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# Evaluation of Factors Affecting the Construction Projects

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***Abstract:*** ***The main objective of this study is to identify the critical factors influencing delay and their impact on project completion. Quality is one of the important aspects of all projects. The level of success of construction projects greatly depends on the quality performance. The Indian construction sector is facing quality related issues, which lead to ineffective and inefficient projects in terms of overrun, delays and excessive rework. The results presented are based on a study carried out at various ongoing and completed construction projects in Indian context. A structured questionnaire survey was used to solicit the causes from various construction professionals in various firms. About forty four respondents were participated in this survey. A questionnaire was developed based on identified factors to take opinion of construction experts. After their feedback a statistical analysis tool such as RII method were used to rank the significance level of these factors.***
***Keywords: Quality, Time, Cost, Delay, Construction Projects, RII Method***

## I. INTRODUCTION

The construction industry is a very important role of the economy development for any developing country. In India, the construction industry plays a very important role for the economy. It provides the physical infrastructure, which is primary for the country's development. Construction projects are falling at an alarming rate worldwide (Matta and Ashkena, 2007). Delay could be defined as the time overrun either beyond the completion date that parties agreed upon for delivery of a project. While several studies that discuss about the critical factors affecting project delay in various countries, (Kumaraswamy and Chan, 1998, Lo et. al, 2006, Assaf and Al-Hejji, 2006, Sambasivan and Soon 2007, Ogunlana et. al, 1996). A Possible reason for the absence of such studies could be that a client would not like to incur additional cost and time on a failed project for studying the reason for delay.
This study makes an attempt to find the critical factor influencing on resource related delay in construction projects. This paper focuses on the construction stage of projects. The objectives of this study include:
To identify the factorcauses of delays in construction projects in India. To identify top ten most important critical factors of delay from a list of sixty one(61) different sub factors with ten different groups of resources based on the RII value and rank. To identify the degree of agreement in most important causes of delays between two parties involved in projects.

## II. BACKGROUND

Time and cost are the two common concerns of construction management. Many factors relate to delay with types of project, locations, sizes, and scopes. Construction projects with their features of complexity and capital requirement have resulted interest to many researchers. Al-Momani (2000) conducted a quantitative analysis of construction delays by examining the records of one hundred and thirty public building projects constructed in Jordan. There were presented the regression models of the relationship between actual and planned project duration for different causes of delays. They concluded that the main causes of delays in construction projects relate to designers, user changes, weather, site conditions, late deliveries, economic conditions, and increase in quantities. Assafet. al (1995) identified fifty six causes of delay under nine major groups and evaluated their relative importance index by them in Saudi Arabia. They were concluded that contractor owners and architects in general agree to the ranking of individual delay factors while contractors and architects substantially agree with the ranking of groups of delay factors while contractors and owners, and architects and owners don't agree. Assaf and Al-Hejji (1995) identified that the most common cause out of the listed 73 causes of delay identified by all parties of construction is change of orders using Frequency Index (FI), Severity Index (SI) and Important Index (II). Chan and Kumaraswamy (1997) examined the relative importance of delay factors in Hong Kong. There were identified five principal delay factors such as: poor risk management, poor supervision, unforeseen site conditions, slow decision making involving variation, and necessary variation works. El-Razeket. al (2008) examined the causes of delays in Egyptian construction projects. There concluded that different parties of construction don't agree on the relative

importance of various factors of delay, mostly blaming each other of delays using importance index and spearman rank correlation. Faridi and El- Sayegh (1995) identified that over 50% of construction projects experience delay due to factors such as delay in approval of construction drawings, poor pre-planning and slow decision making process. Comparing the key factors of construction delay across UAE, the Kingdom of Saudi Arabia (KSA) and Lebanon, the research asserted that delay in approval, owner's slow decision making and material shortages are common causes of construction delay across the region. However, the findings those other high ranked factors in UAE had no significant impact in KSA construction projects clearly highlight the fact that factors causing construction delay cannot be considered common across the countries. Iyer and Jha (2005) reported the success and failure attributes of the project and their latent property failure attributes being: conflict among project participants, ignorance and lack of knowledge, presence of poor project specific attributes and non-existence of cooperation, hostile socio economic and climatic condition, reluctance in timely decision, aggressive competition at tender stage, short bid preparation time. Kumaraswamy and Chan (1998) reviewed eight categories of delay factor as: project related factors, client related factors, design team related factors, contractor related factors, materials, labour, plant and equipment, and external factors. Lo et. al (2006) identified thirty causes of delay factors under seven categories namely client related, engineer related, contractor related, human behavior related, project related, external factors and resource related in Hong Kong construction projects. There were analyzed and ranked by using Rank Agreement Factor (RAF), Percentage Agreement (PA) and Percentage Disagreement (PD) difference in perceptions of various construction practitioners on causes of delay. Mansfield et. al (1994) reported the causes of delays and cost overrun in Nigerian construction projects. There were identified sixteen major factors that caused delays and cost overruns in Nigeria. The most important items agreed on by the contractor, consultants, and public clients surveyed were the financing and payment for completed works, poor contract management, change in site conditions, and shortages of materials inaccurate estimation, and overall price fluctuations. Sambasivan and Soon (1997) reported an integrated approach for causes and effects of construction delays in Malaysia construction projects, they were identified ten important factors Out of twenty eight listed factors and six main effects of delays using relative importance index and in order to test the degree of agreement between the three groups of respondents as to cause of delays. Odeyinka and Yusif (1997) examined the causes of delays in housing projects and identified main categories as: client, consultant, and contractor caused delays, and extraneous factors in inclement weather, acts of nature, labor disputes and strikes in Nigeria. The research asserted that client-caused delays predominately arise from design variation in projects.

## III. RESEARCH METHODOLOGY

For this research, a questionnaire survey method has been adopted to find the impact of critical factors that leads to delay on resource related in the Indian construction sector drawing from various international researchers mentioned above in particular (Sambasivan and Soon 2007). A questionnaire survey was conducted of construction professionals representing various stakeholders involved in construction projects in India.

### *A. Questionnaire Design*

The questionnaire was designed based on critical factors were identified that contributed to the causes of delays. A questionnaire survey was developed to assess the perceptions of various construction professional of the relative importance of causes and the effects of construction delays. The questionnaire was designed into two sections: Section A; section B. Section A is to obtain the requested background information about the respondents. Section B is to obtain the information on factors that contribute to the causes of delays in construction projects from the perspective of construction professionals. A total twenty eight resource related factors were identified under three broad categories namely manpower related, material related and equipment related issues. The critical factors are listed in Table 1. A five point Likert scale (1 very low, 2 low, 3 moderate, 4 high, 5 very high) was adopted where respondents were asked to rank the importance and impact of a particular factors on delay in one of their selected projects. Descriptive statistics techniques namely Relative Importance Index (RII) has been used to highlight the relative importance of critical factors as perceived by the respondents (Assaf et. al, 1995; Faridi and El-Sayegh, 2006; Iyer and Jha, 2005; Kumaraswamy and Chan, 1998).

### *B. Data Analysis*

The data analysis will be done by relative importance index technique used to determine the relative importance of the various cause of factors. The same method is going to be adopted in this study. The five-point scale ranged from 1(very low important) to 5 (very high important) will be adopted and will be transformed to relative importance indices (RII) for each factors as follows:

RII= ∑ W/A*N

Where, W is the weighting given to each factor by the respondents (ranging from 1 to 5), A is the highest weight (i.e. 5 in this case), and N is the total number of respondents. The RII value had a range from 0 to 4 (0 not inclusive), higher the value of the RII, more important was the causes of delays. The RII was used to rank the different uncertainty factors that cause delay. These ranking made it possible to cross-compare the relative importance of the uncertainty factors as perceived by the respondents.

Tables 1: Numerical conversion for the rating attributes

| α , β | |
|---|---|
| Ratting Attributes | Numerical Conversion |
| 0 | 0.0 |
| 1 | 0.2 |
| 2 | 0.4 |
| 3 | 0.6 |
| 4 | 0.8 |
| 5 | 1.0 |

After obtaining index score for each factor, standard deviation and coefficient of variation of each factor is also determined. Subsequently, ranking of factors is done based on Index score.

## IV. RESULT AND DISCUSSION

### *A. Analysis of Data*

Total twenty eight respondents have filled up the questionnaire. Subsequently for analysis of responses following steps are followed:

*1)* Responses were converted into numerical values based on their rating attributes. A sample is shown in Table
*2)* After that mean of numerical values of all twenty eight responses is determined
*3)* Then, Standard deviation and coefficient of variation for each risk factor is determined
*4)* Afterwards, Index Score for each risk is calculated by using RI Method.

Table 2: Conversion of response into numerical values (Questionnaire 1)

| Groups/Factors | Very low important | Low important | Medium Important | High important | Very high important |
|---|---|---|---|---|---|
| (1) Cost factors | 1 | 2 | 3 | 4 | 5 |
| Market share of organization | | | 0.6 | | |
| Liquidity of organization | | | | | 1 |
| Cash flow of project | | | | | 1 |
| Profit rate of project | | | | 0.8 | |
| Overhead percentage of project | | 0.4 | | | |
| Project design cost | | | 0.6 | | |
| Material and equipment cost | | | 0.6 | | |
| Project labor cost | | | | 0.8 | |
| Project overtime cost | | 0.4 | | | |
| Cost of rework | 0.2 | | | | |
| Cost of variation orders | | | 0.6 | | |
| Waste rate of materials | 0.2 | | | | |
| Regular project budget update | | | 0.6 | | |
| Cost control system | | | | 0.8 | |
| Escalation of material prices | | | | 0.8 | |

| | | | | | |
|---|---|---|---|---|---|
| (2) Time factors | | | | | |
| Site preparation time | | | 0.6 | | |
| Planned time for project construction | | | | 0.8 | |
| Percentage of orders delivered late | | | | | 1 |
| Time needed to implement variation orders | | | | 0.8 | |
| Time needed to rectify defects | | | 0.6 | | |
| Average delay in claim approval | | | 0.6 | | |
| Average delay in payment from owner to contractor | | | 0.6 | | |
| Availability of resources as planned through project duration | | | | 0.8 | |
| Average delay because of closures and materials shortage | | | | 0.8 | |
| (3) Quality factors | | | | | |
| Conformance to specification | | | | | 1 |
| Availability of personals with high experience and qualification | | | | | 1 |
| Quality of equipments and raw materials in project | | | | | 1 |
| Participation of managerial levels with decision making | | | | 0.8 | |
| Quality assessment system in organization | | | | | 1 |
| Quality training/meeting | | | | 0.8 | |
| (4) Productivity factors | | | | | |
| Project complexity | | | 0.6 | | |
| Number of new projects / year | | | 0.6 | | |
| Management-labor relationship | | | | 0.8 | |
| Absenteeism rate through project | | | | 0.8 | |
| Sequencing of work according to schedule | | | | 0.8 | |
| (5) Client Satisfaction factors | | | | | |
| Information coordination between owner and project parties | | | | | 1 |
| Leadership skills for project manager | | | | | 1 |
| Speed and reliability of service to owner | | | | | 1 |
| Number of disputes between owner and project parties | | | 0.6 | | |
| Number of reworks | | | 0.6 | | |
| (6) Regular and community satisfaction factors | | | | | |
| Cost of compliance to regulators requirements | | | 0.6 | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Number of non compliance to regulation | | | 0.6 | | |
| Quality and availability of regulator documentation | | | | 0.8 | |
| Neighbors and site conditions problems | | | | 0.8 | |
| (7) People factors | | | | | |
| Employee attitudes in project | | | | | 1 |
| Recruitment and competence development between employees | | | | 0.8 | |
| Employees motivation | | | | | 1 |
| Belonging to work | | | | | 1 |
| (8) Health and Safety factors | | | | | |
| Application of Health and safety factors in organization | | | | 0.8 | |
| Easiness to reach to the site (location of project) | | | | | YES |
| Reportable accidents rate in project | | | 0.6 | | |
| Assurance rate of project | | | 0.6 | | |
| (9) Innovation and learning factors | | | | | |
| Learning from own experience and past history | | | | 0.8 | |
| Learning from best practice and experience of others | | | | 0.8 | |
| Training the human resources in the skills demanded by the project | | | 0.6 | | |
| Work group | | | | | 1 |
| Review of failures and solve them | | | | 0.8 | |
| (10) Environment factors | | | | | |
| Air quality | | | | 0.8 | |
| Noise level | | | | 0.8 | |
| Wastes around the site | | | | | 1 |
| Climate condition in the site | | | | | 1 |

| S.NO | INTERVIEW NO. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | Total | Mean(m) | SD(s) | C.O.V=(s/m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (1) Cost factors | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | Market share of organization | 0.6 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.6 | 0.6 | 0.6 | 0.6 | 0.8 | 0.6 | 0.6 | 0.4 | 0.4 | 0.6 | 0.4 | 0.4 | 0.4 | | 9.6 | 0.50526 | 0.1224 | 0.242 |
| 2 | Liquidity of | 1 | 0. | 0. | 0. | 0. | 1 | 1 | 0. | 1 | 1 | 1 | 1 | 0. | 0. | 1 | 1 | 0. | 0. | 0. | | 15.8 | 0.83158 | 0.1797 | 0.216 |

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | organization | | 6 | 8 | 6 | 6 | | | 8 | | | | | 8 | 8 | | | 6 | 6 | 6 | | | | | |
| 3 | Cash flow of project | 1 | 0.8 | 0.8 | 0.8 | 0.8 | 1 | 1 | 0.8 | 1 | 1 | 0.8 | 1 | 0.8 | 0.8 | 0.8 | 1 | 0.8 | 0.8 | 0.8 | | 16.6 | 0.87368 | 0.0991 | 0.113 |
| 4 | Profit rate of project | 0.8 | 0.8 | 0.4 | 0.8 | 0.8 | 0.8 | 0.8 | 0.6 | 0.8 | 0.8 | 0.6 | 0.8 | 0.8 | 0.4 | 0.6 | 0.8 | 0.8 | 0.8 | 0.8 | | 13.8 | 0.72632 | 0.1368 | 0.188 |
| 5 | Overhead percentage of project | 0.4 | 0.8 | 0.6 | 0.8 | 0.8 | 0.4 | 0.6 | 0.6 | 0.4 | 0.4 | 0.8 | 0.4 | 0.8 | 0.6 | 0.6 | 0.8 | 0.8 | 0.8 | 0.8 | | 12.2 | 0.64211 | 0.171 | 0.266 |
| 6 | Project design cost | 0.6 | 1 | 0.6 | 1 | 1 | 0.6 | 0.6 | 0.8 | 0.6 | 0.4 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.8 | 1 | 1 | 0.8 | | 13.8 | 0.72632 | 0.191 | 0.263 |
| 7 | Material and equipment cost | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.4 | 0.6 | 0.8 | 0.8 | 0.6 | 0.6 | 0.6 | | 11.6 | 0.61053 | 0.0809 | 0.132 |
| 8 | Project labor cost | 0.8 | 0.6 | 0.4 | 0.6 | 0.6 | 0.6 | 0.4 | 0.6 | 0.8 | 0.4 | 0.4 | 0.8 | 0.4 | 0.4 | 0.8 | 0.6 | 0.6 | 0.6 | 0.6 | | 11 | 0.57895 | 0.1475 | 0.254 |
| 9 | Project overtime cost | 0.4 | 0.4 | 0.8 | 0.4 | 0.4 | 0.8 | 0.6 | 1 | 0.4 | 0.8 | 0.8 | 1 | 0.6 | 0.8 | 0.8 | 0.6 | 0.4 | 0.4 | 0.6 | | 12 | 0.63158 | 0.2136 | 0.338 |
| 10 | Cost of rework | 0.2 | 0.4 | 0.8 | 0.4 | 0.4 | 0.6 | 0.4 | 0.8 | 0.4 | 0.6 | 0.6 | 0.4 | 0.6 | 0.8 | 0.6 | 0.8 | 0.4 | 0.4 | 0.4 | | 10 | 0.52632 | 0.179 | 0.340 |
| 11 | Cost of variation orders | 0.6 | 0.6 | 0.8 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.4 | 0.6 | 0.6 | 0.6 | 0.8 | 0.8 | 0.6 | 0.6 | 0.6 | 0.4 | | 11.6 | 0.61053 | 0.1049 | 0.171 |
| 12 | Waste rate of materials | 0.2 | 0.6 | 0.6 | 0.6 | 0.6 | 0.4 | 0.4 | 0.6 | 0.6 | 0.4 | 0.4 | 0.2 | 0.6 | 0.8 | 0.6 | 0.8 | 0.6 | 0.6 | 0.6 | | 10.2 | 0.53684 | 0.164 | 0.305 |
| 13 | Regular project budget update | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.4 | 0.4 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | | 11 | 0.57895 | 0.0631 | 0.108 |
| 14 | Cost control system | 0.8 | 0.8 | 0.6 | 0.8 | 0.8 | 0.8 | 0.6 | 0.6 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.6 | 0.6 | 0.6 | 0.8 | 0.6 | 0.6 | | 13.6 | 0.71579 | 0.1015 | 0.141 |
| 15 | Escalation of material prices | 0.8 | 1 | 0.4 | 1 | 1 | 0.6 | 0.8 | 0.8 | 0.6 | 0.6 | 0.8 | 0.8 | 0.8 | 0.6 | 0.8 | 0.6 | 1 | 1 | 0.8 | | 14.8 | 0.77895 | 0.1751 | 0.224 |
| | (2) Time factors | | | | | | | | | | | | | | | | | | | | | | | | |
| 16 | Site preparation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 12 | 0.64 | 0.1 | 0.22 |

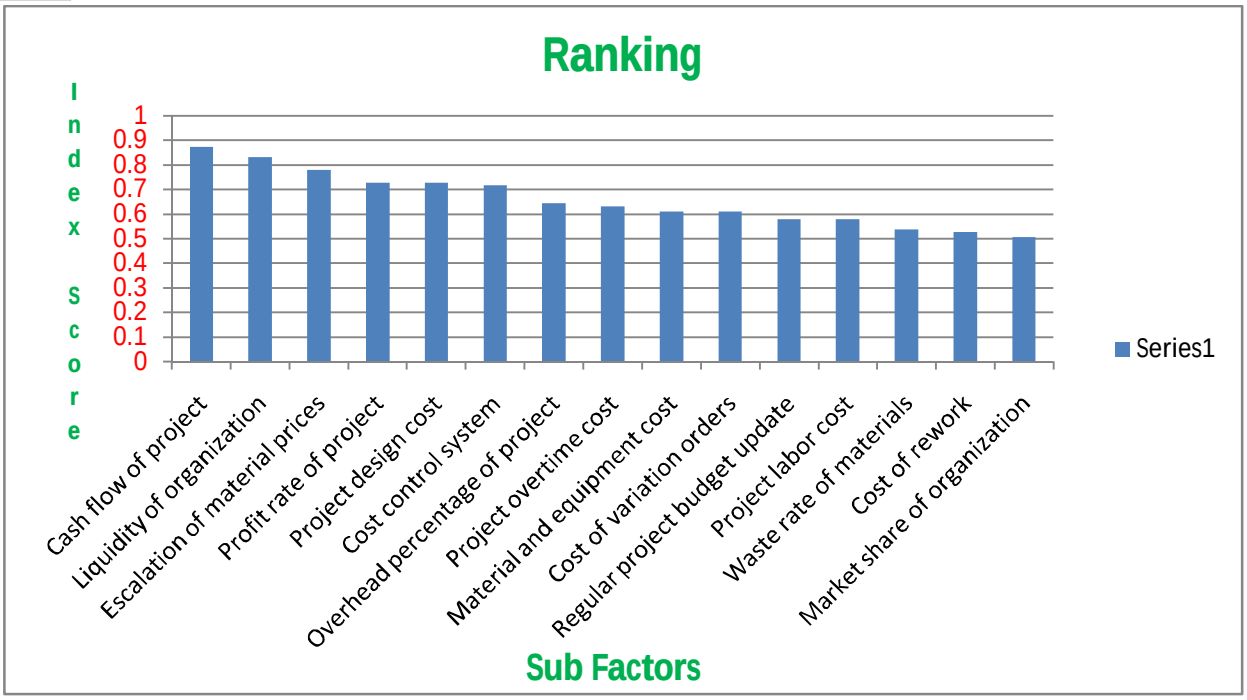
| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | time | .6 | .8 | .6 | .8 | .8 | .6 | .6 | .6 | .4 | .6 | .4 | .6 | .8 | .4 | .6 | .6 | .8 | .8 | .8 | | .2 | 211 | 427 | 2 |
| 17 | Planned time for project construction | 0.8 | 0.8 | 0.6 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.6 | 0.6 | 0.8 | 0.8 | 0.8 | 0.6 | 0.6 | 0.6 | 0.8 | 0.6 | 0.8 | | 13.8 | 0.72632 | 0.0991 | 0.136 |
| 18 | Percentage of orders delivered late | 1 | 0.8 | 0.6 | 0.8 | 0.8 | 1 | 0.8 | 0.8 | 0.6 | 0.6 | 0.8 | 1 | 0.8 | 0.6 | 0.6 | 0.6 | 0.8 | 0.6 | 0.8 | | 14.4 | 0.75789 | 0.1427 | 0.188 |
| 19 | Time needed to implement variation orders | 0.8 | 0.6 | 0.4 | 0.6 | 0.6 | 0.8 | 0.8 | 0.8 | 0.6 | 0.8 | 0.8 | 0.8 | 0.6 | 0.4 | 0.4 | 0.4 | 0.8 | 0.6 | 0.6 | | 12.2 | 0.64211 | 0.1575 | 0.245 |
| 20 | Time needed to rectify defects | 0.6 | 0.4 | 0.4 | 0.4 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | | 9.4 | 0.49474 | 0.1026 | 0.207 |
| 21 | Average delay in claim approval | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.4 | 0.6 | 0.6 | 0.6 | 0.6 | | 11.2 | 0.58947 | 0.0459 | 0.077 |
| 22 | Average delay in payment from owner to contractor | 0.6 | 0.8 | 0.6 | 0.6 | 0.8 | 0.6 | 0.6 | 0.4 | 0.6 | 0.6 | 0.4 | 0.6 | 0.8 | 0.6 | 0.4 | 0.6 | 0.6 | 0.6 | 0.6 | | 11.4 | 0.6 | 0.1155 | 0.192 |
| 23 | Availability of resources as planned through project duration | 0.8 | 1 | 0.4 | 0.4 | 0.8 | 0.8 | 0.8 | 0.4 | 0.8 | 0.8 | 0.6 | 0.8 | 0.8 | 0.4 | 0.6 | 0.4 | 0.4 | 0.4 | 0.4 | | 11.8 | 0.62105 | 0.2097 | 0.337 |
| 24 | Average delay because of closures and materials shortage | 0.8 | 1 | 0.8 | 0.8 | 0.6 | 0.8 | 0.8 | 0.8 | 0.8 | 0.4 | 0.8 | 0.8 | 0.8 | 0.8 | 0.6 | 0.8 | 0.8 | 0.8 | 0.8 | | 14.6 | 0.76842 | 0.1204 | 0.156 |
| | (3) Quality factors | | | | | | | | | | | | | | | | | | | | | | | | |
| 25 | Conformance to specification | 1 | 1 | 0.6 | 0.6 | 0.4 | 0.6 | 1 | 0.8 | 0.8 | 0.8 | 0.8 | 1 | 1 | 0.6 | 0.6 | 0.8 | 0.6 | 0.6 | 0.6 | | 14.2 | 0.74737 | 0.1867 | 0.249 |
| 26 | Availability of personals with high experience and qualification | 1 | 0.8 | 0.8 | 0.6 | 0.6 | 0.4 | 0.8 | 0.8 | 0.8 | 0.8 | 0.6 | 1 | 0.8 | 0.8 | 0.8 | 0.8 | 0.6 | 0.6 | 0.6 | | 14 | 0.73684 | 0.1499 | 0.203 |
| 27 | Quality of equipments and raw materials in project | 1 | 0.8 | 0.6 | 0.6 | 0.6 | 0.6 | 0.8 | 0.8 | 0.8 | 0.4 | 0.8 | 1 | 0.8 | 0.6 | 0.6 | 0.6 | 0.6 | 0.8 | 0.6 | | 13.4 | 0.70526 | 0.1545 | 0.219 |
| 28 | Participation of managerial levels with decision making | 0.8 | 0.8 | 0.8 | 0.6 | 0.8 | 0.6 | 0.8 | 0.6 | 0.6 | 1 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.6 | 0.8 | 0.6 | | 14.2 | 0.74737 | 0.1124 | 0.150 |

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 29 | Quality assessment system in organization | 1 | 1 | 0.6 | 0.8 | 0.8 | 0.6 | 0.6 | 0.8 | 0.6 | 0.8 | 0.8 | 0.8 | 1 | 0.6 | 0.6 | 0.8 | 0.8 | 0.6 | 0.8 | | 14.4 | 0.75789 | 0.1427 | 0.188 |
| 30 | Quality training/meeting | 0.8 | 0.8 | 0.6 | 0.4 | 0.6 | 0.4 | 0.6 | 0.6 | 0.4 | 0.6 | 0.4 | 0.8 | 0.8 | 0.6 | 0.6 | 0.6 | 0.4 | 0.4 | 0.4 | | 10.8 | 0.56842 | 0.1529 | 0.269 |
| | (4) Productivity factors | | | | | | | | | | | | | | | | | | | | | | | | |
| 31 | Project complexity | 0.6 | 0.6 | 0.8 | 0.6 | 0.6 | 0.6 | 0.6 | 0.8 | 0.6 | 0.8 | 0.6 | 0.6 | 0.6 | 0.8 | 0.8 | 0.8 | 0.6 | 0.6 | 0.6 | | 14 | 0.73684 | 0.0955 | 0.129 |
| 32 | Number of new projects / year | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.4 | 0.6 | 0.6 | 0.8 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | | 13.4 | 0.70526 | 0.0667 | 0.0945 |
| 33 | Management-labor relationship | 0.8 | 0.8 | 0.6 | 0.6 | 0.8 | 0.8 | 0.8 | 0.6 | 0.6 | 0.6 | 0.6 | 0.8 | 0.8 | 0.8 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | | 14.2 | 0.74737 | 0.1015 | 0.135 |
| 34 | Absenteeism rate through project | 0.8 | 0.6 | 0.8 | 0.4 | 0.4 | 0.8 | 0.8 | 0.6 | 0.4 | 1 | 0.4 | 0.8 | 0.6 | 0.6 | 0.8 | 0.8 | 0.4 | 0.4 | 0.4 | | 14.4 | 0.75789 | 0.1988 | 0.262 |
| 35 | Sequencing of work according to schedule | 0.8 | 1 | 0.4 | 0.6 | 0.4 | 0.8 | 0.8 | 0.4 | 0.6 | 0.8 | 0.6 | 0.8 | 1 | 0.6 | 0.4 | 0.4 | 0.4 | 0.6 | 0.6 | | 10.8 | 0.56842 | 0.2029 | 0.356 |
| | (5) Client satisfaction factors | | | | | | | | | | | | | | | | | | | | | | | | |
| 36 | Information coordination between owner and project parties | 1 | 1 | 0.6 | 0.6 | 0.6 | 1 | 0.8 | 0.6 | 0.8 | 0.8 | 0.8 | 1 | 0.8 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | | 14 | 0.73684 | 0.164 | 0.222 |
| 37 | Leadership skills for project manager | 1 | 0.8 | 0.6 | 0.8 | 0.6 | 0.8 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 1 | 0.8 | 0.6 | 0.6 | 0.6 | 0.8 | 0.8 | 0.8 | | 13.6 | 0.71579 | 0.1385 | 0.193 |
| 38 | Speed and reliability of service to owner | 1 | 0.8 | 0.6 | 0.6 | 0.4 | 0.8 | 0.6 | 0.8 | 0.6 | 0.6 | 0.6 | 1 | 0.8 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | | 12.8 | 0.67368 | 0.1522 | 0.225 |
| 39 | Number of disputes between owner and project parties | 0.6 | 0.6 | 0.4 | 0.4 | 0.4 | 0.6 | 0.6 | 0.4 | 0.4 | 0.4 | 0.4 | 0.6 | 0.6 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | | 8.8 | 0.46316 | 0.0955 | 0.206 |
| 40 | Number of reworks | 0.6 | 0.6 | 0.4 | 0.4 | 0.4 | 0.6 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.6 | 0.6 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | | 8.6 | 0.45263 | 0.0905 | 0.199 |
| | (6) Regular and community satisfaction factors | | | | | | | | | | | | | | | | | | | | | | | | |
| 41 | Cost of compliance to regulators | 0.6 | 0.6 | 0.6 | 0.8 | 0.8 | 0.6 | 0.4 | 0.6 | 0.6 | 0.8 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.4 | 0.8 | 0.8 | 0.8 | | 12.2 | 0.64211 | 0.1261 | 0.196 |

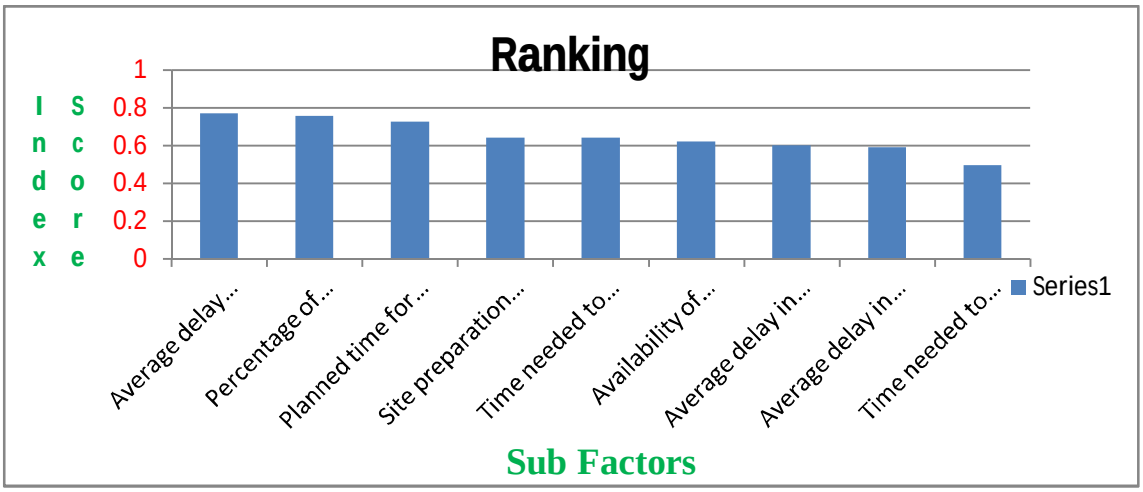
| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | requirements | | | | | | | | | | | | | | | | | | | | | | | | |
| 42 | Number of non compliance to regulation | 0.6 | 0.6 | 0.6 | 0.6 | 0.8 | 0.6 | 0.4 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.4 | 0.6 | 0.8 | 0.6 | | 11.4 | 0.6 | 0.0943 | 0.157 |
| 43 | Quality and availability of regulator documentation | 0.8 | 0.6 | 0.8 | 0.6 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.6 | 0.8 | 0.8 | 0.6 | 0.6 | 0.8 | 0.4 | 0.6 | 0.6 | 0.6 | | 13.2 | 0.69474 | 0.1224 | 0.176 |
| 44 | Neighbors and site conditions problems | 0.8 | 0.6 | 0.8 | 0.6 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.6 | 0.8 | 0.8 | 0.4 | 0.6 | 0.8 | 0.6 | 0.6 | 0.6 | 0.6 | | 13.2 | 0.69474 | 0.1224 | 0.176 |
| | (7) People factors | | | | | | | | | | | | | | | | | | | | | | | | |
| 45 | Employee attitudes in project | 1 | 1 | 1 | 0.6 | 0.4 | 0.6 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 1 | 0.8 | 0.8 | 1 | 1 | 0.6 | 0.4 | 0.6 | | 14.8 | 0.77895 | 0.1988 | 0.255 |
| 46 | Recruitment and competence development between employees | 0.8 | 0.8 | 0.8 | 0.4 | 0.4 | 0.8 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.4 | 0.6 | 0.4 | | 12.4 | 0.65263 | 0.1611 | 0.246 |
| 47 | Employees motivation | 1 | 0.8 | 0.8 | 0.6 | 0.6 | 0.6 | 0.6 | 0.8 | 0.6 | 0.8 | 0.8 | 1 | 0.8 | 0.8 | 0.8 | 0.8 | 0.6 | 0.6 | 0.6 | | 14 | 0.73684 | 0.1342 | 0.182 |
| 48 | Belonging to work | 1 | 1 | 0.8 | 0.4 | 0.6 | 0.6 | 0.6 | 0.8 | 0.6 | 0.8 | 0.8 | 1 | 1 | 0.8 | 0.8 | 0.8 | 0.4 | 0.4 | 0.4 | | 13.6 | 0.71579 | 0.2141 | 0.299 |
| | (8) Health and Safety factors | | | | | | | | | | | | | | | | | | | | | | | | |
| 49 | Application of Health and safety factors in organization | 0.8 | 0.6 | 0.8 | 0.6 | 0.6 | 0.8 | 1 | 0.8 | 0.8 | 0.4 | 0.8 | 0.8 | 0.6 | 0.8 | 0.8 | 0.8 | 0.6 | 0.6 | 0.6 | | 13.6 | 0.71579 | 0.1385 | 0.193 |
| 50 | Easiness to reach to the site (location of project) | 1 | 0.8 | 1 | 0.6 | 0.4 | 0.6 | 0.8 | 0.8 | 0.6 | 0.8 | 0.6 | 1 | 0.6 | 1 | 1 | 1 | 0.6 | 0.6 | 0.6 | | 14.4 | 0.75789 | 0.1953 | 0.257 |
| 51 | Reportable accidents rate in project | 0.6 | 0.6 | 0.6 | 0.6 | 0.4 | 0.6 | 0.6 | 0.6 | 0.8 | 0.6 | 0.6 | 0.6 | 0.8 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | | 11.6 | 0.61053 | 0.0809 | 0.132 |
| 52 | Assurance rate of project | 0.6 | 0.8 | 0.6 | 0.8 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.8 | 0.6 | 0.6 | 0.6 | 0.8 | 0.8 | 0.8 | | 12.6 | 0.66316 | 0.0955 | 0.144 |
| | (9) Innovation and learning factors | | | | | | | | | | | | | | | | | | | | | | | | |
| 53 | Learning from own experience and past history | 0.8 | 1 | 0.6 | 0.8 | 0.6 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.6 | 0.6 | 0.8 | 0.8 | 0.8 | | 14.6 | 0.76842 | 0.1003 | 0.130 |
| 54 | Learning from | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 12 | 0.63 | 0.1 | 0.28 |

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | best practice and experience of others | .8 | | .4 | .6 | .4 | .8 | .8 | .6 | .6 | .8 | .6 | .8 | .8 | .4 | .4 | .4 | .6 | .6 | .6 | | | 158 | 797 | 4 |
| 55 | Training the human resources in the skills demanded by the project | 0.6 | 1 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.8 | 0.8 | 0.4 | 0.6 | 0.6 | 0.6 | 0.6 | 12 | 0.63158 | 0.1204 | 0.190 |
| 56 | Work group | 1 | 1 | 0.8 | 0.6 | 0.4 | 0.8 | 0.8 | 0.6 | 0.6 | 0.8 | 0.6 | 1 | 0.8 | 0.8 | 0.4 | 0.8 | 0.6 | 0.6 | 0.6 | | 13.6 | 0.71579 | 0.1803 | 0.251 |
| 57 | Review of failures and solve them | 0.8 | 1 | 0.6 | 0.6 | 0.4 | 0.8 | 0.6 | 0.4 | 0.4 | 0.8 | 0.4 | 0.8 | 0.8 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | | 12 | 0.63158 | 0.1668 | 0.264 |
| | (10) Environment factors | | | | | | | | | | | | | | | | | | | | | | | | |
| 58 | Air quality | 0.8 | 0.6 | 0.6 | 0.4 | 0.4 | 0.6 | 0.6 | 0.6 | 0.4 | 0.6 | 0.6 | 0.8 | 0.6 | 0.6 | 0.6 | 0.6 | 0.4 | 0.4 | 0.4 | | 10.6 | 0.55789 | 0.1261 | 0.226 |
| 59 | Noise level | 0.8 | 0.6 | 0.6 | 0.6 | 0.4 | 0.6 | 0.6 | 0.6 | 0.4 | 0.6 | 0.6 | 0.8 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | | 11.4 | 0.6 | 0.0943 | 0.157 |
| 60 | Wastes around the site | 1 | 0.6 | 0.4 | 0.6 | 0.4 | 0.6 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 1 | 0.6 | 0.4 | 0.4 | 0.4 | 0.4 | 0.6 | 0.6 | | 12 | 0.63158 | 0.2029 | 0.321 |
| 61 | Climate condition in the site | 1 | 0.8 | 0.6 | 0.6 | 0.6 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 1 | 0.8 | 0.6 | 0.4 | 0.6 | 0.6 | 0.6 | 0.6 | | 13.6 | 0.71579 | 0.1537 | 0.214 |

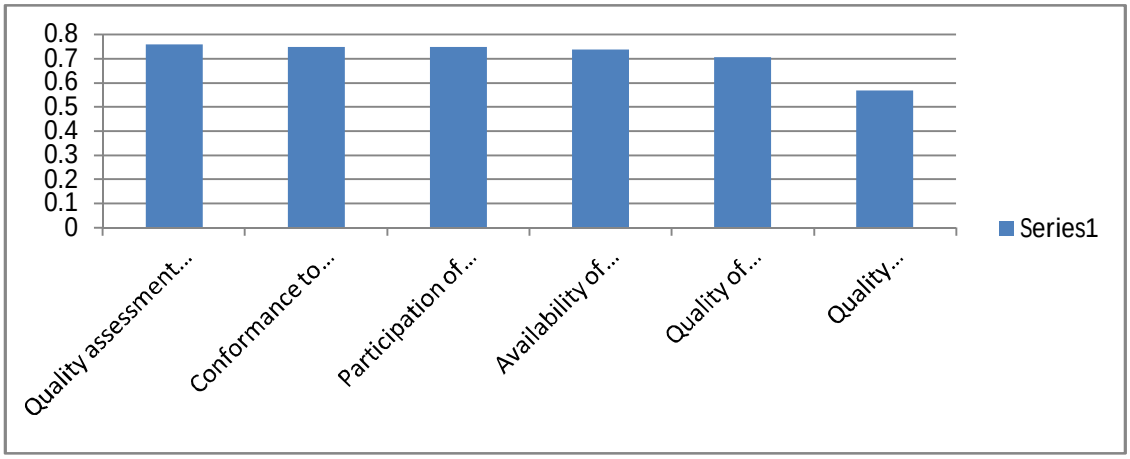
| 1 | Cost factors | | |
|---|---|---|---|
| S. No | Sub factors | Index Score | Ranking |
| 1 | Cash flow of project | 0.873 | 1 |
| 2 | Liquidity of organization | 0.831 | 2 |
| 3 | Escalation of material prices | 0.778 | 3 |
| 4 | Profit rate of project | 0.726 | 8 |
| 5 | Project design cost | 0.726 | 8 |
| 6 | Cost control system | 0.715 | 9 |
| 7 | Overhead percentage of project | 0.642 | 15 |
| 8 | Project overtime cost | 0.631 | 16 |
| 9 | Material and equipment cost | 0.61 | 18 |
| 10 | Cost of variation orders | 0.61 | 18 |
| 11 | Regular project budget update | 0.578 | 21 |
| 12 | Project labor cost | 0.578 | 21 |
| 13 | Waste rate of materials | 0.536 | 24 |
| 14 | Cost of rework | 0.526 | 25 |
| 15 | Market share of organization | 0.505 | 26 |



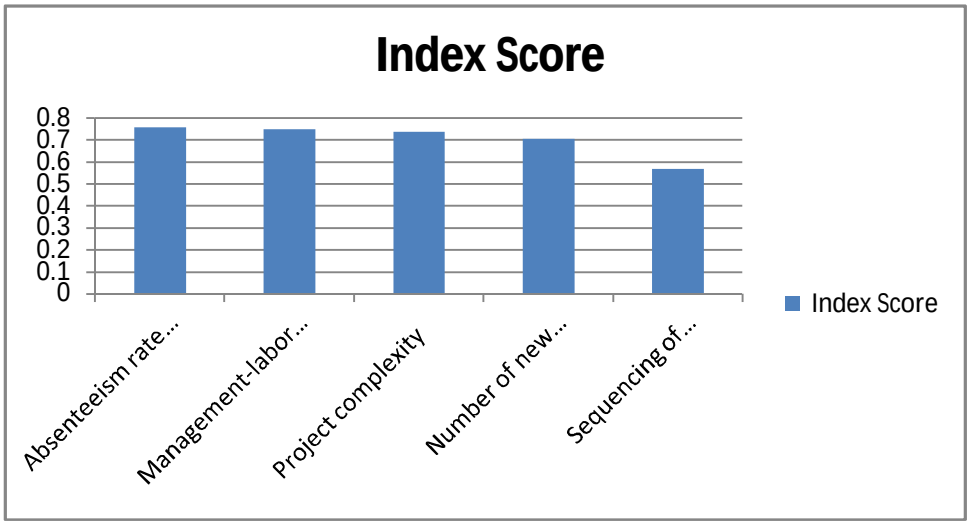

| 2 | Time factor | | |
|---|---|---|---|
| S. No | Sub factors | Index Score | Ranking |
| 1 | Average delay because of closures and materials shortage | 0.768 | 4 |
| 2 | Percentage of orders delivered late | 0.757 | 5 |
| 3 | Planned time for project construction | 0.726 | 8 |
| 4 | Site preparation time | 0.642 | 15 |
| 5 | Time needed to implement variation orders | 0.642 | 15 |
| 6 | Availability of resources as planned through project duration | 0.621 | 17 |
| 7 | Average delay in payment from owner to contractor | 0.6 | 19 |
| 8 | Average delay in claim approval | 0.589 | 20 |
| 9 | Time needed to rectify defects | 0.494 | 27 |



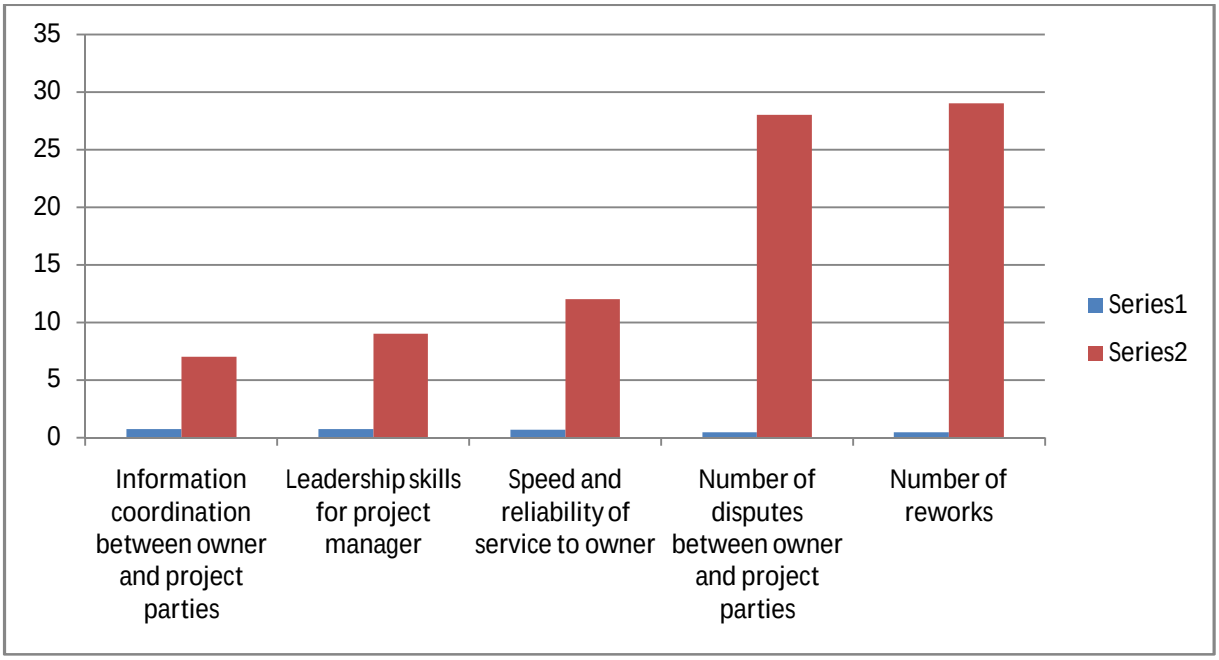
| 3 | Quality factors | | |
|---|---|---|---|
| S. No | Sub factors | Index Score | Ranking |
| 1 | Quality assessment system in organization | 0.757 | 5 |
| 2 | Conformance to specification | 0.747 | 6 |
| 3 | Participation of managerial levels with decision making | 0.747 | 6 |
| 4 | Availability of personals with high experience and qualification | 0.736 | 7 |
| 5 | Quality of equipments and raw materials in project | 0.705 | 10 |
| 6 | Quality training/meeting | 0.568 | 22 |



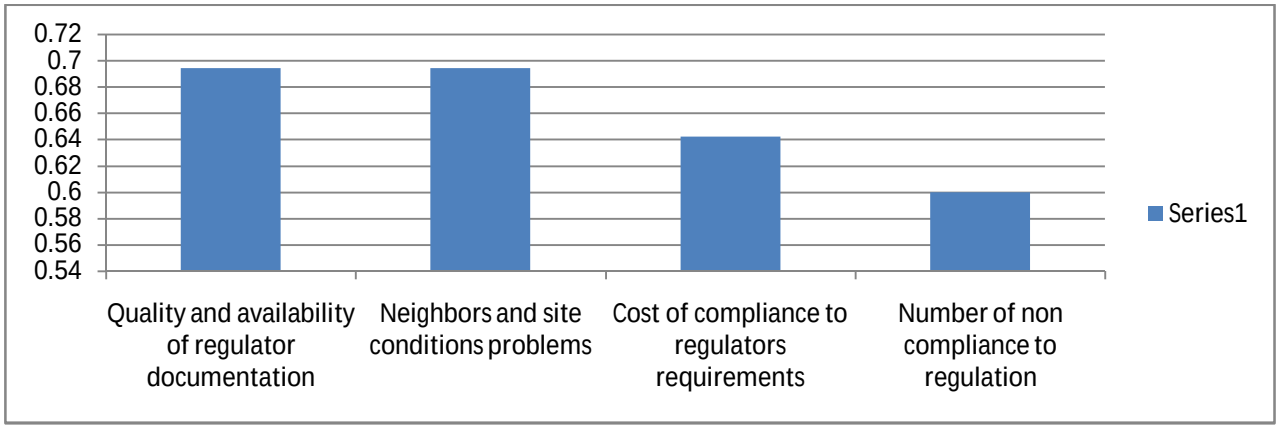

| 4 | Productivity factors | | |
|---|---|---|---|
| S.No | Sub factors | Index Score | Ranking |
| 1 | Absenteeism rate through project | 0.757 | 5 |
| 2 | Management-labor relationship | 0.747 | 6 |
| 3 | Project complexity | 0.736 | 7 |
| 4 | Number of new projects / year | 0.705 | 10 |
| 5 | Sequencing of work according to schedule | 0.568 | 22 |



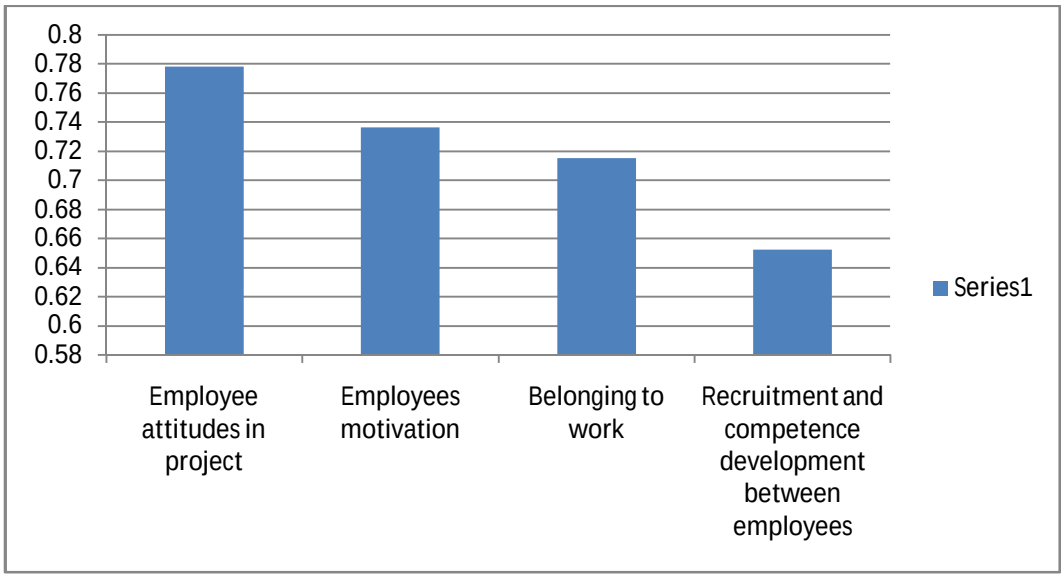
| 5 | Client satisfaction factors | | |
|---|---|---|---|
| S. No | Sub factors | Index Score | Ranking |
| 1 | Information coordination between owner and project parties | 0.736 | 7 |
| 2 | Leadership skills for project manager | 0.715 | 9 |
| 3 | Speed and reliability of service to owner | 0.673 | 12 |
| 4 | Number of disputes between owner and project parties | 0.463 | 28 |
| 5 | Number of reworks | 0.452 | 29 |



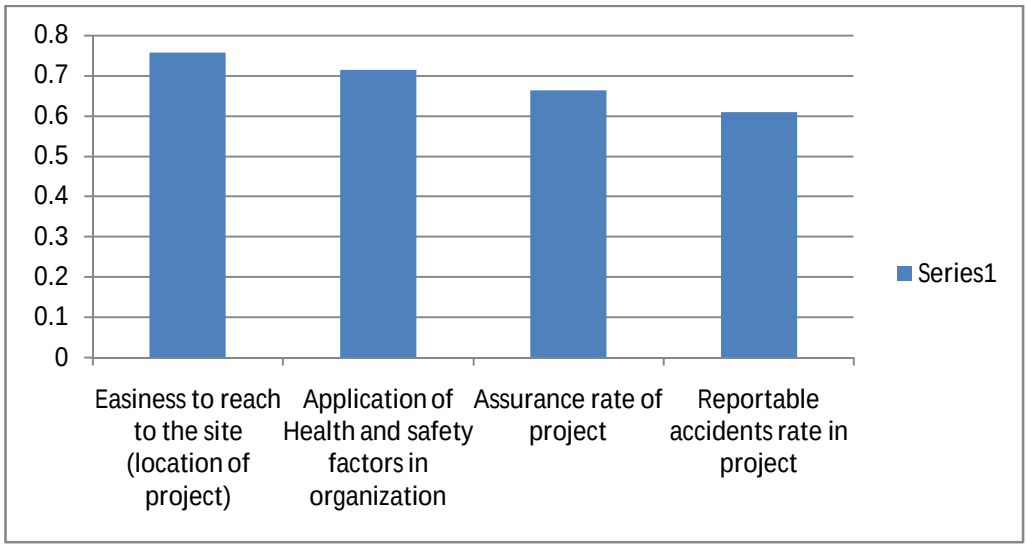

| 6 | Regular and Community Satisfaction Factor | | |
|---|---|---|---|
| S.No | Sub factors | Index Score | Ranking |
| 1 | Quality and availability of regulator documentation | 0.694 | 11 |
| 2 | Neighbors and site conditions problems | 0.694 | 11 |
| 3 | Cost of compliance to regulators requirements | 0.642 | 15 |
| 4 | Number of non compliance to regulation | 0.6 | 19 |



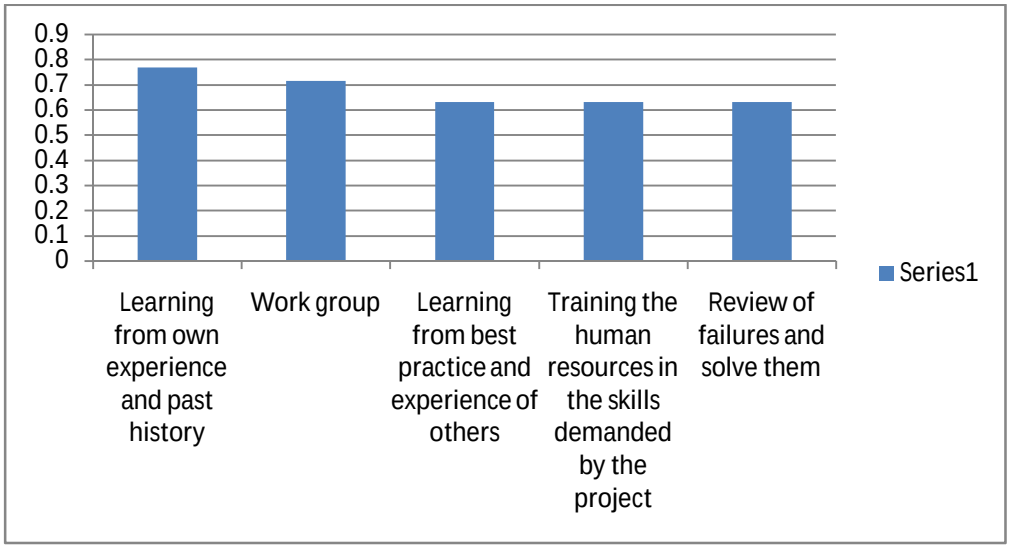
| 7 | people factors | | |
|---|---|---|---|
| S.No | Sub factors | Index Score | Ranking |
| 1 | Employee attitudes in project | 0.778 | 3 |
| 2 | Employees motivation | 0.736 | 7 |
| 3 | Belonging to work | 0.715 | 9 |
| 4 | Recruitment and competence development between employees | 0.652 | 14 |



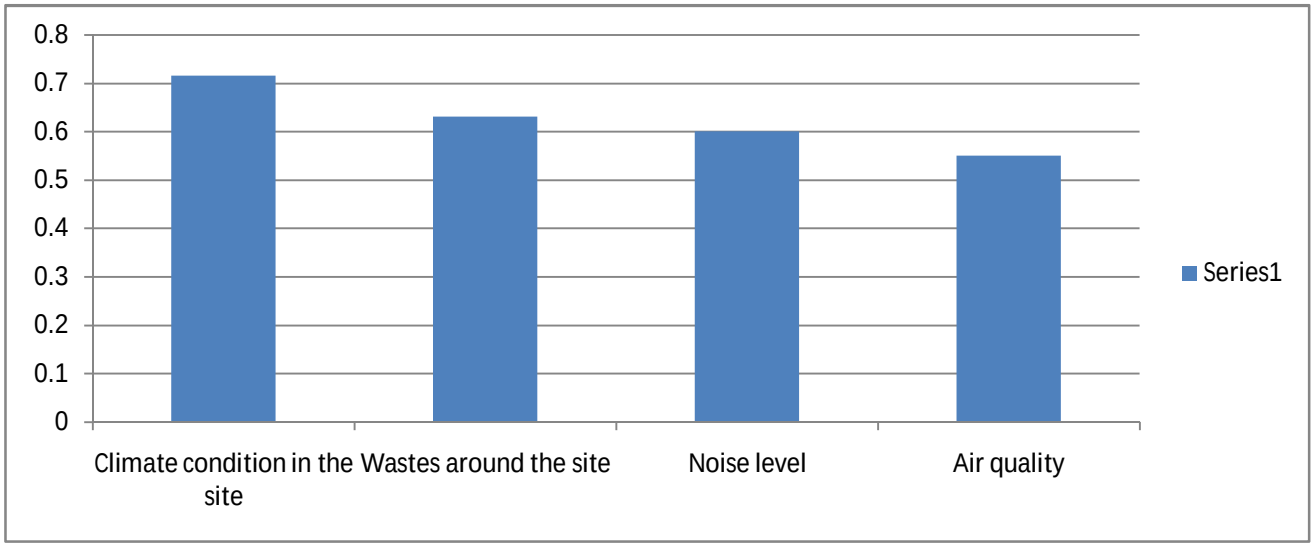

| 8 | Healthy and Safety factors | | |
|---|---|---|---|
| S.No | Sub factors | Index Score | Ranking |
| 1 | Easiness to reach to the site (location of project) | 0.757 | 5 |
| 2 | Application of Health and safety factors in organization | 0.715 | 9 |
| 3 | Assurance rate of project | 0.663 | 13 |
| 4 | Reportable accidents rate in project | 0.61 | 18 |



| 9 | Innovation and Learning factors | | |
|---|---|---|---|
| S.No | Sub factors | Index Score | Ranking |
| 1 | Learning from own experience and past history | 0.768 | 4 |
| 2 | Work group | 0.715 | 9 |
| 3 | Learning from best practice and experience of others | 0.631 | 16 |
| 4 | Training the human resources in the skills demanded by the project | 0.631 | 16 |
| 5 | Review of failures and solve them | 0.631 | 16 |




| 10 | Environment Factors | | |
|---|---|---|---|
| S.No | Sub factors | Index Score | Ranking |
| 1 | Climate condition in the site | 0.715 | 9 |
| 2 | Wastes around the site | 0.631 | 16 |
| 3 | Noise level | 0.6 | 19 |
| 4 | Air quality | 0.55 | 23 |



## V. CONCLUSIONS

The aim of this paper is to identify the critical factors in construction projects because delays are considered to be serious problem in the construction industry.

Construction delay is a critical function in construction projects.

In general, the amount of time-delay and cost-increase (overrun), increased with an increase in the total cost of a residential project.

Cost overrun and time overrun (extension of project duration) were the two most frequent effects of delays which significantly affects the construction projects.

There are loss and expense claims arising from delay and fluctuation claims during the delay period which have significant effects on cost overrun.

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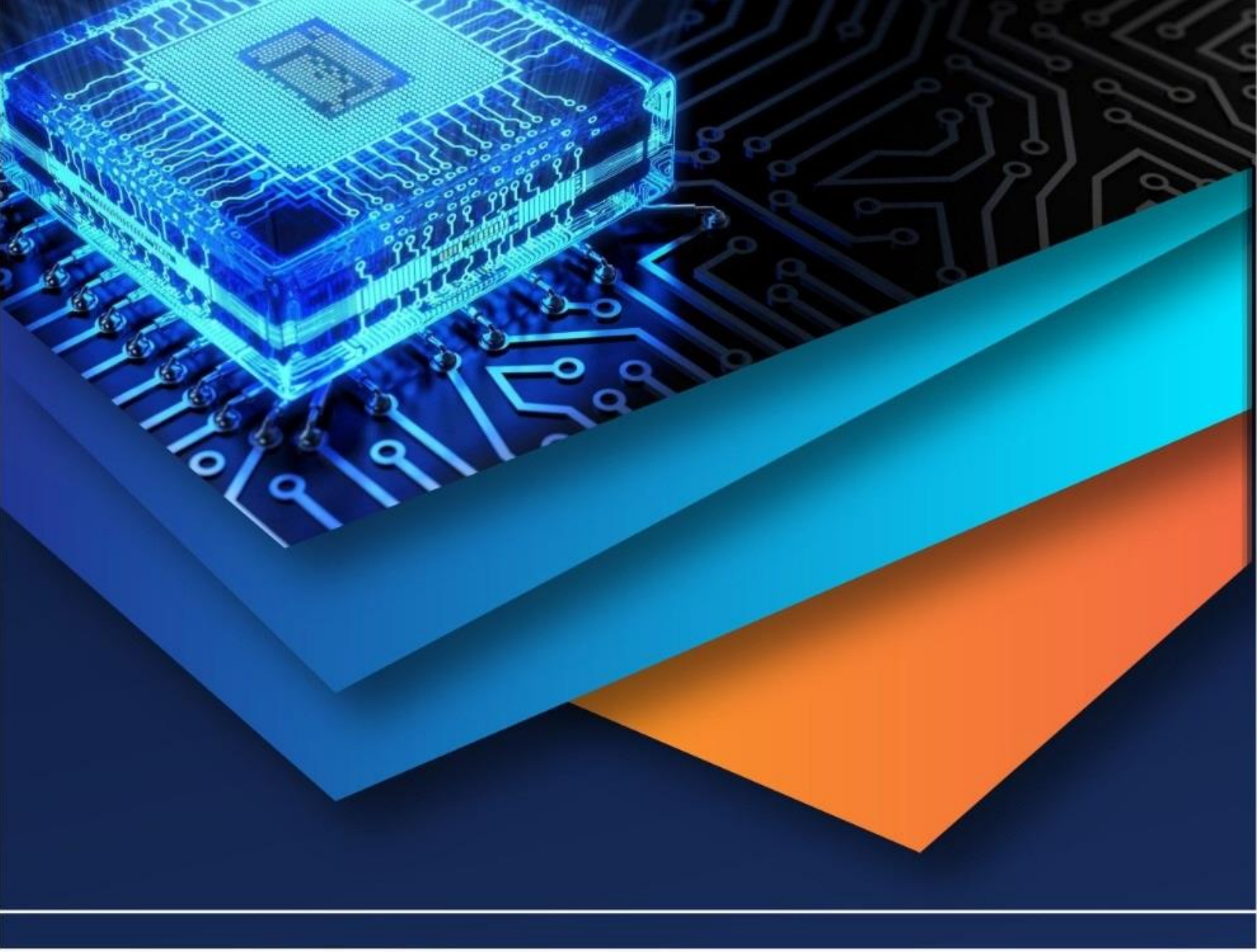

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