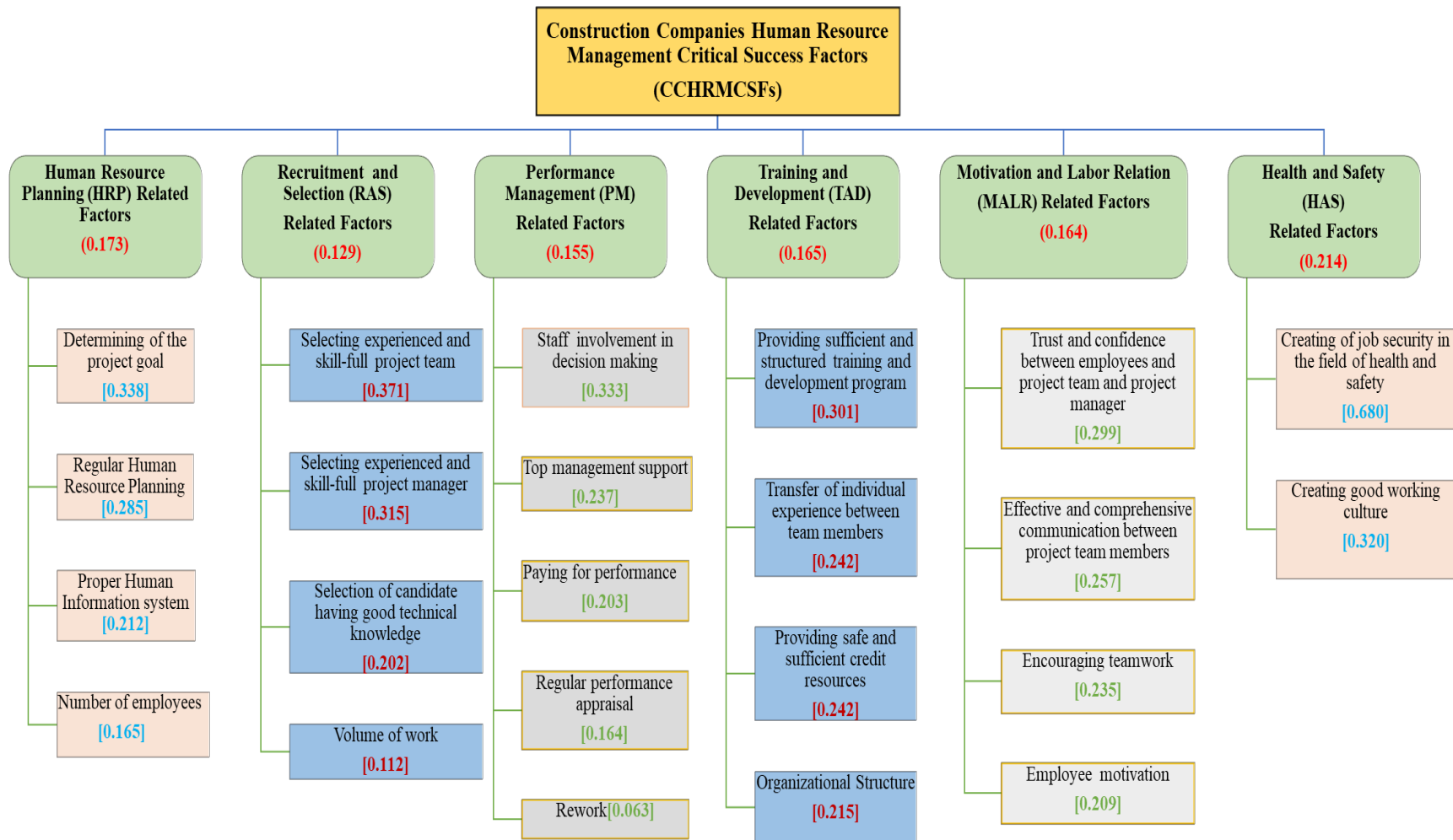


Figure 6 Hierarchal structure of construction companies HRM critical success factors

4.5 Prioritization of Construction Companies HRM Critical Success Factors (CCHRMCSFs) using ISM

According to the data analysis, construction companies human resource management critical success factors (CCHRMCSFs) are identified and ranked based up on their relative importance. As per the recommendations of experts and the result of AHP analysis, factors whose global weight is less than 0.01 where discarded in succeeding analysis as they have less significance when compared to others. Depending up on the experts recommendations and importance weight of factors, factors whose weight is insignificant can be discarded((H. Sharma, Sohani, & Yadav, 2021).

Table 9 Construction companies human resource management critical success factors (CCHRMCSFs)

HRM Factors	Global Weight	Global Ranks	Factors Code for ISM Analysis
CJSIHAS	0.1455	1	F22
CGWC	0.0685	2	F21
DPG	0.0585	3	F1
SIIDM	0.0516	4	F12
PSSTADP	0.0497	5	F15
RHRP	0.0493	6	F2
TCEPTM	0.0490	7	F17
SEASPT	0.0479	8	F6
ECCPTM	0.0421	9	F18
SEASPM	0.0406	10	F7
PSASCR	0.0400	11	F13
TIEBTM	0.0400	11	F14
ETW	0.0386	13	F19
TMS	0.0367	14	F10
PHIS	0.0367	14	F4
OS	0.0354	16	F16
EM	0.0343	17	F20
PFP	0.0345	18	F11
NOE	0.0285	19	F3
SCHGTK	0.0261	20	F5
RPA	0.0254	21	F9
VOW	0.0144	22	F8

The Interpretive Structural Modeling (ISM) technique was used to analyze the interrelationship among 22 factors, which were identified based on literature review, expert opinion and the result of AHP analysis. By using this technique, we have identified factors that have the most influence on the other factors in the analysis. These factors will have a greater impact on the other factors and can be considered as key drivers in the research. By understanding the interrelationship and identifying the most influential factors, we can prioritize them and allocate resources accordingly.

The experts have determined that there is evidence of a relationship or influence between two factors based on their judgment and expertise. This suggests that one factor has an impact on the other, either directly or indirectly. Accordingly, the intended relationship was developed based on the most common opinion of experts (Bag et al., 2021; G. Sharma & Kumar, 2021). Experts' opinions were taken through questionnaire, telephonic conversations and physical interaction. Depending up the relationship developed by expert structural self-interacting matrix (SSIM) was constructed as shown under appendix D in table 8. After construction of SSIM, initial reachability matrix is developed using the binary numbers (0 and 1).

Based on the initial reachability model, the final reachability matrix is developed after checking for transitivity. Using this relationship, transitivity is validated for the initial reachability matrix. Accordingly, the final reachability matrix (FRM) was developed as shown under appendix D including dependency power and driving power. The driving power of a particular element is the total number of elements in row direction including itself, which it may help to achieve. The dependence power is the total number of elements in column direction including itself which may help achieving it.

To determine the hierarchy amongst factors identified, level partitions were performed. The reachability and antecedent set for every factor was identified after analyzing the final reachability matrix. Factors having higher driving power and lower dependence power take higher levels while factors having lower driving powers and higher dependence power take lower level. By taking this assumption into consideration, factors were divided into several levels according to the final reachability matrix's findings, as shown in appendix C.

4.5.1 Development of interpretative structural modeling model.

After performing level partitioning, the conceptual consistency was checked. The basic assumption for contextual relationships made by ISM is transitivity. The assumption of transitivity is checked and had been found to be satisfied. The final structural model is derived based on the final reachability matrix and is designated as a digraph. The digraph shows the relationship among factors and is represented by arrows. A directed graph (digraph), in which the factors are represented by the network's nodes and the relationships between any two factors are indicated by directional arrows (links), which represent the features of the relationships (leads to or has influence on), can then be used to visually interpret the contextual relationships between each of these CSFs and their hierarchies. Figure 7 shows developed ISM model and the factor level in addition to arrows denoting direct and indirect relationships.

4.5.2 Classification of CSFs based on MICMAC Analysis

Matriced' Impacts croises-multiplication applique' and classment (cross-impact matrix multiplication applied to classification) is abbreviated as MICMAC. MICMAC analyses the factors based on their driving and dependence powers to identify the key factors that drive the system in various categories. To categorize CSFs and determine their relationship based on their driving and dependency powers, MICMAC analysis is used.

CSFs with greater driver power have a greater ability to strongly affect others, and vice versa for CSFs with greater dependent power. Figure 8 illustrates the four distinct quadrants (independent, linkage, autonomous, and dependent) into which the 22 CSFs are divided as shown figure 7 below. CSFs with strong driver powers and mild dependence powers make up the independent quadrant. There is no factor under this quadrant. The CSFs in the autonomous quadrant have low driver and dependent powers. We have no factor in this category for the current study. This means that all factors have no weak driving power and weak dependency power, which indicates that no factor is disconnected from the system. Hence Managers and concerning bodies need to pay attention and focus on all identified factors. CSFs with strong reliance and poor driver powers make up the dependent quadrant. Factor 20(employee motivation) is found in this quadrant, which indicates that it has less influence on others and totally dependent on others. Strong CSFs with both strong driving and dependent powers make up the linkage quadrant. All remaining factors are found under this quadrant.

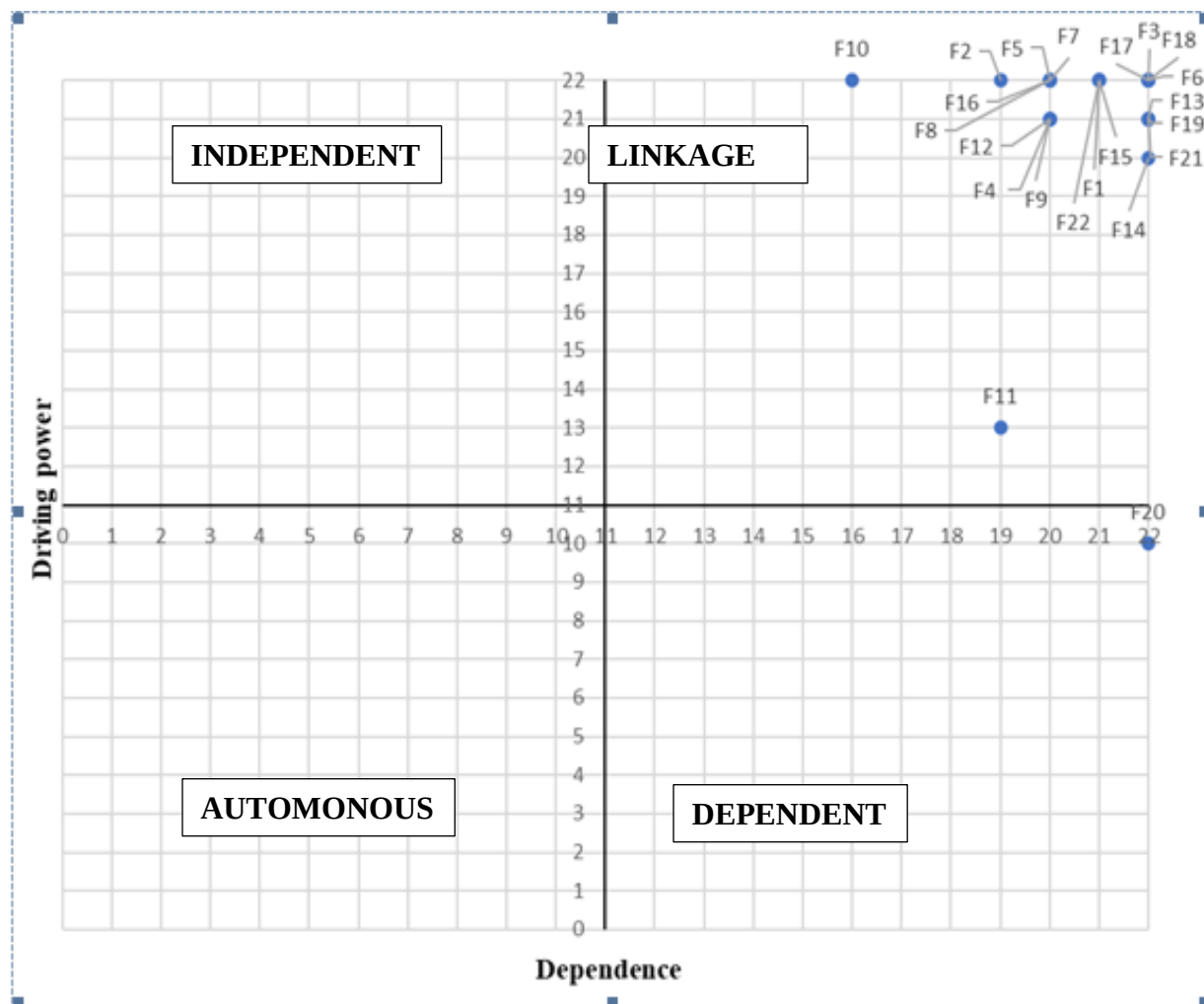


Figure 7 The result of MICMAC analysis

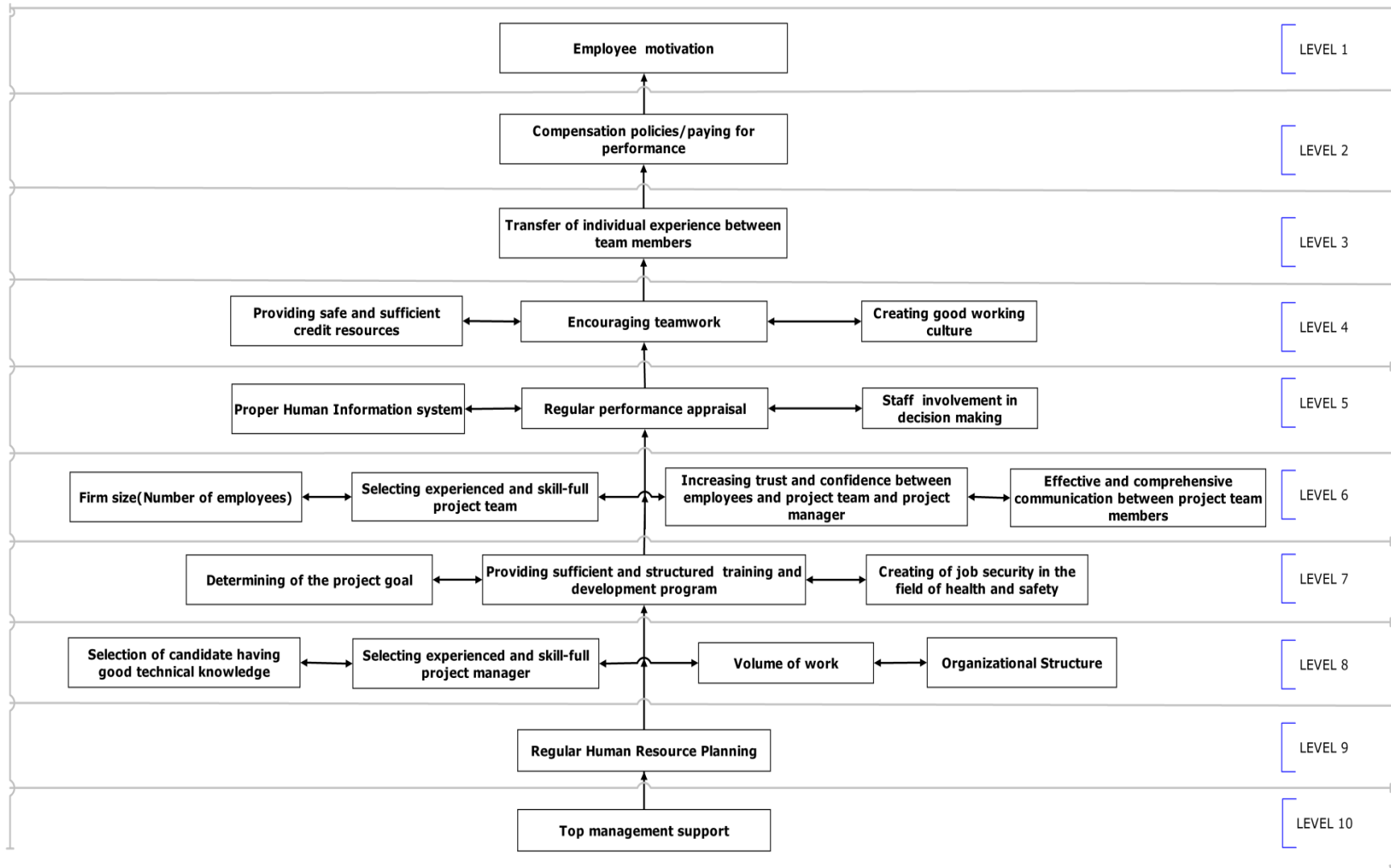


Figure 8 Hierarchal structures of construction companies HRM critical success factors based on influence

4.6 Discussion on the result of ISM Analysis

In Figure 8, the 22 critical success factors are represented in a clear hierarchical structure consisting of ten levels. This structure also illustrates the important interdependence between these factors. According to the ISM model, "top management support (F10)" is positioned at the tenth level, indicating its high driving power and lower dependence power. This factor promotes "regular human resource planning (F2)" which is located at the ninth level. The placement of these two factors at the tenth and ninth levels respectively suggests that they are the root factors with a profound influence over the other critical success factors. "Top management support (F10)" plays a crucial role in driving the success of the organization, while "regular human resource planning (F2)" contributes to and influences all the factors that follow in the hierarchy. This hierarchical structure highlights the importance of these two factors as they have the ability to shape and impact the overall success of the organization. Their high driving power and lower dependence power indicate their critical role in the achievement of the other critical success factors.

The prior study undertaken by (Salum, 2017) suggests that the support and involvement of top management have a direct impact on the effectiveness and implementation of human resource planning in the organization. Top management is responsible for setting the strategic direction of the organization. The top management factor has taken the bottom level of ISM model in the work of (Pandey et al., 2021; H. Sharma et al., 2021). Management style, priorities and practices within an organization significantly influence human resource management practices (Garavan et al., 2008). This influence indicates that when top management is supportive and actively involved in the human resource planning process, it can lead to better planning, allocation, and utilization of human resources within the organization.

Top management support can provide the necessary resources, guidance, and direction to ensure that human resource planning aligns with the overall strategic goals and objectives of the organization. By recognizing the importance of regular human resource planning and providing support for its implementation, top management can create a culture and environment that values and prioritizes effective management of human resources. This, in turn, can contribute to the overall success and performance of the organization. Level 8 of ISM constitutes selecting of candidates having good technical knowledge (F5), selecting skillful and experienced project manager (F7), volume of work (F8) and organizational structure (F16). These factors are influenced both by top management support and by regular human resource planning factors.

This is due to the fact that regular human resource planning involves selection of skillful and experienced project manager under selecting candidates having good technical knowledge as project manager is typical example of candidate. The result is underpinned by Adu-Darkoh (2014) which is as stated that organizations seeking recruits for base-level entry positions often require minimum qualifications and experiences. Recruitment and selection is one category of HRM activities which involves human resource planning and the process of selecting of candidates having good technical knowledge depends up on the volume of work and organizational structure. The reason behind this is that level and volume of the work determines the level of the skill and technical knowledge needed. Human resource planning influences recruitment and selection, while recruitment and selection (selection of qualified individuals) influences the success of every organization.

Poor HR panning is one of the top six barriers for choice of recruitment and selection(Adu-Darkoh, 2014). The success of construction projects in construction companies HRM will be greatly influenced by aforementioned three levels, which serve as the strong foundation of the entire hierarchy of the developed model. Moreover, a firm organizational structure is important in determining HR practices flexibility and integration(ÖZUTKU & ÖZTÜRKLER, 2009). Selecting of candidates having good technical knowledge, selecting skillful and experienced project manager, volume of work and organizational structure have direct influences on: determining of the project goal (F1), providing sufficient and structured training and development program (F15) and Creating of job security in the field of health and safety (F22) factors which have arrived in the seventh level.

Regarding Project manager's skills and experience for construction projects success there is evidence in the work of (DuBois, Hanlon, Koch, Nyatuga, & Kerr, 2015)which states: project manager influences other factors as it is at the head of the project process, and has an important role of overseeing the project and project team, and ultimately ensuring the project ends in success. Regarding determining of the project goal/objective, there was evidence from (Simon, 2017) which stated that HRP alignment with overall objectives of the organization has a positive effect on organizational effectiveness and the organizational effectiveness is measured for the preset and predetermined goals/objectives.

By actively supporting resource planning efforts, we can ensure that all resources i.e. manpower, money, material and machines are allocated in a way that aligns with the organization's goals and objectives. This helps to ensure that resources are focused on the right projects and initiatives that drive the organization's success.

Seven CSFs have fallen in the sixth and fifth levels. The sixth level has consisted of Firm size (Number of employees) (F3), Selecting experienced and skill-full project team (F6), Increasing trust and confidence between employees and project team and project manager (F17) and Effective and comprehensive communication between project team members (F18), while the fifth level constituted proper human resource information system (F4), regular performance appraisal (F9) and Staff involvement in decision making (F12).

These factors are either directly or indirectly influenced by factors: determining of the project goal, providing sufficient and structured training and development program and Creating of job security in the field of health and safety. Factors falling under level six are directly influenced while level five factors are influenced indirectly. Tansel and Gazioğlu (2014) have revealed that there is relationship between creation of job security in the field of health and safety and firm size. Similarly, as it lies at bottom level of ISM hierarchy, HRP indirectly influences all other factors including performance appraisal. This is because that HRP identifies the training needs of the personnel. If the personnel lack knowledge and skills, then necessary arrangements can be made by the organization to provide appropriate training.

Moreover, HRP assists in the performance appraisal of the employees in the organization, as it helps in the identification of strengths and weaknesses of the employees in relation to their job (George, 2017). Selection of skillful and experienced project manager indirectly influences selection skillful and experienced project team. This is supported by the work Carden, Kovach, and Flores (2021) that states the project manager in consultation with management, selects project team members that have knowledge and experience relative to the project being conducted.

Effective and comprehensive communication between team members influences staff involvement in decision making and staff involvement in turn influences factors: providing safe and sufficient credit resource (F13), encouraging teamwork (F19), and creating good working culture (F21). These factors all are mutually supporting each other. Number of researchers supports this.

Effective communication is an attribute that has led to 80% of project success (DuBois et al., 2015). Frequent communication between personnel and laborers would improve HRM, thus improving the performance of project (I. Othman et al., 2012). The fifth and sixth level of ISM model consists about fifty percent of total CSFs identified. It is the key intermediate level which is very important to understand, since it will have a significant impact on its succeeding levels in the hierarchy as well as the decision-making practices of the first four levels. Hence these factors should be given attention and focus in decision making process.

Transfer of individual experience between team members (F14), Compensation policies/paying for performance (F11) and employee motivation (F20) factors have fallen in the third, second and first level respectively. Employee motivation (F20) is a factor appearing at the top of the ISM hierarchy, showing that it has no influence on other factors and all other factors are influencing it. Based on the provided context, employee motivation (F20) is considered as the outcome or result of various factors in a hierarchy. These factors can include top management support, regular human resource planning, compensation policies, and other critical success factors. However, the last three factors in the hierarchy, which are located in the last three consecutive levels, are influenced directly or indirectly by all the other factors. As a result, these factors are considered to have less influence compared to others. Finally, from MICMAC analysis as shown in figure 8, CSFs for construction companies HRM were divided into different clusters depending up on their driving and dependence power. Majority of the factors were concentrated in two clusters of the four MICMAC analysis clusters.

Factors, Determining of the project goal, Regular Human Resource Planning, Firm size (Number of employees), Proper Human Information system, Selection of candidate having good technical Knowledge, electing experienced and skill-full project team, Selecting experienced and skill-full project manager, Volume of work, Regular performance appraisal are located in the linkage cluster. Additionally, factors top management support, Compensation policies, Staff involvement in decision making, Providing safe and sufficient credit resources, Transfer of individual experience between team members, Providing sufficient and structured training and development program, Organizational Structure, increasing trust and confidence between employees and project team and project manager, Effective and comprehensive communication between project team members, Encouraging teamwork, Creating good working culture, Creating of job security in the field of health and safety are also located in the linkage cluster.

The factor in this cluster has a strong dependency and driving power. Any change occurring to the factor of this group will affect other factors in the system. The remaining factor “Employee motivation” is located in the dependent cluster. This CSF is a CSF with strong dependence power and poor driving power. This indicates that it has less influence on others and totally dependent on others. Concerning the result of AHP analysis and ISM analysis; though some factors were ranked relevantly, most of them ranked differently in both methods and other studies. Though there is no one to one correspondence in ranking, most of the CSFs those occupied the bottom level (the root levels) in ISM analysis result were ranked among top ten CSFs in the AHP analysis result.

Creating of job security in the field of health and safety was ranked first in AHP result and it has also taken the bottom level in the result of ISM analysis. This shows that creating of job security in the field of health and safety has a very significant role in construction companies HRM activities for achieving a preset goal in construction projects. In the AHP analysis, creating a good working culture was considered to be the second most important factor. However, in the ISM analysis, it was ranked at the top level, indicating its high significance. In the study conducted by Prajapati et al. in 2015, it was ranked 12th, implying a moderate level of importance.

On the other hand, the volume of work was ranked last (22nd) in the previous analysis method. However, in the developed model using ISM, it occupied the bottom part, indicating its high influence compared to other factors. Moreover, top management factor has taken the bottom level of ISM model in the work of(Pandey et al., 2021; H. Sharma et al., 2021), though it was ranked 14th in the result of AHP analysis.

The discrepancy in the ranking of the top management factor in the ISM model and the AHP analysis could be due to various reasons. It is important to note that different research studies may have different methodologies, sample sizes, and contexts, which can lead to variations in the results. In the work of Pandey et al. (2021) and H. Sharma et al. (2021), the top management factors might have been given more importance based on their specific research objectives, industry focus, or organizational context. They might have found that top management's role and influence were particularly significant in their study settings, leading to its higher ranking in the ISM model.

On the other hand, the AHP analysis might have considered a broader perspective or a larger sample size, leading to a different ranking for the top management factor. AHP analysis involves a systematic process of pairwise comparisons, where different criteria are evaluated based on their relative importance. The results of AHP analysis can be influenced by the preferences and judgments of the decision-makers involved in the process.

Overall, the difference in rankings between the ISM model, the AHP analysis and other studies highlights the subjective nature of research and the importance of considering multiple perspectives when evaluating factors in a complex model like the ISM. It also emphasizes the need for further research and validation to establish the relative importance of different factors in specific contexts.

4.7 Prioritization of Construction Companies HRM Critical Success Factors (CCHRMCSFs) Based on Integrated Structure.

The general goal of this study is to use importance and influence as a criterion to hierarchically structure critical success factors for HRM in construction firms. In both situations, the elements were hierarchically structured, albeit individually. Furthermore, to facilitate the selection of success factors and integrate the two prioritization and simplify the interpretation quadrant analysis was conducted and the result was given in figure 9. According to the result, five critical success factors fall into the lower-left quadrant: keep up the good work. These critical success factors were: determining of the project goal, regular human resource planning, selecting experienced and skill-full project manager, providing sufficient and structured training and development program, and creating of job security in the field of health and safety.

These factors are not only have the highest importance but also have a strong influence. Given their importance, efforts must be made to maintain these factors for the good performance of the project. Selection of candidate having good technical knowledge, volume of work, top management support, firm size (number of employees) and organizational structure factors have fallen in the possible overkill quadrant. These factors have high influence but low importance. They might have the ability to influence decisions or outcomes, but their impact may not be significant in terms of overall goals.

Based on the quadrant analysis, the factors of selecting experienced and skill-full project team, increasing trust and confidence between employees and project team and project manager, effective and comprehensive communication between project team members, staff involvement in decision making, providing safe and sufficient credit resources, transfer of individual experience between team members, and creating a good working culture have been classified as falling into the under priority for improvement quadrant. These factors are considered to have high importance but low influence.

By actively prioritizing the improvement of these factors, despite their low influence, their impact on the project's overall performance and success can be enhanced. The remaining five critical success factors: proper human information system, regular performance appraisal, compensation policies/paying for performance was categorized as low priority. While they may have a low priority, it is still important to address these factors to some extent.

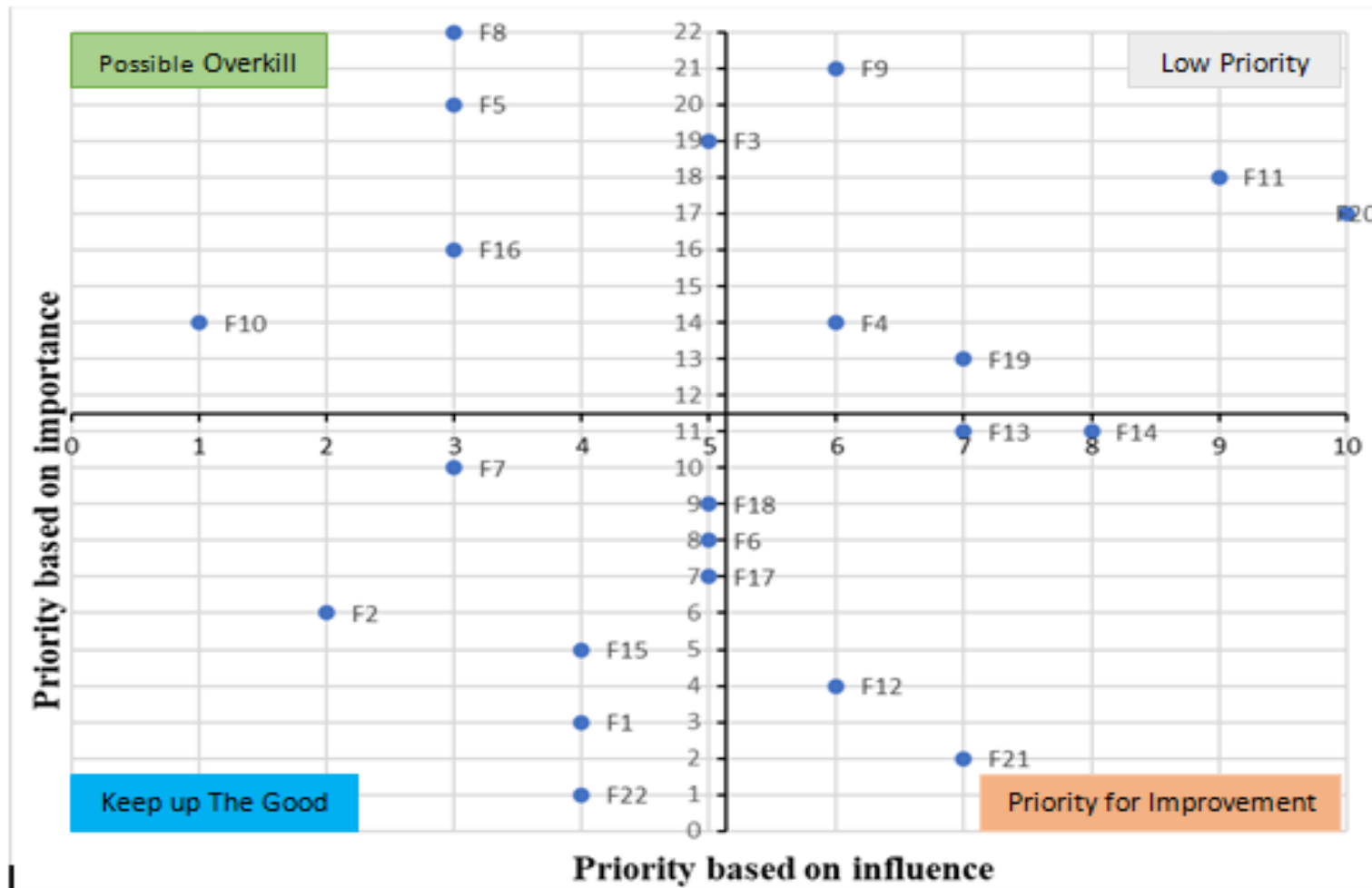


Figure 9 Result of Quadrant Analysis

4.8 Discussion on Integrated Structure

The overall quality of Human Resource Management (HRM) can have a significant impact on various aspects of a project, especially in the construction industry. Poor working relationships within the project team can lead to lower quality of work, lack of innovation, project delays, and harm the company's reputation. Human capital and effective HRM practices play a vital role in organizational performance. Studies, such as the one conducted by Simarmata (2020), have shown a positive association between human capital and organizational performance. Having skilled and knowledgeable employees, along with effective HRM practices, can enhance the overall performance of an organization. Moreover, adopting universal HRM practices can directly impact organizational performance, as highlighted in the research by Safari, Karimian, and Khosravi (2014).

When organizations implement standardized HRM practices across different projects and departments, they can achieve better alignment, consistency, and efficiency, ultimately leading to improved performance outcomes. Project managers need to be aware of the criteria that can influence the achievement of their goals throughout the project lifecycle. By understanding these factors, they can proactively address potential issues and ensure the project's success. One of the fundamental criteria that should be kept in mind and should be aligned with organizations' goals and objectives is the identification of HRM critical success factors. In previous sections i.e. section 4.4 and section 4.6, discussions were undertaken based on either influence or importance which is not for the both cases. Since one among objectives of this study is identification of factors which are both important and influential, the use of quadrant analysis is indeed a relevant approach.

By categorizing the factors based on their importance and influence, the analysis helps identify those that fall into the desired quadrant - i.e., the factors that are both highly important and have a strong influence on the project. Accordingly, the analysis has revealed a total of five critical success factors to be the most important as well as the most influential factors among all other factors. These factors have fallen into the lower-left quadrant: keep up the good (high importance and thigh influence) work as shown in figure 9.

These critical success factors were: determining of the project goal, regular human resource planning, selecting experienced and skill-full project manager, providing sufficient and structured training and development program, and creating of job security in the field of health and safety. These critical success factors have been identified as crucial for construction firms HRM practices, which directly influences the success of construction projects. Among all other factors creating of job security in the field of health and safety is the most significant factor within the specified quadrant. This factor ranked first based on importance and 4th based on influence, which further confirms its significance in construction firms' HRM practices.

Job security in the field of health and safety refers to the assurance provided to employees that their physical well-being and safety will be prioritized and protected while working on construction projects. This can be achieved through implementing strict safety measures, providing necessary training and protective equipment, and creating a culture of safety within the organization. Job security in the field of health and safety is crucial because the construction industry is inherently hazardous, and ensuring the well-being and protection of workers is of utmost importance. When employees feel secure in their jobs and confident that their health and safety are prioritized, they are more likely to be motivated, productive, and committed to their work. This, in turn, contributes to the overall success of construction projects.

The study by Safari et al. (2014) provides further evidence of the importance of job security in health and safety in construction firms' HRM practices. The findings of this research aligns with the rankings mentioned by Leilaee & Rezaeian (2021), emphasizing the significance job security in the field of health and safety in influencing the success of construction projects. Overall, creating job security in the field of health and safety emerges as a critical success factor for construction firms' HRM practices. It not only ensures the well-being of workers but also contributes to improved project outcomes.

According to the quadrant analysis, the second most important critical success factor in the keep-up the good work quadrant is determining the project goal/setting of clear goals and objectives, but it ranked the 4th based on the influence. Determining the project goal is important as it sets the direction and purpose for the project, allowing all team members to work towards a common objective. In the work of Nguyen & Ogunlana (2004), this factor ranks ninth in importance, indicating that it is still considered significant but not as critical as in the quadrant analysis.

On the other hand, Gudienė, Banaitis, & Banaitienė (2013) ranked it 25th, suggesting that they may not prioritize it as highly as other factors in their study. These different rankings could be due to various factors such as the specific context, industry, or methodology of the studies. It highlights the subjective nature of ranking factors and emphasizes the need for considering multiple perspectives when assessing critical success factors. Providing sufficient and structured training and development programs allows the team members to enhance their skills and knowledge, enabling them to perform their tasks more effectively. This factor has ranked 3rd based on importance and influence as it can be seen from quadrant analysis. In contrast to this it was ranked 5th and 4th according to importance and influence respectively. But the rank got based on influence is in line with findings of Prajapati et al. (2015).

Providing sufficient and structured training and development programs allows the team members to enhance their skills and knowledge, enabling them to perform their tasks more effectively. According to the information provided, RHP was ranked 4th in integrated prioritization, 6th based on importance, and 2nd based on influence. However, according to Prajapati et al. (2015), RHP was ranked 17 in their study. Regular human resource planning ensures that the project has the right people with the necessary skills and experience. Selecting experienced and skillful team members and project managers ensures that the project is led and executed by competent professionals. Selecting skillful and experienced project manager was the fifth (last) most important factor in the quadrant of keep-up the good work. It was ranked 10th based on importance and 3rd based on influence. This factor was ranked seventh in the work of (Leilaee & Rezaeian, 2021).

Furthermore, it has been found that there are seven CSFs fallen under priority for improvement quadrant. Of these factors, the most important factor that should be given emphasis is creating good working culture. Creating a good working culture is essential for the success of any project. It helps in building a positive and motivating environment where team members can work together effectively and efficiently. In the study by Prajapati et al. (2015), it was ranked 12th in terms of importance, while in the current study considering influence and importance, it was ranked 7th and 2nd respectively. The difference in rankings could be due to variations in the research methods or the specific context examined in each study.

Another factors in this category are: selecting experienced and skill-full project team, increasing trust and confidence between employees and project team and project manager, effective and comprehensive communication between project team members, staff involvement in decision making, providing safe and sufficient credit resources, transfer of individual experience between team members. These factors are considered to have high importance but low influence. They are highly significant or relevant but have limited power or ability to bring about change or have an effect.

On the other hand, four factors were located in the possible overkill quadrant: selection of candidate having good technical knowledge, volume of work, top management support and organizational structure factors tend to have higher influence but low importance. These factors are factors that are root causes and require higher resources to achieve but they are still critical to success in the long term. They might have the ability to influence decisions or outcomes, but their impact may not be significant in terms of overall goals.

These factors are important to consider in the decision-making process and can have an impact on the success of a project or organization. However, their influence may not be as significant as other factors, and they may require a higher allocation of resources to address effectively. Despite this, they are still critical for long-term success and can play a role in influencing decisions and outcomes. Low priority(low importance and low influence) factors like firm size, proper human information system, regular performance appraisal, encouraging teamwork, compensation policies/paying for performance, and employee motivation may have a lower importance and influence on the overall success of a construction company compared to factors in the other three quadrants. These factors may not play a significant role in determining the success or failure of a business.

The size of a firm, for example, is not necessarily indicative of its success. A small company can be highly successful, while a large company can struggle. The number of employees does not directly translate to success. Similarly, while having a proper human information system and regular performance appraisals are important for managing employees and ensuring efficient operations, they may not be the primary factors that drive success. These factors are more instrumental in maintaining organizational effectiveness rather than directly impacting success. Encouraging teamwork and implementing compensation policies that reward performance are also important, but they are not the sole determinants of success.

Employee motivation is crucial for productivity and engagement, but it alone may not guarantee success. A highly motivated workforce can contribute to success, but it is just one piece of the puzzle. In summary, while the low priority quadrant factors mentioned may still be important for managing and maintaining an organization, they have a relatively lower impact on the overall success of a company compared to factors in the other quadrants. Figure 10 would then visually represent the final structure, illustrating the relationships between the factors and their relative importance as determined by the analysis techniques used.

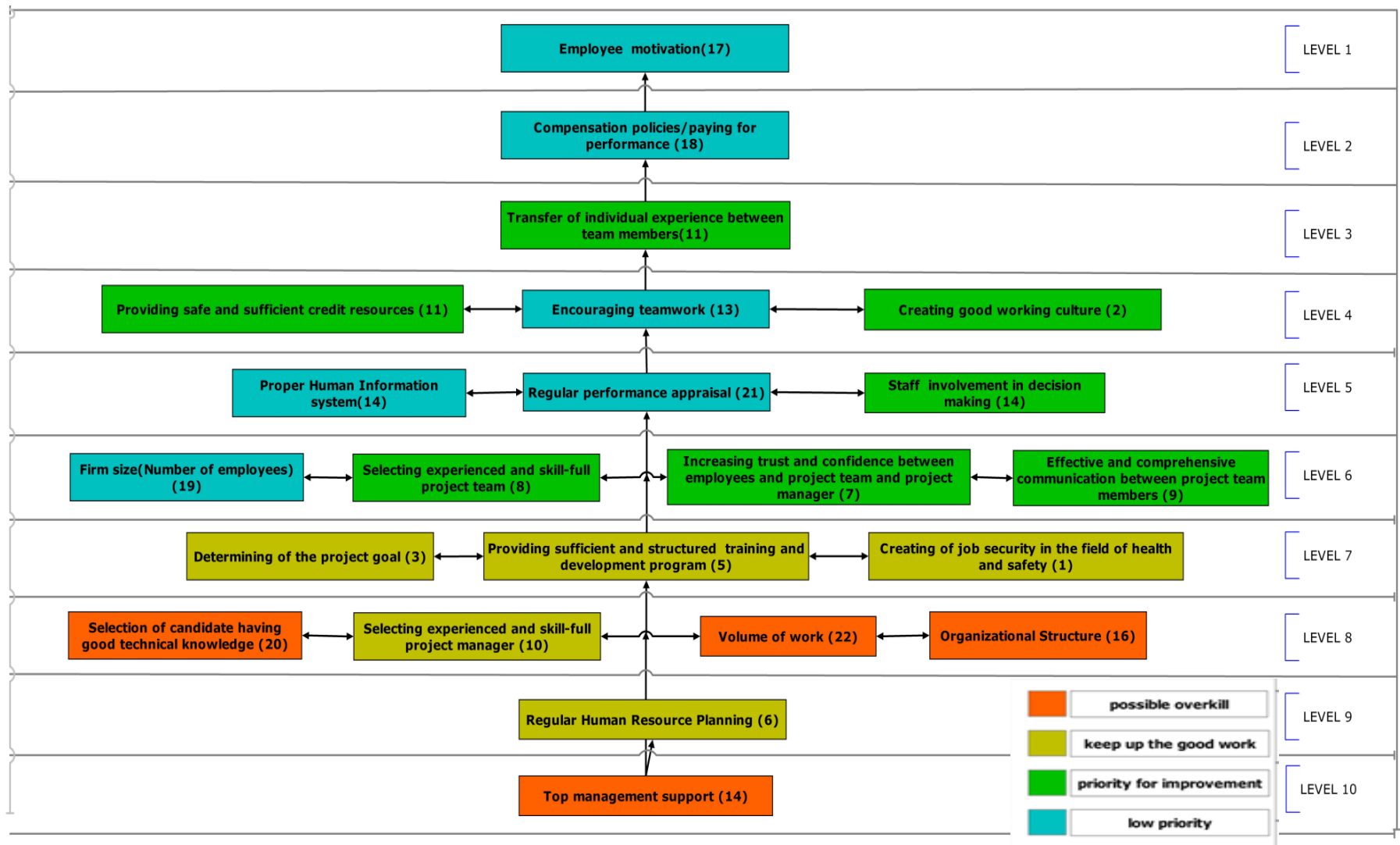


Figure 10 The final hierarchal structure based on influence and importance

Chapter Five

Conclusion and Recommendation

5.1 Conclusions

Critical success factors for construction companies' HRM can be defined as the key areas of focus that are essential for the effective management of human resources in the construction industry. These factors are crucial for achieving organizational goals, improving overall performance, and maintaining a competitive advantage in the market. Effective HRM in the construction industry is vital for the success of projects. It is essential for attracting, developing, and retaining a skilled workforce, improving productivity, ensuring safety, resolving conflicts, and planning for the future. In this study a blend of hierarchal methods was utilized for analyzing HRM critical success factors in Ethiopian construction companies. Accordingly based on the undertaken analysis, the following conclusions were driven.

- According to the multi-criteria decision analysis, the most significant HRM categories that influence the success of construction projects in Ethiopian construction companies' are those factors linked to health and safety. In this regard, the top ten most important HRM critical success factors were identified to be: creating job security in the field of health and safety, creating good working culture, determining project goal/clear setting of goals and objectives, staff involvement in decision making, providing systematic and structured training and development program, regular human resource planning, increasing trust and confidence between employees, project team and project manager, selecting experienced and skillful project team, effective and comprehensive communication between project team members and selecting experienced and skillful project manager.
- The analysis of ISM has revealed that most of identified critical success factors are highly interrelated. Top management support, regular human resource planning, selection of candidate having good technical knowledge, selecting experienced and skillful project manager, volume of work, organizational structure, determining project goal, providing systematic and structured training, and creating of job security in the field of health and safety are also found to be the most significant factors.

These factors have been identified as being highly influential in the success of construction projects ranging from one to four in the bottom portion of ISM model. They have been found by high driving powers as compared to other factors. By identifying and managing these factors effectively, construction firms can enhance their overall performance and achieve successful project outcomes.

- From MICMAC analysis it has been found that 95% of these factors were found to be in linkage cluster. These factors are interconnected, and any change occurring to one factor within this cluster will have an impact on the other factors within the system. This interdependence creates a delicate balance where changes in one area can ripple throughout the entire system.
- The integrated analysis has revealed a total of five critical success factors to be the most important as well as the most influential factors among all other factors. These critical success factors were: determining of the project goal, regular human resource planning, selecting experienced and skill-full project manager, providing sufficient and structured training and development program, and creating of job security in the field of health and safety. These critical success factors have been identified as very important for the human resource management activities of construction companies, directly affecting the success of construction projects.
- It's important to understand that these factors are interrelated and should be viewed holistically. By integrating these factors into a comprehensive HRM framework, construction firms can create a supportive and conducive working environment that fosters employee growth, satisfaction, and productivity. This, in turn, will positively impact the success of construction projects and the overall reputation and sustainability of the firm within the industry

The research results provide valuable information on awareness and knowledge of critical success factors in the human resource management of construction companies. The results presented in this article help construction project participants conceptualize the development of a human resource management strategy and achieve project success.

5.2 Recommendation

Based on the research findings and conclusion, the following recommendations are made by researcher.

5.2.1 Recommendation for practitioners

- ❖ It's important for construction firms to recognize these critical success factors and incorporate them into their HRM strategies. By prioritizing and investing in these areas, firms can enhance their overall project success and create a positive working environment that promotes the growth and well-being of their employees.
- ❖ Professionals within the construction industry, including project managers and human resource managers, should actively recognize the importance of these factors and integrate them into their decision-making processes. This involves understanding how each factor impacts project success, and then taking deliberate actions to prioritize and allocate resources accordingly.
- ❖ By using the hierarchical structure as a guide, professionals can conduct a comprehensive evaluation of each factor and determine their level of influence on the project's success which helps them in identifying potential bottlenecks, gaps, or areas of improvement that need attention.

5.2.2 Recommendation for future study

- .Due to time limitation, factor analysis was not undertaken before the start of AHP and it is encouraged to perform factor analysis in future study.
- Fuzzy AHP and Fuzzy ISM was not conducted for the same reason and it should be considered in the future research.
- Regarding the identification of Human Resource Management (HRM) critical success factors in the construction industry of Ethiopia, it's remarkable that this area has not been extensively investigated before. This highlights the need for further research using different methods to gain a comprehensive understanding of the HRM challenges and factors that contribute to project success in the Ethiopian construction industry.

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Appendices

Appendix A

AHP Questionnaire

General Information

This research survey is designed to fulfill an academic research paper requirement for the partial fulfillment of M.Sc. degree in Construction Engineering Management at Adama Science and Technology University (ASTU).

Dear respondent,

I am Student of Masters of science degree in Construction Engineering Management at Adama Science and Technology University (ASTU).As partial fulfillment of the program; I am undertaking a research on the topic “**Investigation of Critical Success for Construction Companies Human Resource Management**”. The research outcome could be helped as an input for decision makers, professionals, academicians and other interested groups to play their respective role for the achievement of project objectives. I kindly request you to fill out this questionnaire attached with this letter that would take approximately 30 minutes of your time.

The questionnaire consists of three sections. Section 1 General profile of the respondent, Section 2 General question related to HRM critical factors for construction companies and at the end there is a space left for general comments regarding the research topic.

Your response, in this regard, is highly valuable and contributory to the outcome of the research.

All feedback will be kept strictly confidential, and utilized for this academic research only.

For any clarification on this questionnaire, please contact the researcher on

+251 932576946 /+251937115921

Thanks in advance

Jemal Kedir Shuka

MSC Candidate in Construction Engineering Management
Adama Science and Technology University
Adama, Ethiopia

Advised by: - Fikreyesus Demeke(PhD)

Section 1: General Information

1. Your designation in the organization/your role in the implementation of construction projects

Project manager ☐ Project Coordinator ☐ Project manager assistant ☐

Human Resource Manager ☐ Office Engineer ☐ Site Engineer ☐ Site Foreman ☐

2. Please tick on your education level Diploma ☐ Bachelor ☐ Masters ☐ Doctoral ☐

3. Please indicate your years of experience of working in Construction industry/construction projects

Less than 5 years ☐ 5 – 10 years ☐ 10 – 15 years ☐ More than 15 years ☐

4. What is the age of your company? _____

5. How many employees do your organization has?

Below 20 ☐ 21- 50 ☐ 51 – 100 ☐ 101 - 200 ☐ More 200 ☐

Section 2: Rating of Construction companies HRM Factors Using AHP Method

Table 1: Scores for the importance of variable

Importance Scale	Definition of Importance Scale	Explanation
1	Equally Important Preferred	Option A and B are equally important
3	Moderately Important Preferred	Option A is moderately more important than option B
5	Strongly Important	Option A is strongly more important than option B
7	Very Strongly Important	Option A is very strongly more important than option B
9	Extremely Important	Option A is extremely more important than option B
2,4,6,8	Even numbers for intermediate values	Intermediate judgments

EXAMPLE:

#1) In the given table column, *if you think the Human Resource Planning activity of HRM is strongly more important than Recruitment and Selection activity of HRM*, then you **mark 5 with (X) on the left hand side**.

If you think the *Performance Management* activity of HRM is *extremely more important than Human Resource Planning*, then you **mark 9 with(X) on the right hand side**. **If you think the Determining Project Goal of Human Resource Planning** related factor is **equally important to the Number of Employees of Human Resource Planning** related factor, then you **mark 1 with(X) on the center**. If you think the *Determining Project Goal of Human Resource Planning* related factor has *intermediate importance (from moderately important to strongly important)* to the *Number of Employees of Human Resource Planning* related factor, then you **mark 4 with(X) on the left side**.

8. In regard to construction companies, indicate the importance of the following Human Resource Management activities in comparison.

HRM Activities	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	HRM Activities
Human Resource Planning																		Recruitment And Selection
Human Resource Planning																		Performance Management
Human Resource Planning																		Training And Development
Human Resource Planning																		Motivation And Labor Relation
Human Resource Planning																		Health And Safety
Recruitment And Selection																		Performance Management
Recruitment And Selection																		Training And Development
Recruitment And Selection																		Motivation And Labor Relation
Recruitment And Selection																		Health And Safety
Performance Management																		Training And Development
Performance Management																		Motivation And Labor Relation
Performance Management																		Health And Safety
Training And Development																		Motivation And Labor Relation
Training And Development																		Health And Safety
Motivation And Labor Relation																		Health And Safety

9. In regard to construction companies, indicate the importance of the following Human Resource Management factors related to Human Resource Planning (HRP) in comparison.

Human Resource Planning(HRP) Factors	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Human Resource Planning(HRP) Related Factors
Determining of the project goal																		Regular Human Resource Planning
Determining of the project goal																		Number of employees
Determining of the project goal																		Proper Human Information system
Regular Human Resource Planning																		Number of employees
Regular Human Resource Planning																		Proper Human Information system
Number of employees																		Proper Human Information system

10. In regard to construction companies, indicate the importance of the following Human Resource Management factors related to Recruitment and Selection (RAS) in comparison.

Recruitment And Selection (RAS) Related Factors	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Recruitment And Selection (RAS) Related Factors
Selection of candidate having good technical knowledge																		Selecting experienced and skill-full project team
Selection of candidate having good technical knowledge																		Selecting experienced and skill-full project manager
Selection of candidate having good technical knowledge																		Volume of work
Selecting experienced and skill-full project team																		Selecting experienced and skill-full project manager
Selecting experienced and skill-full project team																		Volume of work
Selecting experienced and skill-full project manager																		Volume of work

11. In regard to construction companies, indicate the importance of the following Human Resource Management factors related to Performance Management (PM) in comparison.

Performance Management(PM) Related Factors	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Performance Management(PM) Related Factors
Regular performance appraisal																		Top management support
Regular performance appraisal																		Rework
Regular performance appraisal																		Paying for performance
Regular performance appraisal																		Staff involvement in decision making
Top management support																		Rework
Top management support																		Paying for performance
Top management support																		Staff involvement in decision making
Rework																		Paying for performance
Rework																		Staff involvement in decision making
Paying for performance																		Staff involvement in decision making

12. In regard to construction companies, indicate the importance of the following Human Resource Management factors related to Motivation and Labor Relation (MALR) in comparison.

Motivation and Labor Relation (MALR) Related Factors	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Motivation and Labor Relation (MALR) Related Factors
Trust and confidence between employees and project team and project manager																		Effective and comprehensive communication between project team members
Trust and confidence between employees and project team and project manager																		Encouraging teamwork
Trust and confidence between employees and project team and project manager																		Employee motivation
Effective and comprehensive communication between project team members																		Encouraging teamwork
Effective and comprehensive communication between project team members																		Employee motivation
Encouraging teamwork																		Employee motivation

13. In regard to construction companies, indicate the importance of the following Human Resource Management factors related to Training and Development (TAD) in comparison.

TRAINING AND DEVELOPMENT (TAD) RELATED FACTORS	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	TRAINING AND DEVELOPMENT (TAD) RELATED FACTORS
Providing safe and sufficient credit resources																		Transfer of individual experience between team members
Providing safe and sufficient credit resources																		Providing sufficient and structured training and development program
Providing safe and sufficient credit resources																		Organizational Structure
Transfer of individual experience between team members																		Providing sufficient and structured training and development program
Transfer of individual experience between team members																		Organizational Structure
Providing sufficient and structured training and development program																		Organizational Structure

14. In regard to construction companies, indicate the importance of the following Human Resource Management factors related to Health and Safety (HAS) comparison.

HEALTH AND SAFETY (HAS) RELATED FACTORS	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	HEALTH AND SAFETY (HAS) RELATED FACTORS
Creating good working culture																		Creating of job security in the field of health and safety

Comments

Please feel free to give any comments on the following space.

Appendix B

ISM Questionnaire

General Information

This research survey is designed to fulfill an academic research paper requirement for the partial fulfillment of M.Sc. degree in Construction Engineering Management at Adama Science and Technology University (ASTU).

Dear respondent,

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For any clarification on this questionnaire, please contact the researcher on

+251 932576946 /+251937115921

Thanks in advance

Jemal Kedir Shuka

MSC Candidate in Construction Engineering Management
Adama Science and Technology University
Adama, Ethiopia

Advised by: - Fikreyesus Demeke(PhD)

Section A: General Information

A) For professionals

If you are construction professional please answer the following questions accordingly.

1. Your designation in the organization/your role in the implementation of construction projects(if you are construction professional)

Project manager ☐ Project Coordinator ☐ Project manager assistant ☐

Human Resource Manager ☐ Office Engineer ☐ Site Engineer ☐ Site Foreman ☐

2. Please tick on your education level Diploma ☐ Bachelor ☐ Masters ☐ Doctoral ☐

3. For how many years you have been working in Construction industry/construction projects? _____

B) For Academicians

1. Please tick on your education level Diploma ☐ Bachelor ☐ Masters ☐ Doctoral ☐

2. For how many years you have been teaching? _____

3. What is your research area? _____

4. What is your academic rank? _____

Section B: Constructing contextual relationship between Factors

The purpose of the following table is to record academics' and industry professionals' perspectives in order to create a pairwise contextual relationship between the Factors. Please fill in the white boxes (unmarked area) of the given table with the appropriate symbols based on their relationship accordingly. Where i = Column and j = Row.

V = Variable i will help to achieve variable j

A = Variable j will help to achieve variable i

X = Variable i and j will help to achieve each other

O = Variable i and j are unrelated to each other

HRM Critical Success Factors																							
Factors Code	<i>i=Column (↓) j=Row(→)</i>	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
F1	Determining of the project goal																						
F2	Regular Human Resource Planning																						
F3	Firm size(Number of employees)																						
F4	Proper Human Information system																						
F5	Selection of candidate having good technical knowledge																						
F6	Selecting experienced and skill-full project team																						
F7	Selecting experienced and skill-full project manager																						
F8	Volume of work																						
F9	Regular performance appraisal																						
F10	Top management support																						
F11	Compensation policies/paying for performance																						
F12	Staff involvement in decision making																						
F13	Providing safe and sufficient credit resources																						
F14	Transfer of individual experience between team members																						
F15	Providing sufficient and structured training and development program																						
F16	Organizational Structure																						
F17	Increasing trust and confidence between employees and project team and project manager																						
F18	Effective and comprehensive communication between project team members																						
F19	Encouraging teamwork																						
F20	Employee motivation																						
F21	Creating good working culture																						
F22	Creating of job security in the field of health and safety																						

NB:- Numbers on the right hand side of the table (numbers in the row i.e. 1 to 22) represents the same factors in the column

Appendix C

Level Partitioning of Critical Success Factors

Factor	Reachability set	Antecedent set	Driving power	Dependency Power
	Level 1(F20)			
F1	1-22,	1-10,12-22	22	21
F2	1-22,	1-10,12-18,21,22	22	19
F3	1-22,	1-22,	22	22
F4	1-9, 11-22	1-10,12-19,21,22	21	20
F5	1-22,	1-10,12-19,21,22	22	20
F6	1-22,	1-22,	22	22
F7	1-22,	1-19,22	22	20
F8	1-22,	1-10,12-19,21,22	22	20
F9	1-9,11-22	1-10,12-19,21,22	21	20
F10	1-22,	1-3,5-8,10,12,15-19,21,22	22	16
F11	3,6,7,11,13,14, 17-22	1-11,13, 15-19,21,22	13	19
F12	1-10,12-22	1-10,12-19,21,22	21	20
F13	1-9,11-22	1-22,	21	22
F14	1-9,12-22	1-22,	20	22
F15	1-22,	1-19,21,22	22	21
F16	1-22,	1-10,12-19,21,22	22	20
F17	1-22,	1-22,	22	22
F18	1-22,	1-22,	22	22
F19	1,2-22,	1-22,	21	22
F20	1,3,6,13,14,	1-22,	10	22
F21	17-21	1-22,	21	22
F22	1-6,8-22	1-22,	22	21

	Level 2 (F11)			
F1	1-22,	1-10,12-22	22	21
F2	1-22,	1-10,12-18,21,22	22	19
F3	1-22,	1-22,	22	22
F4	1-9, 11-22	1-10,12-19,21,22	21	20
F5	1-22,	1-10,12-19,21,22	22	20
F6	1-22,	1-22,	22	22
F7	1-22,	1-19,22	22	20
F8	1-22,	1-10,12-19,21,22	22	20
F9	1-9,11-22	1-10,12-19,21,22	21	20
F10	1-22,	1-3,5-8,10,12,15-19,21,22	22	16
F11	3,6,7,11,13,14, 17-22	1-11,13, 15-19,21,22	13	19
F12	1-10,12-22	1-10,12-19,21,22	21	20
F13	1-9,11-22	1-22,	21	22
F14	1-9,12-22	1-22,	20	22
F15	1-22,	1-19,21,22	22	21
F16	1-22,	1-10,12-19,21,22	22	20
F17	1-22,	1-22,	22	22
F18	1-22,	1-22,	22	22
F19	1,2-22,	1-22,	21	22
F21	17-21	1-22,	21	22
F22	1-6,8-22	1-22,	22	21
	Level 3 (F14)			
F1	1-22,	1-10,12-22	22	21
F2	1-22,	1-10,12-18,21,22	22	19
F3	1-22,	1-22,	22	22
F4	1-9, 11-22	1-10,12-19,21,22	21	20
F5	1-22,	1-10,12-19,21,22	22	20
F6	1-22,	1-22,	22	22
F7	1-22,	1-19,22	22	20
F8	1-22,	1-10,12-19,21,22	22	20
F9	1-9,11-22	1-10,12-19,21,22	21	20
F10	1-22,	1-3,5-8,10,12,15-19,21,22	22	16
F12	1-10,12-22	1-10,12-19,21,22	21	20
F13	1-9,11-22	1-22,	21	22
F14	1-9,12-22	1-22,	20	22
F15	1-22,	1-19,21,22	22	21
F16	1-22,	1-10,12-19,21,22	22	20
F17	1-22,	1-22,	22	22

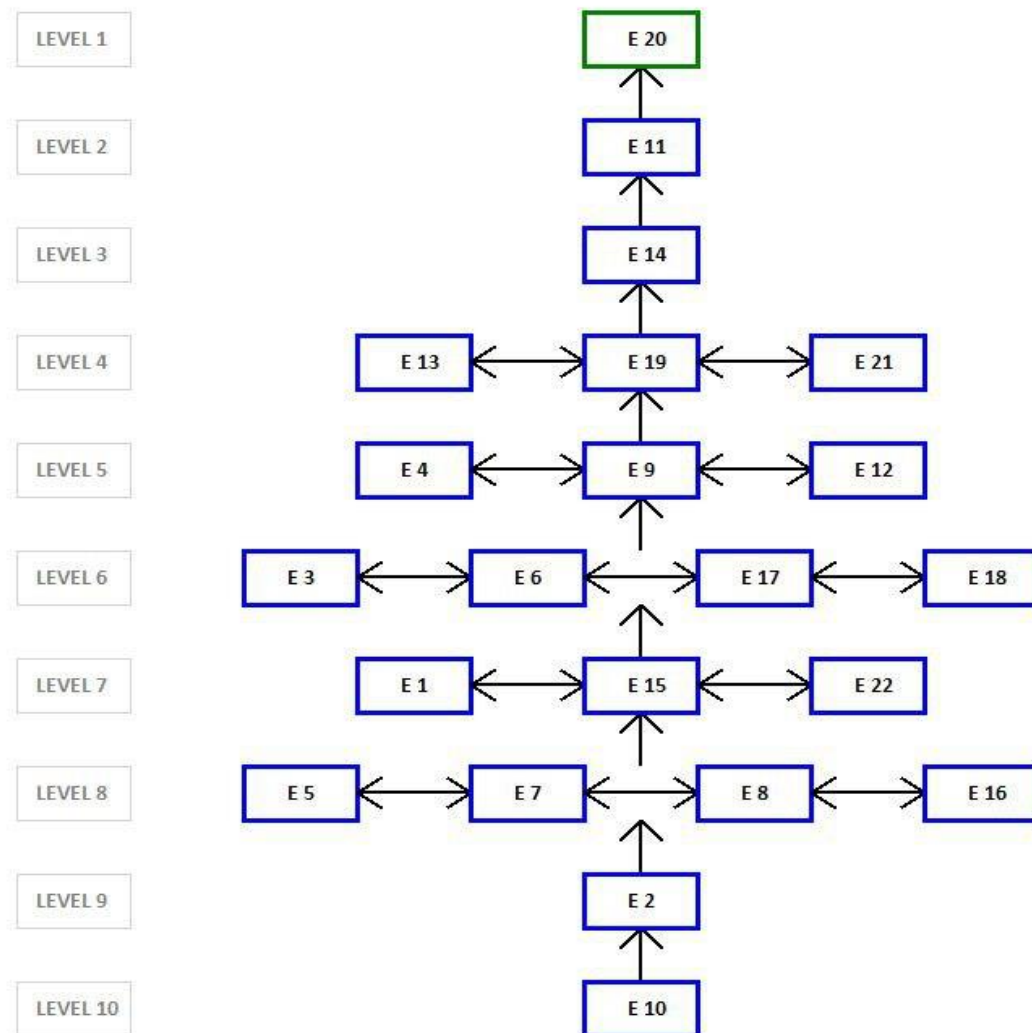
F18	1-22,	1-22,	22	22
F19	1,2-22,	1-22,	21	22
F21	17-21	1-22,	21	22
F22	1-6,8-22	1-22,	22	21
	Level 4 (F13, F19,F21)			
F1	1-22,	1-10,12-22	22	21
F2	1-22,	1-10,12-18,21,22	22	19
F3	1-22,	1-22,	22	22
F4	1-9, 11-22	1-10,12-19,21,22	21	20
F5	1-22,	1-10,12-19,21,22	22	20
F6	1-22,	1-22,	22	22
F7	1-22,	1-19,22	22	20
F8	1-22,	1-10,12-19,21,22	22	20
F9	1-9,11-22	1-10,12-19,21,22	21	20
F10	1-22,	1-3,5-8,10,12,15-19,21,22	22	16
F12	1-10,12-22	1-10,12-19,21,22	21	20
F13	1-9,11-22	1-22,	21	22
F15	1-22,	1-19,21,22	22	21
F16	1-22,	1-10,12-19,21,22	22	20
F17	1-22,	1-22,	22	22
F18	1-22,	1-22,	22	22
F19	1,2-22,	1-22,	21	22
F21	17-21	1-22,	21	22
F22	1-6,8-22	1-22,	22	21
	Level 5 (F4, F9,F12)			
F1	1-22,	1-10,12-22	22	21
F2	1-22,	1-10,12-18,21,22	22	19
F3	1-22,	1-22,	22	22
F4	1-9, 11-22	1-10,12-19,21,22	21	20
F5	1-22,	1-10,12-19,21,22	22	20
F6	1-22,	1-22,	22	22
F7	1-22,	1-19,22	22	20
F8	1-22,	1-10,12-19,21,22	22	20
F9	1-9,11-22	1-10,12-19,21,22	21	20
F10	1-22,	1-3,5-8,10,12,15-19,21,22	22	16
F12	1-10,12-22	1-10,12-19,21,22	21	20
F15	1-22,	1-19,21,22	22	21
F16	1-22,	1-10,12-19,21,22	22	20
F17	1-22,	1-22,	22	22

F18	1-22,	1-22,	22	22
F22	1-6,8-22	1-22,	22	21
	Level 6 (F3, F6,F17,F18)			
F1	1-22,	1-10,12-22	22	21
F2	1-22,	1-10,12-18,21,22	22	19
F3	1-22,	1-22,	22	22
F5	1-22,	1-10,12-19,21,22	22	20
F6	1-22,	1-22,	22	22
F7	1-22,	1-19,22	22	20
F8	1-22,	1-10,12-19,21,22	22	20
F10	1-22,	1-3,5-8,10,12,15-19,21,22	22	16
F15	1-22,	1-19,21,22	22	21
F16	1-22,	1-10,12-19,21,22	22	20
F17	1-22,	1-22,	22	22
F18	1-22,	1-22,	22	22
F22	1-6,8-22	1-22,	22	21
	Level 7 (F1, F15,F22)			
F1	1-22,	1-10,12-22	22	21
F2	1-22,	1-10,12-18,21,22	22	19
F5	1-22,	1-10,12-19,21,22	22	20
F7	1-22,	1-19,22	22	20
F8	1-22,	1-10,12-19,21,22	22	20
F10	1-22,	1-3,5-8,10,12,15-19,21,22	22	16
F15	1-22,	1-19,21,22	22	21
F16	1-22,	1-10,12-19,21,22	22	20
F22	1-6,8-22	1-22,	22	21
	Level 8 (F5, F7,F8,F16)			
F2	1-22,	1-10,12-18,21,22	22	19
F5	1-22,	1-10,12-19,21,22	22	20
F7	1-22,	1-19,22	22	20
F8	1-22,	1-10,12-19,21,22	22	20
F10	1-22,	1-3,5-8,10,12,15-19,21,22	22	16
F16	1-22,	1-10,12-19,21,22	22	20
	Level 9(F2)			
F2	1-22,	1-10,12-18,21,22	22	19
F10	1-22,	1-3,5-8,10,12,15-19,21,22	22	16
	Level 10(F10)			
F10	1-22,	1-3,5-8,10,12,15-19,21,22	22	16

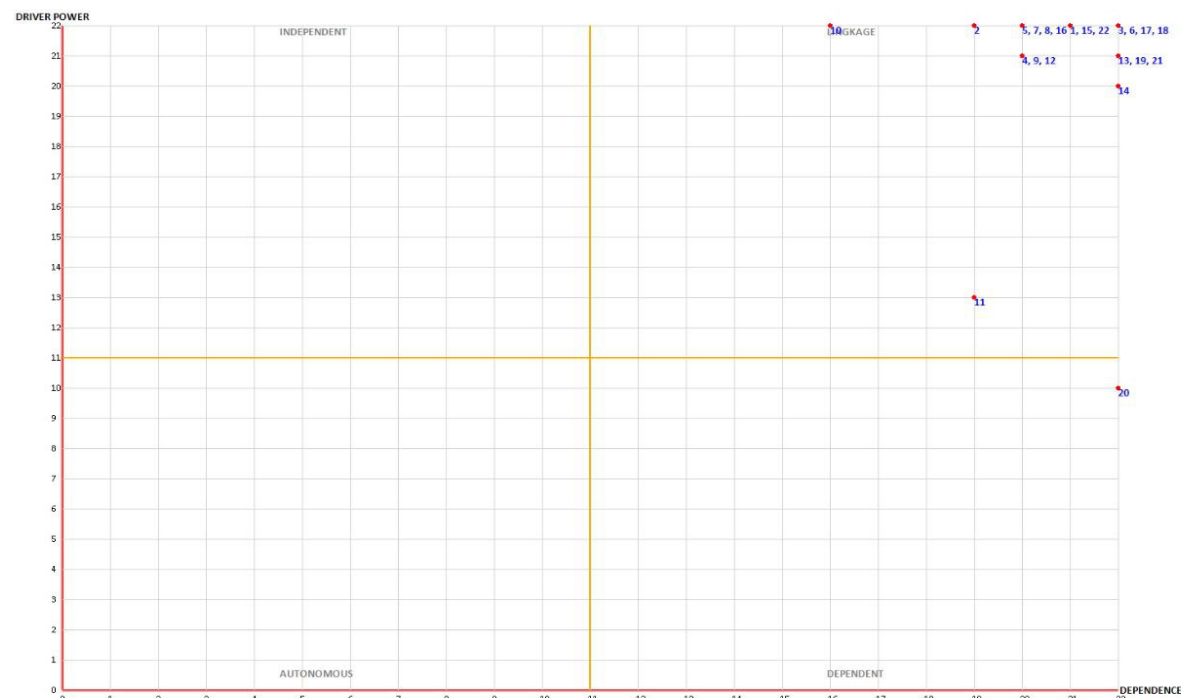
Appendix D

Software Outputs

1. Levels of CSFs from ISM Software



2. MICMAC Analysis of CSFs from ISM Software



3. Revision matrix from ISM software

Expert List		SSIM																
Element List		Reachability Matrix				Revision Matrix				Final Matrix				Graph		Structure		
Expert Name		Institu																
E1	--																	
AGREGAT	AGREGAT																	

NO	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17
A1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
A2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
A3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
A4	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1
A5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
A6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
A7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
A8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
A9	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1
A10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
A11	0	0	1	0	0	1	1	0	0	0	1	0	1	1	1	0	1
A12	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1
A13	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1
A14	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1
A15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
A16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
A17	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
A18	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
A19	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
A20	1	0	1	0	0	1	0	0	0	0	0	1	1	0	0	1	1
A21	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1
A22	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

4. Comparison Matrix from AHP Spice Logic Software outputs

Table 1 Pairwise comparison matrix of HRM activities categories with priorities

	HRP	RAS	PM	TAD	MALR	HAS	GM	v
HRP	1	1.868	1.488	0.804	0.920	0.662	1.053	0.173
RAS	0.535	1	1.014	1.338	0.645	0.445	0.770	0.129
PM	0.672	0.987	1	1.267	1.066	0.809	.948	0.155
TAD	1.244	0.747	0.789	1	1.449	0.839	.981	0.165
MALR	1.087	1.551	0.938	0.690	1	0.935	1.003	0.164
HAS	1.511	2.250	1.236	1.191	1.069	1	1.323	0.214
$\Sigma = 6.077$								

Table 2 Pairwise comparison matrix of HRM factors under HRP category

	DPG	RHRP	NOE	PHIS	Priorities
DPG	1	1.810	1.374	1.579	0.338
RHRP	0.552	1.000	2.992	1.132	0.285
NOE	0.728	0.334	1.000	0.799	0.165
PHIS	0.633	0.884	1.251	1.000	0.212
$\lambda_{\max} = 4.1668$ $CI = 0.0556$ $CR = 0.063 \leq 0.1$					

Table 3 Pairwise comparison matrix of HRM factors under RAS category

	SCHGTK	SEASPT	SEASPM	VOW	Priorities
SCHGTK	1	0.537	0.686	1.742	0.202
SEASPT	1.861	1.000	1.308	2.963	0.371
SEASPM	1.459	0.765	1.000	3.331	0.315
VOW	0.574	0.338	0.300	1.000	0.112
$\lambda_{\max} = 4.0144$ $CI = 0.0048$ $CR = 0.0054 \leq 0.1$					

Table 4 Pairwise comparison matrix of HRM factors under PM category

	RPA	TMS	RW	PFP	SIIDM	Priorities
RPA	1	0.770	2.945	0.780	0.416	0.164
TMS	1.299	1.000	3.560	1.559	0.616	0.237
RW	0.340	0.281	1.000	0.308	0.204	0.063
PFP	1.282	0.642	3.250	1.000	0.766	0.203
SIIDM	2.402	1.624	4.907	1.305	1.000	0.333
$\lambda_{\max} = 5.045$ $CI = 0.0112$ $CR = 0.010 \leq 0.1$						

Table 5 Pairwise comparison matrix of HRM factors under MALR category

	TCEPTM	ECCPTM	ETW	EM	Priorities
TCEPTM	1	1.132	1.333	1.395	0.299
ECCPTM	0.883	1.000	1.108	1.179	0.257
ETW	0.750	0.902	1.000	1.197	0.235
EM	0.717	0.848	0.836	1.000	0.209
$\lambda_{\max} = 4.003$ $CI = 0.001$ $CR = 0.001 \leq 0.1$					

Table 6 Pairwise comparison matrix of HRM factors under TAD category

	PSASCR	TIEBTM	PSSTADP	OS	Priorities
PSASCR	1	0.983	0.906	1.027	0.242
TIEBTM	1.017	1.000	0.845	1.057	0.242
PSSTADP	1.103	1.183	1.000	1.659	0.301
OS	0.974	0.946	0.603	1.000	0.215
$\lambda_{\max} = 4.0144$ $CI = 0.0048$ $CR = 0.0054 \leq 0.1$					

Table 7 Pairwise comparison matrix of HRM factors under HAS category

	CGWC	CJSIHAS	Priorities
CGWC	1	0.470	0.320
CJSIHAS	2.126	1.000	0.680
$\lambda_{\max} = 2$ $CI = 0.00$ $CR = 0.00 \leq 0.1$			

5. SSIM, Reachability matrix and Final reachability matrix

Table 8 Structural Self Interacting Matrix (SSIM) of CCHRMCSFs

	F2	F2	F2	F1	F1	F1	F1	F1	F1	F1	F1	F1	F1	F9	F8	F7	F6	F5	F4	F3	F2	F1
CSFs	2	1	0	9	8	7	6	5	4	3	2	1	0									
F1	V	O	V	O	O	O	V	V	A	O	A	O	A	V	X	X	X	V	O	A	V	
F2	V	O	O	O	O	O	A	A	V	V	O	V	A	X	O	V	V	V	A	X		
F3	X	O	O	O	O	O	V	X	A	A	O	O	O	O	X	V	X	O	O			
F4	O	O	O	O	A	O	A	V	V	O	X	O	A	A	O	A	A	X				
F5	O	O	O	O	V	A	V	O	V	A	O	V	A	A	X	X	O					
F6	X	V	V	X	X	V	V	V	V	V	V	V	X	V	X	X						
F7	X	V	V	V	V	V	V	V	V	X	V	V	A	V	X							
F8	V	O	O	O	O	O	X	A	O	O	O	O	A	A								
F9	V	A	V	V	O	O	A	V	O	V	O	A	V									
F10	V	V	V	V	V	X	X	V	V	O	V	V										
F11	V	O	V	O	O	O	A	A	O	O	O											
F12	V	X	O	O	X	X	A	O	V	O												
F13	X	O	V	O	O	A	A	O	X													
F14	O	X	A	A	V	O	O	A														
F15	A	A	V	V	V	V	X															
F16	O	A	V	V	V	O																
F17	A	X	O	A	X																	
F18	A	X	O	V																		
F19	A	X	X																			
F20	A	A																				
F21	A																					
F22																						

Source: Author's construction based on aggregated respondents' response

Table 9 Initial reachability matrix (M)

<i>CSFs</i>	F2 2	F2 1	F2 0	F1 9	F1 8	F1 7	F1 6	F1 5	F1 4	F1 3	F1 2	F1 1	F1 0	F9	F8	F7	F6	F5	F4	F3	F2	F1
F1	1	0	1	0	0	0	1	1	0	0	0	0	0	1	1	1	1	1	0	0	1	1
F2	1	0	0	0	0	0	0	0	1	1	0	1	0	1	0	1	1	1	0	1	1	0
F3	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	1	0	0	1	1	1
F4	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	1		0	0	0
F5	0	0	0	0	1	0	1	0	1	0	0	1	0	0	1	1	0	1	1	0	0	0
F6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1
F7	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	0	1
F8	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	1	1	0	1	0	1
F9	1	0	1	1	0	0	0	1	0	1	0	0	1	1	1	0	0	1	1	0	1	0
F10	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	0	1	1
F11	1	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
F12	1	1	0	0	1	1	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	1
F13	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	1	0	1	0	1	0	0
F14	0	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	1
F15	0	0	1	1	1	1	1	1	1	0	0	1	0	0	1	0	0	0	0	1	1	0
F16	0	0	1	1	1	0	1	1	0	1	1	1	1	1	1	0	0	0	1	0	1	0
F17	0	1	0	0	1	1	0	0	0	1	1	0	1	0	0	0	0	1	0	0	0	0
F18	0	1	0	1	1	1	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0
F19	0	1	1	1	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0
F20	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
F21	0	1	1	1	1	1	1	1	1	0	1	0	0	1	1	1	1	1	1	1	1	1
F22	1	1	1	1	1	1	0	1	0	1	0	0	0	0	0	1	1	0	0	1	0	0

Source: Interpretive Structural Modeling Software output

Table 10 Final reachability matrix (FRM)

No	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19	F20	F21	F22	DP	R
F1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	22	1
F2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	22	1
F3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	22	1
F4	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	21	2
F5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	22	1
F6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	22	1
F7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	22	1
F8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	22	1
F9	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	21	2
F10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	22	1
F11	0	0	1	0	0	1	1	0	0	0	1	0	1	1	1	0	1	1	1	1	1	1	13	4
F12	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	21	2
F13	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	21	2
F14	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	20	3
F15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	22	1
F16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	22	1
F17	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	22	1
F18	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	22	1
F19	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	2
F20	1	0	1	0	0	1	0	0	0	0	0	0	1	1	0	0	1	1	1	1	1	0	10	5
F21	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	2
F22	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	22	1
D	21	19	22	20	20	22	20	20	20	16	19	20	22	22	21	20	22	22	22	22	22	21		
L	2	4	1	3	3	1	3	3	3	5	4	3	1	1	2	3	1	1	1	1	1	2		

Source: Interpretive Structural Modeling Software output

