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FACTORS AFFECTING TIME AND COST OVERRUN IN RURAL CONSTRUCTION PROJECTS IN SRI LANKA

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DECLARATION

I declare that this thesis has been composed solely by myself and that it has not been submitted, in whole or in part, in any previous application published or written by another person or material which is to a substantial extent has been accepted for the award of any other degree or diploma of a University or other institution of higher education, except where due acknowledgment and reference is made in the text.

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This is to certify that Mr. K. B. S. Ruwansiri has done this research dissertation titled "Factors affecting time and cost overruns in rural construction project in Sri Lanka" under my supervision.

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ABSTRACT

Developing countries have identified the importance of the active participation of residential communities in remote areas for a country's economic development. Therefore, several projects are being implemented in Sri Lanka, aiming to develop infrastructure facilities such as internal roads, irrigation structures, and government buildings in rural areas. It helps to uplift the living standards of rural communities. Completion of these infrastructure development projects according to the pre-defined time frame and agreed budget are more critical to developing countries like Sri Lanka. However, time and cost overruns are noted in rural construction projects. Specific factors that influence the time and the cost overrun in projects could be identified in projects operating in rural areas than urban areas. This study investigated the most significant factors influencing the time and cost overrun in rural projects and the mitigation measures to overcome such factors within this context.

A comprehensive literature survey was carried out to identify time and cost overrun factors and their mitigation measures applied in the construction industry. A total of 30 such factors, and 27 mitigation measures were identified and validated through a pilot survey with the participation of 05 experts working in public and private organizations associated with construction projects in the Puttalam District; this region is considered as a rural area and has many ongoing projects. The experts' comments were used to modify the literature findings in particular to rural projects and develop the questionnaire. Accordingly, the questionnaire contained adjusted 25 and 21 time/cost overrun factors and mitigation measures, respectively. Professionals consisted with Project Managers, Site Managers & Engineers, Quantity Surveyors, Procurement Engineers from 12 of ongoing and 25 of completed projects in Puttlam District were considered to draw the sample for the questionnaire survey. The Chi-Square test was employed for statistical analysis of the quantitative data collected through the questionnaire survey. Findings were validated by the same experts who were involved in the pilot survey.

Nine and seven significant time/cost overrun factors and mitigation factors, were established for rural projects in Sri Lanka.

DEDICATION

This study is wholeheartedly dedicated to my beloved parents, who have been my source of inspiration, and who gave me the strength when I thought of giving up, and who continually provide their moral, spiritual, and emotional support.

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LIST OF ABBREVIATION

QS	– Quantity Surveyor
GOSL	– Government of Sri Lanka
GDP	– Gross Domestic Product
CIDA	– Construction Industry Development Authority
NGO	– Non-Government Organization
CDD	– Community Driven Development
QA	– Quality Assurance
QC	– Quality Control
ADB	– Asian Development Bank
UK	– United Kingdom
JICA	– Japan International Cooperation Agency
NWS&DB	– National Water Supply and Drainage Board
NSBS	– Nearest School is the Best School
RDA	– Road Development Authority
CRIP	– Climate Resilience Improvement Project
ABC	– Aggregate Base Course

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CHAPTER 01

1.0 INTRODUCTION

1.1 Background of the study

The construction industry is one of the biggest and most growing industries in the world. The major role is being played by them in economic development in the less industrialized nations since it constitutes a significant portion of both gross national product and employment (Al-Khalil & Al-Ghafly, 1999). According to the World Bank Annual Report (2017), the contribution of this industry towards the global Gross Domestic Product (GDP) revolves around one-tenth of the total amount (Arshi & Sameh, 2006). The construction industry has important linkages with other sectors, such as road, energy, transportation, power, water, etc. Therefore, its impact on GDP and economic development exceeds the direct contribution of construction activities. It is also a potential employment generator and provides work to nearly seven percent (7%) of the world's total employed persons.

The industry of the constructions also plays a leading role at the physical development and growth of Sri Lankan economy. According to the Central Bank Annual Report (2019), the construction sector of Sri Lanka recorded a 4.0% growth rate while its contribution to Gross Domestic Product stood at Rs. 683 371 Mn, which is 6.9% of the GDP at the time. It ranks 7th among 513 main sectors contributing to the country's GDP. Direct employment in this sector is 562,000 persons (7.4% of the total employment), while the industry's contribution to Gross Domestic Fixed Capital Formation was 70.0% (Labor Statistics, 2017).

Although, in the past, most construction projects were congested in urban areas, whereas the current trend of infrastructure and other development projects is mainly in rural areas. National schemes such as Gama Naguma, Pura Naguma, Gam Udawa, and Dayata Kirula were implemented during the last couple of decades, basically concentrated on rural development (Annual Report, Central Bank, 2017). The current government also initiated many rural development projects that tend to uplift rural people's living standard, which is mainly based on community water supply, power supply, and development projects of rural roads (Annual Report, World Bank, 2017).

However, the Sri Lankan construction industry, specifically in rural areas, faces several challenges: the shortage of skilled labor, obtaining adequate construction materials, and obtaining approvals from the relevant parties (Balachandra, 2015). The construction delay and the cost overrun are the significant challenges in the Sri Lankan construction industry.

Time and cost are the two common concerns of construction management. The scheduled time duration and the project cost are the two main criteria determining the success of projects and project management. Many factors are related to time and cost overruns and vary along with the type of projects, locations, sizes, and scopes. Large construction projects with their complexity and capital requirement features have created interest in many researchers (Arshi & Sameh, 2006).

Definition of 'Delay' is "the time over-run, either beyond the completion date specified in a contract or beyond the date that the parties agreed upon to handover a project (Al-Khalil & Al-Ghafly, 1999). According to the Choudhry (2004), the cost overrun is defined as "the difference between the original cost estimate of the project and actual construction cost on completion of work". A construction project's key performance indicators are time, cost, quality, and safety, and they are adversely affected by delays. Delays occur in every construction project, and the magnitude of these delays varies considerably from project to project. It generates various adverse effects on the projects and its stakeholders, including the client, design professionals, construction professionals, users, and others. The effects of construction delays are not only restricted to the construction industry as a country but influence the overall economy of a nation. Subsequently, it is essential to identify the actual causes of delay to avoid or minimize delays in any construction project.

Many causes are associated with project time overrun. According to Aibinu and Jagbora (2015), design changes, poor labor productivity, lack of adequate planning, shortage of materials, poor site management, and unforeseen ground conditions are affected for time overrun of the projects. Alghbari et al. (2007) identified the factors that affect time overrun in projects operating in developing countries. Inefficient site management, poor coordination in site, improper planning, lack of communication,

and poor labor productivity were identified as the factors affecting time overrun in their study.

Various factors affect cost overrun in construction projects. According to the findings of Omoregle and Radford (2012), price fluctuations, change in site condition, inaccurate estimations, additional work, and inefficient contract management mainly affect cost overrun. Ameh et al. (2010) conducted a study on this subject. They listed the disagreements in Condition of Contract, the local currency problems concerning dollar value, inaccurate quantity take-off, non-performance of sub-contractors, and contract and specification interpretations as the most significant factors for cost overrun in infrastructure development projects.

The developing countries have focused on infrastructure development in the rural area to improve the desired quality of life and increase rural economic growth. Many drinking and wastewater projects, rural road improvement projects, and common infrastructure facility improvement projects are implemented to enhance rural areas' living standards worldwide. Hence, the timely completion of projects to the agreed budget is critical in rural infrastructure development projects.

However, unique problems can be identified in rural projects and those problems have been occurred mainly due to the remoteness of the project. The shortage of skilled and unskilled laborers and inadequate education and experiences of village workers are labor-related issues in remote sites (Adam, Josephson & Lindahl, 2015: Sidawi, 2012). Less availability of construction material, equipment, and machinery due to remoteness has severely affected the progress in rural projects (Sambasivan & Soon, 2007; Kestle & London, 2003). The lack of communication, social issues, barriers in regulation policy in rural transport, damaged and narrow access road, etc., are the other factors affecting cost and time overrun in rural projects (Szava et al. 2007: Brunes & Lind, 2014). A few research studies focusing the rural projects have been conducted, but they are not in-depth investigations. Ultimately, rural development is an essential feature for the country's economic development as it directly targets poverty mitigation in the rural sector.

1.2 Problem Statement

The construction industry continues to be a central stimulant in the economic growth of any country. This strong interrelationship further strengthens the requirement of effective project planning without time and cost overrun. As described in the previous section, the Government of Sri Lanka pays increasing attention to rural projects, namely "Maga Naguma," "Gama Naguma," and "Dayata Kirula," since there is an immediate need to address the unique issues related to projects operated in rural areas.

Approximately Rs. 18-billion worth of rural infrastructure development projects are currently ongoing in 12 rural districts under the financial support of foreign and GOSL funds. According to the annual reports of the World Bank (2018) and the Asian Development Bank (2019), the Puttalam district has received a higher budget allocation compared to other rural districts. Analyzing the financial data in the project named "Nearest School is the Best School" and "Integrated Road Investment Project (Phase 1)" revealed higher budget allocations for Puttalam district than other rural districts and the details of these projects are mentioned in the Table 2.1 in Chapter 02.

Most projects in the rural regions run behind their construction program and may face cost overruns. It is always a waste of time, money, and resources, which could have been used for another development project.

Many literary works are available regarding the factors affecting time and cost overruns in. the construction industry, as this is particularly important to resolve the problem. However, as debated in the literature, factors affecting construction time and cost overruns have considerable variation concerning the project's scope and its nature. Due to differences in the characteristics in performing the rural projects in Sri Lanka, there may be specific factors for cost and time overruns. Also, mitigation measures may have different scales in terms of implementation. With the country's current rural development trend, it is worthy of addressing the time and cost overruns in construction projects in rural areas. As discussed in the background, many causes are associated with project time and cost overrun of rural projects. However, this has not been researched substantially to explore any deviations from the common factors

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concerning the construction projects. Further, no literature was found related to the Sri Lankan context.

Therefore, now is the appropriate time to investigate the contributing significant factors affecting the time and the cost overruns in rural construction projects and propose suitable remedies to avoid or minimize such time and cost overruns.

1.3 Aim and Objectives

The research aims to investigate then factors affecting time and cost overruns in rural construction projects.

1.4 Objectives

The followings are the set of objectives targeting the above aim:

1. Identifying the factors affecting time and cost overruns in rural construction projects.
2. Evaluate the significance of the factors affecting time and cost overruns in rural construction projects.
3. Establish practical mitigation measures to avoid or minimize those time and cost overruns in rural construction projects.

1.5 Methodology

Data collection is based on a questionnaire survey to understand the current situation of delays in construction projects. The questionnaire is distributed among professionals attached to ongoing and completed rural projects. A pilot survey is conducted via interviews and discussions with the experts working in the industry for more than 20 years, representing Clients, Consultants, and Contractors' organizations to finalize the questionnaire.

The questionnaire has three main parts. Part One includes the respondents' and organizations' information. Part Two contains influencing factors which can be caused for the time overrun and the cost overrun in construction projects associated with rural areas. Finally, part Three contains mitigation measures to avoid or minimize those factors in rural construction projects operated in Sri Lanka.

A sample of 70 professionals are selected from the 25 completed and 12 ongoing projects in Puttlam District for the questionnaire survey.

1.6 Limitations

Data collection to analyze the factors affecting time and cost overruns in the projects in rural areas in the entire country creates practical difficulties. Hence, the Puttalam district was chosen for data collection. This study considered only the time and cost overruns that occurred during the construction phase.

1.7 Chapter Breakdown

The dissertation of this study has five chapters, as depicted below:

Chapter 1 - Introduction

Chapter One presents the background of the study, aim, objectives, the scope of the study, and organization of the report with a brief introduction to the research methodology.

Chapter 2 - Literature Review

Chapter Two will synthesize of the existing knowledge by studying the books, journal paper articles, dissertations, websites, and other publications to understand the factors affecting time and cost overruns in rural construction projects in the world.

Chapter 3 - Research Process and Methodology

Chapter Three will describe the research approach adopted to carry out this research. The chapter also contains data gathering and data analysis methods deployed to validate then research output.

Chapter 4 - Analysis of Data and Findings

Chapter Four explains the research findings of this study.

Chapter 5 - Conclusions and Recommendations

Chapter Five will form conclusions and recommendations for the study based on empirical findings gathered through the case study and the questioner survey.

1.8 Summary

Chapter One summarized the background to the research investigation, strengthened by the literature review. The survey's aim and objectives are also concisely emphasized, together with scope and limitations and research methodology.

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CHAPTER 02

2.0 LITERATURE REVIEW

2.1 Introduction

Chapter Two intends to combine the research area's current knowledge by further referring to the research problem. This chapter presents the general and the specially notified features of construction projects associated with rural areas and the industry of the construction works in general. The traits of rural construction projects in Sri Lanka and recently implemented projects were discussed to provide background information. The causes of time and cost overruns were then presented with suggested mitigation in literature.

2.2 Overview of the Construction Industry

The construction industry is a vital tool through which society attains its urban and rural development goals (Olawale & Sun, 2010). It is one of the area that deliver major contribution for the development of the economy of the country. Even though this industry tends to vary with the general economy, it quickly responds to the economy changes (Bernstein, 2005). According to Chitkara (2008), This industry accounts 9% of the Gross Domestic Product (GDP) in many countries.

However, construction management has become more complicated due to the sophistication of the process itself and the many parties involved in the construction process (Olawale & Sun, 2010). As explained by Baoping (2011), the main target of construction management is planning and controlling resources within the project's framework. Further to him, the efficient management of construction sites is vital to have the utmost benefit for the economy of any country, achieved via the efficient application of the resources. The site activities are only the secondary part of the entire construction process. The description of the project life cycle by Olawale and Sun (2010) denotes that the first phase comprises in house offices work.

Activities such as preparation of project proposal, feasibility studies, design work, preparation of drawings, cost estimating, purchasing, programming and accounting should be carried out before start the site work of the projects (Chitkara, 2008). According to Ahmed (2009), time and cost overruns are the major phenomenon in

projects which are associated with construction works. These factors have a harmful effect on contractors, clients, and consultants in terms of growth in adversarial relationships, arbitration, mistrust, litigation, and a general feeling of tension towards each other.

2.3 Features of rural construction projects in developing countries

The countries such as China and India, rural areas are generally inhabited by the bulk of the nation's population (Bernstein, 2001). Further, in these countries, the people serve as the base to produce food and domestic needs. They are major contributing sources for the formation of capital of the country and a prominent market place for domesticated products of manufacturers (Olatunbosun, 2003). In general terms, according to Kearns, Lewis, McCreanor, and Witten (2009), rural areas engage in primary activities that form the foundation for any economic development. Despite the importance attached to the rural areas, they are not attractive to live in infrastructure, which improves the quality of life, is absent in these regions, and potable water, electricity, and good feeder roads (Olatunbosun, 2003). Bernstein (2001) explained that rural people possess minimal purchasing power and a primitive living standards. However, many countries have a current trend for rural infrastructure development.

Though the infrastructure development in rural areas has given priority, literature has paid significantly less attention to issues and limitations of implementing and planning rural projects.

2.4 Characteristics of rural construction projects in Sri Lanka

Sri Lanka is a lower-middle-income country situated off the south-east coast of India. It has a population of 21 million according to statistics of 2017, and nearly 80% of that population lives in rural areas. Research findings of Perera (2001) conclude that rural construction projects are essential for a large portion of the population. Besides, developing infrastructure in rural areas assure to provide lot of benefits for the poor (Abeykoon, Weerahewa, & Silva, 2013). Experts may agree that to reduce the poverty of people, it is necessary to develop infrastructure in rural areas (Ranaweera, 2009).

The rural construction projects have different characteristics when compare with the projects in urban areas, because the requirements of the people living in the rural area

are varied with the necessities of the people in urban area and project type shall be decided accordingly (Li, Anchao, Zhu, 2012).

In Sri Lanka, several strategies implemented targets to succeed the rural construction projects to provide maximum benefits (Munasinghe, 1998). Accordingly, the majority of those strategies have targeted the planning issues of rural construction projects. The type of project and suitable location are selected through the socially organized small groups such as welfare societies and they decide what kind of infrastructure facility really fit for their day to day activities (Sritharan, 1995). These project proposals were prepared and submitted to the funding agencies for their approval, appraisal, and funding.

The method of finalizing the infrastructure to be constructed and the project location at the initial stage is more convenient for make the technical decision when implement the project. (Ofori & Lean, 2001). Further to them, it avoids unnecessary time and money for land acquisition, resettlement work, etc. The joining approach for project feasibility studies between project technical team and the small remote groups/societies is not success and unpractical when design the larger infrastructure projects such as drinking water supply and transport due to different views (Sritharan, 1995). The planning methods for rural infrastructure projects might be ineffective where lack of political assistance or their bad influence when making of decision for rural development (Munasinghe, 1998). As an example, according to Gunatilaka (2003), the politician at the local government awarded the infrastructure development projects to the contractors who act as political supporters and some instant the lands, required for development, belongs to opposition follows and the conflict may have occurred when land acquisition.

Kumarage and Disanayake (2008) report that the local governments have been adapted to executing construction projects in rural area through their line ministries and the departmental structure to implement infrastructure projects does not comply with the requirement. As per the CIDA Annual Report 2002, the government sector's project implementation capacity has been weakened by fragmenting the public institutional system. Further, the report says when obtaining of necessary approval, clearance to

implement the multipurpose projects, it is required to refer several government organization and there is no proper coordination and corporation in some instant. In addition, according to Peiris (2006), these issues have become stubborn following the decentralization of power to Provincial Councils in the late 1980s, mainly when different political parties control the Centre Province and local government authority with contradictory political agendas.

However, the non-government organizations are playing a more significant role to implement some mega projects through their contractual arrangements with private construction firms (Kumarage & Disanayake, 2008). The private contractors are selected from the project area itself in many rural construction projects, giving opportunity to develop and gain experience through the project (Jayantha, 2002). The author further added that the output of the majority of those projects is less and disappointing due to poor quality control due to the lack of technical capacity of local administrative authorities to provide a sufficient supervision level.

In contrast, as reported by Gunatilaka, Perera, Salih, and de Silva (2007), construction work in community projects implemented by various NGOs in rural areas were comparatively better as the project execution process was well programmed to laid out and covered monitoring and evaluation by the well experience engineers throughout the project cycle. According to the authors, the person who is recruited as planning and monitoring engineer by the NGOs require to prepare weekly/monthly progress reports, evaluation reports and supporting document for prepare payment claims as the work continued.

2.4.1 The rural construction projects implemented in Sri Lanka during last two decades

Even though there are several issues in implementing and planning of rural construction projects, the government of Sri Lanka diverted the infrastructure development policy to accomplish balanced economy in the region that gives special consideration to address economic and social inequalities through remote areas (Kumarage & Disanayake, 2008). With this objective, the government launched several development projects in rural areas such as 'Gama Neguma' aimed for village development, 'Gemidiriya' aimed for village infrastructure development, and 'Maga

Neguma' aimed for road development projects at the regional level (Gunatilaka & Ramani 2008). As per the publication of the Ministry of Nation Building and Estate Infrastructure Development in 2006, Gama Neguma is an accelerated infrastructure development program for rural improvement, which designs to give solution for unresolved problems in the areas where infrastructure development is lagging. Its main concept is the completing of rural development projects with the active participation of community. Further to the above publication, this project targets to resolve many rural development issues as one. development program through a range of initiatives confirming good governance in the local level and widening the service delivery scope of the local authorities. Further, the report says this is basically focused on infrastructure development projects to enhance the rural roads network, supply of drinking water, electricity, restoration of canals, construction of small-scale rural buildings, which can create direct and indirect support and contributions for the economic activities in rural villages.

The program called, 'Maga Neguma' was commenced to support local government bodies to develop rural road network (Annual Report 2004, Ministry of Economic Development). It mostly consists of community-based internal roads to address rural transport problems. The program was executed with community participation of the rural areas. The government will finance about 90% of the project cost, while the beneficiaries will support the remaining 10% (Annual Report 2004, Ministry of Economic Development).

The "Gemidiriya" is for self-governing local establishments which can achieve sustainable investments, using the Community Driven Development (CDD) approach (Gemidiriya foundation, 2004). The foundation says that the project has a long term target of supporting the rural poverty reduction strategy, encouraging sustainable and rightful rural infrastructure development through providing necessary support to productive activities and improving rural roads and economic infrastructure and services. According to the annual report of the above foundation in 2005, its infrastructure development component is mainly addressed to improving rural access roads, economic infrastructure and services. At the same time, the 'Uthuru

Wasanthaya' and 'Negenahira Navodaya' programs are emphasized to develop the infrastructure in the former conflict-affected provinces.

The national project named "Nearest School is the Best School" was implemented to enhance the infrastructure facilities in 200 selected schools in rural areas of the country under government funds from 2016 to 2020. The program's objectives were to convert the selected rural schools in each Divisional Secretarial Division as super-schools, minimize the overcrowding at popular urban schools, and provide equal educational opportunities for all (Ministry of Education Website).

The Government of Sri Lanka implemented the Integrated Road Investment Program and Rural Bridge Projects from 2017 to 2021 under ADB, UK, and Netherland funds. The aim was to enhance the connectivity between rural communities and socioeconomic centers. These projects will improve and maintain about 3,400 km of rural access roads across the country (The Annual Report ADB, 2018).

Currently, the rural infrastructure development project is being implemented in Northern, Eastern, North Central, and Uva provinces to raise the living standards and livelihood of local people by improving basic infrastructures such as medium- and small-scale irrigation and potable water supply facility and rural roads. The funding agency is JICA, and the expected completion is the end of the year 2021 (Annual Report JICA, 2020).

2.4.2 Infrastructure Development Projects Implemented in Puttlam District

According to the annual report of Mahaweli Authority (2013), Thabbowa, Iginimitiya, Kottukachchiya, and Kachchimadu reservoirs and their irrigation structures were rehabilitated under Dam Safety and Water Resource Planning Project at the cost of Rs. 540 Mn of World Bank funds in Puttlam District. Further, under the Climate Resilience Improvement Project (CRIP), irrigation canals networks connecting to the Thabbowa and Iginimitiya reservoirs were rehabilitated to enhance the paddy cultivation (Annual Report of Mahaweli Authority, 2018).

As per the Audited Project Financial Statements Report of NWS&DB (2019), the Dry Zone Urban Water and Sanitation Projects was implemented to enhance the capacity of water intakes, reservoirs, pipe networks, etc. in the District. The project has been

implemented during the period of 2014 to 2018 under the funds of ADB. The cost involvement for the project was Rs. 11,858.00 Mn and it was covered the rehabilitation of Eluwankulama and Achchamolai tanks, rehabilitation of Daduruoya intake, pipe laying of 34 km tansmission mains and 153 Km distribution network at Chilaw and Puttlam.

The Ministry of Education is implementing a national programme called "The Nearest School is the Best School" to enhance the infrastructure facilities in schools (Project Progress report of NSBS, 2019). As per the report, Rs 665 Mn of highest budget has been allocated for the Puttlam district when consider the budget allocation for other rural District. Further, when analyze the financial data of the annual report of Asian Development Bank, (2018), The amount of Rs 127 Mn has been allocated for Puttlam District to improve the internal road network in Puttlam District under the Integrated Road Investment Project (Phase 1).

Table 2. 1:The details of the few on-going and completed projects in Puttlam District

No	Project Description	Status	Funded By	Estimated Cost (Rs. Mn)	Source
01	Nearest School is the Best School Project	Ongoing	World Bank/GOSL	665	Project Progress report of NSBS, 2019
02	Hospital Building Projects	Ongoing	GOSL	246	Engineering Department, NWP
03	Dry Zone Urban Water and Sanitation Projects (2014-2019)	Ongoing	ADB	11,858	Audited Project Financial Statements Report, 2019 NWS & DB
04	100,000 km road development projects under RDA	Ongoing	GOSL	650	Annual Performance Report of Ministry of Highway 2020
05	Puttalam City development project under UDA	Ongoing	GOSL	1,200	Annual Report UDA 2019
06	Dam Safety and Water Resource Planning Projects	Completed	World Bank	540	Annual Report of the Mahaweli Authority 2013
07	Integrated Road Investment Program (Phase I)	Completed	ADB Funds	127	Annual Report Asian Development Bank 2018
08	Climate Resilience Improvement Project (CRIP)	Completed	World Bank	285	Annual Report of the Mahaweli Authority 2018

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2.5 Construction Delays and Cost Overrun

Aibinu and Jagboro (2002) expressed that time overrun is a situation where a contractor, consultant and the client jointly or separately contribute to the non-completion of the project within specified or agreed contract period. Sambasivan and Soon (2007) pointed out that a delay is an act or event that extends the time required to complete the jobs under a contract. However, the time schedule of the project is being considered as the most important tool used under the subject field of construction management and it can be viewed as a prominent driving factor of the successful projects. Despite their verified significance, most of the construction projects in developing countries as well as developed countries, have been faced scheduled time overruns, which make such a long-lasting consequence in a universal context (Doloi, Sawhney, Iyer, & Rentala, 2012; Kaliba, Muya, & Mumba, 2009). According to Odeyinka and Yusuf (1997), 70% of Nigerian projects suffered delays in their execution.

A study carried out in the Gazza strip by Razek, Bassioni, and Mobarak (2008) reported that 76% which representing the contractors stated the average reading of the time overrun is among 10% to 30% of the actual duration. As well as the same percentage has been specified by about 56% of the consultants. Ogunlana and Promkuntong (2005) conducted a research on construction time overrun in Thailand and concluded the performance of the building construction industry in terms of time was poor in Thailand. The construction sector in Malaysia has not escaped the problem of delays, and according to Sambasivan and Soon (2007), about 17.3% of government contract projects in Malaysia were considered sick for more than three months. Al-Momani (2000) has gathered information in 135 public infrastructure projects in Dubai and identified delays in 80% of projects, whereas Frimpong, Oluwoye and Crawford (2003) observed that 70% of Ghana's development projects were delayed. A survey by KPMG (2015) revealed, in general, only 25% of then projects were completed within their original deadlines.

The literature debate on different categories of time overrun. Reames (2000) defined excusable or compensable delays that occurred due to the client's fault thus, the contractor gets an extension of time and delay damages. Further to him, excusable/non-

compensable delays occur due to neither contractor nor the client. In this situation, the contractor gets an extension of time but no delay damages. Even more, the report stated that non-excusable delays cause due to the contractor's fault. Hence, no extension of time will be provided, and the client can claim damages. Rubin, Guy, Maevis, and Fairweather (1983) have described another type of concurrent delay is as more than one delays in project activities occur at one-time period either of which had It happened alone would have been affected for target project completion date. However, according to the Kavuma, Ock, and Jang (2019), the construction project time overrun could be categorized as either "excusable" or "non-excusable" as per the position of each parties of the civil contract. According to the root cause of the time overrun these are again classified as "compensable" or "non-compensable". Al-Gahtani and Mohan (2007) have stated another way of classification of delays according to the severity of their effect on the progress of projects.

Zhu and Lin (2004) explained that cost overrun is the surplus of the actual cost over budget. The terms budget overrun and cost increase are synonymously helped to mean cost overruns. Choudhry (2004) explained that cost overrun is the difference among the initially prepared budget and the actual construction cost on completion of jobs. Chang and Shing-Tao (2002) categorized the industry as uncertain and dynamic in terms of budgeting. As a result, in construction industry project completion within the allocated budget and time duration is more critical as companies obtain the projects with narrow profit margins (Zhu, 2004). Even though various cost control software and techniques are completing a project within budget, they are complex with the nature of construction and not common all worldwide (Olawale & Sun, 2010). However, according to Ejaz and AliTahir (2013), a project would be succeeded when it is accomplished in the agreed budget, period of time, and standard quality control. Further cost overrun has become serious issue for both developed and developing countries as it has a draining effect on project parties, including contractor, consultant and client. Further to their explanation, cost overrun generates problems related to mistrust, litigation and arbitration in construction projects. According to Devi and Ananthanarayana (2017), lot of construction projects do not perform as estimated

budgets and they stated that nearly 9 out of 10 construction projects fall in to significant cost overrun.

In order to discover this problem of cost overrun in construction projects all over the world, Flyvbjerg (2007) studied 260 projects in 22 nations with an approximate size of the projects fluctuating from US$ 1.0 million to 8.56 billion and found that cost increment was a common practice with an average of 27% higher than estimated budget. Further, they summarized that average cost increment in North America was 22.6%, Europe 24.7%, and other geographical areas were 65.6%, while cost performance in construction projects has not enhanced over time, and it is in the same order of magnitude today as it was 69 years ago. World Bank (2010) also stated that poor performance has been demonstrated by 62% of construction projects with average of 40% of budget overrun. A questionnaire survey on cost study in the United Kingdom, Olawale and Sun (2010) informed that lot of construction projects still suffer cost overruns, and only 40% of respondents participating in the survey experienced cost overrun less than 10% of their cost projects. This shows about 60% of respondents experienced more than 10% cost overrun. Another study in south Africa described that 74% of the projects exceeded the awarded project cost, whereas only 27% were completed within the budget (Frimpong, 2003). Cost overrun is a severe issue in Malaysia. According to Abdullah (2009), 90% of large construction projects suffered; delays with a major effect of delay and cost overrun: since 1984.

2.6 Causes and effects of construction delays and cost overruns in rural projects

Many regions across the world have rural construction projects. Their extensive distance between major project stakeholders, in some instant spreading over international boundaries is one of the major reason of time overrun when making of decision (Thorpe, 2000). Then members of the project team must handle not only common management issues but also the environment, religious and socio-economic issues due to remoteness (Kestle 2009; Kestle and London 2002, 2003). These authors have pointed out that remoteness is a major cause of management problems. According to the literature, there are many articles and studies conducted to investigate the causative factors and the significant impacts which can be caused to the time and cost overrun in construction projects associated with rural areas.

2.6.1 Poor Accessibility to the working site

The poor accessibility is a significant task in a remote area to operate a construction project (Usman & Ibrahim, 2015). Tran, Hallowell, and Molenaar (2014) identified that the limited access and unsatisfactory road condition to the project site is one critical factor that can be effected for time and cost overrun in a rural construction project. According to them, many matters must be considered, such as managing travel time, efficient use of vehicles, and wear and tear on vehicles.

According to the survey of Sidawi (2012), the damaged and narrowness of the road affect the mobilization of material to rural construction sites. As an example, he pointed out that the heavy machinery for site excavation and borehole piling are weighty and hence need a carrier to facilitate the transportation. If timely delivery of such machinery and equipment is not happened, it will cause for time and cost overrun. The long travel time of lab technicians to the site and time taken for material sample testing are also causing delaying project activities (Wiegand & Maze, 2009). Further, they emphasized that in some instants, a test result is compulsory to proceed to the next stage of construction. Therefore, the delaying of material and other frequent testing due to poor accessibility directly affect the project progress.

2.6.2 Material related delays

McAnulty and Baroudi (2010) explained that the procurement and delivery of materials to the rural site are more difficult compared to the metropolitan area due to unpredictable road conditions. According to him, the procurement companies allocate contingency amounts to the material price as mobilization or implementation cost to the rural site construction, and it caused the cost overrun.

The research of Mcanulty and Baroudi (2010) described that the isolation and transportation of long distances affect the timely delivery of the materials to the construction sites. Also, miscalculating the quantity of material required, or missing the highly important materials, can make significant consequences. The misjudgment of the material quantity and range of stock required for the building Contractor before undertake work in remote places and poor readiness for unforeseen activities were reported by well qualified and experienced contractors (Sultan, 2005).

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2.6.3 Difficulties in attracting and retaining workers

Acharya, Yong Kim, and Dai Lee (2004) identified that the shortage of skilled or experienced laborers is one cause for time and cost overrun in the rural projects. Further, they stated that skilled and well experienced workers for rural construction projects are highly needed to increase labor productivity, compared to the urban regions. As per Durdyey, Omaroy, and Ismail (2017), laborers tend to do overtime due to a labor shortage, which decreases their productivity.

Most remote construction projects suffer from recruit and retain project staff, and it badly affects project scheduling, quality control, project control, and safety management (Tran, Hallowell, & Molenaar, 2014). Besides, the lack of utility facilities such as potable water, sewer system, mobile signal, hospitals, and schools are some leading causes which prevent retaining site staff in a remote area (McAnulty & Baroudi, 2010).

2.6.4 Lack of motivation of workers

As per the survey of McAnulty and Baroudi (2010), the family life of employees may have a negative impact by working in a construction site of a rural area. According to their finding, only three days per two months are allowed for the project workers from other areas to visit their homes. Hence their homesickness has a significant influence on the accuracy and quality of work and construction productivity. Further, according to Mojahed and Aghazadeh (2008), the excessive alcohol consumption of workers is another significant adverse effect of construction productivity. They pointed out that workers receiving daily petty cash and lack of facilities for recreational activities after working hours is the main reason.

2.6.5 Lack of spare parts and workshop facility

Randunupura and Hadiwattege (2013) reported that the poor machinery and plant handling, and less efficiency of machine operating, are a cause for regular machine and equipment breakdowns, which delays the progress in a rural construction project. Also, the lack of skilled technicians and garages or workshops for repairing heavy machinery and the unavailability of spare parts in a remote area are critical factors responsible for delays.

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Mcanulty and Baroudi (2010) explained that finding a plant and equipment from remote areas is a challenge in rural construction. Also, the unpredictability of the condition of machinery/equipment and unsafety operation creates this an unattractive option. Hence they said that the contractors prefer to deliver their equipment, thereby further increasing the cost for transportation. Therefore, the contractors should be familiar with local conditions thoroughly to accomplish these uncertainties.

2.6.6 Difficulties in project scheduling

Using a suitable scheduling and planning technique is very important for successfulness of remote projects (Womach, 2005). According to Dai, Matthew, and Keith (2014), the main challenge of rural project scheduling contains local events, harvest seasons, festivals, and environmental restrictions. As a result, they pointed out that the contractor must carefully identify the socio and cultural aspects and select suitable scheduling and planning techniques that can be easy to update and revise. If the primary employment sector of the people in a rural area is the agriculture, the contractor must consider the different stages of agriculture, especially the harvesting period, and evaluate the workers' absenteeism for that period after analyzing past records while preparing the project schedule in rural projects (Womach, 2005).

2.6.7 Difficulties in feasibility studies

Abbas and Gidado (2012) expressed that the time and cost overrun happen due to inadequate knowledge and lack of attention for feasibility studies of the rural project. Further, they stated that the inadequate historical data, climate data, and information of the similar construction sites in rural areas are also major challenges faced by the project engineer during feasibility studies. Chandler and Anderson (2010) described that lack of historical bid data in rural areas is a major issue when preparing an accurate cost estimate for rural projects. According to them, this underestimation results in time and cost overrun. Ahuja, Yang, and Shankar (2010) described that the difficulty in predicting the ground condition of virgin lands in a rural area is a main task in the project feasibility stage. They further stated that a substantial additional cost is involved with the ground investigation due to the high price for mobilizing machinery for geological analysis.

2.6.8 Lack of communication in rural areas

Tran, Hallowell, and Molenaar (2014) reported that project communication and coordination plays a vital role for smooth functioning of projects, operating in rural areas. According to them, rural projects are generally sited distance away from the main project head office, raising some issues, for example longer traveling time, lack of expertise with the economic and agricultural or not having cellular coverage and proper internet service. Further, problems on communication and coordination happen, especially in the construction projects at the rural and remote areas, in which all the participants are based in discrete locations. These issues are negatively affected the project by dropping the quality of work and its causes time and cost overrun and effect for main project stake holders in to higher risk (Kestle, 2009).

According to Deng et al. (2001), there is a time gap for decision making due to the long distance between managerial and site staff in a construction project in a rural area. Sidawi (2012) surveyed randomly selected project contractors in Ghana and revealed that the site supervisors in remote locations mostly used digital cameras and cell phones to monitor progress of projects and communicate through the E-mails with managerial staff. These lengthen the decision-making process. Usually, the resident engineering offices are located far away from the rural projects sites. Hence, the dealing with Sub Contractors, lack of internet connection and longer travel time are challenges when carry out the documentation work in remote projects (Ang-Olson, 2003).

2.6.9 Delays in the approval process

The timely receiving of good quality construction material to the working site is one of the critical factors for the timely completion of the projects (Wiegand & Maze, 2009). Accordingly, there are barriers to obtaining some construction materials such as sand, earth filling materials (sub-base & subgrade), and ABC materials in rural areas due to the constraint of relevant authorities. The authorities consider the environment regulations, road/highway regulations, and other local authorities while approving mining, stockpiling, and transporting.

The study of Bhzab (2011) on management problems in remote construction projects expressed that the transport of materials and equipment is affected by road/highway rules and regulations in Saudi Arabia. Hence, the regulation and conditions are established against contractors to transport batches with limited quantity of materials, which increases cost of transportation. In addition, the existing terrible conditions of some rural roads make it difficult for all project parties to transport the material to the rural site.

Gunarathne (2012) emphasized that government authorities are responsible for granting permissions for activities such as land valuation, clearance, transferring, and construction of a building and other infrastructure. According to him, the remoteness and the inaccessible roads complicate the obtaining of necessary approval and permission process, as it is challenging for frequent visit of the government officers. The inefficiency of employees of government authorities also delays the approval process.

In addition, if the land proposed for construction has a scenic and historical value, approval from the authorities responsible for that land is a necessity (Perera & Danasinghe, 2009).

2.6.10 Difficulties in quality control and quality assurance processes

According to Dai, Matthew, Hallowell, and Molenaar (2014), less experienced and non-qualified staff may have a significant impact on the QA and QC process of remote projects. For example, they pointed out that qualified laboratory technicians must do the material sampling, testing, mix designs, etc., and their unavailability delays the QA/QC part of the project. Further, delaying of delivery of material samples to the laboratory and receiving certified testing documents for materials on time is happened, due to lengthy physical distance between the remote site and laboratories. In some instances, the next step of the construction activity could not be carried out due to the delaying of test reports (Venugopal & Tarko, 2000).

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Table 2. 2: Summary of the factors affecting time and cost overrun under literature review

No	Time and Cost Overrun Factors	Source
01.	Lack of availability of historical, climate and other required data for project feasibility study in remote areas.	McAnulty (2010) & Adam, Josephson & Lindahl (2015)
02.	Un availability of high speed internet connections and network coverage in remote locations.	Arayici, Egbu, & Coates (2012).
03.	Lack of communication between the parties. communications among the site of the work place and the office involved for decision making are critical factor for the project success.	Brilakis (2007), Sidawi 2012
04.	Less productivity due to damaged and narrow access roads to the remote working sites.	Thomas (2002)
05.	Unawareness of project benefit and negative impact by the villages	(Olander and Landin, 2005) & Kestle (2009)
06.	Lengthy process of obtain approval for scenic and history value of lands.	Aina & Wahab (2011)
07.	Unavailability of flood data (flood level) in remote areas.	Scally (2011) & Sidawi (2012)
08.	Insufficient regional infrastructure facilities	Chitkara (2012)
09.	Difficulty in Procure construction materials, hardware items.	Olatunji (2010)
10.	Construction Equipment & Machinery unavailability	(Sambasivan and Soon, 2007) & (Kestle and London 2002, 2003)
11.	Difficult to mobilize resources to the remote sites. eg. construction materials, equipment and machinery etc.	Dainty et al. (2005), Thomas (2002)
12.	Barriers in regulation policy in rural transport (limited axial load in some road)	Ahuja, Yang Jay, Shankar Ravi (2010).
13.	Shortage of spare parts of Plant/equipment	McAnulty & Baroudi (2010)
14.	Additional cost for mobilization due to remoteness.	Szava *et al.* (2007) & Brunes & Lind (2014)
15.	Lethargic due to the excessive consumption of alcohol and due to the homesickness	Mansfield and Odeh (1991) and Mojahed and Aghazadeh (2008)
16.	Social and cultural constrains and labor absenteeism	Kestle, L and London, K. (2002)
17.	Inadequate of education, experienced and incompetence neighborhood workers	Adam, Josephson & Lindahl (2015)

No	Time and Cost Overrun Factors	Source
18.	Inadequate laboratory facilities and qualified lab technicians for material sample testing and required onsite testing.	Bowden (2005) & Aljohani, Ahiaga-Dagbui & Moore (2017)
19.	Inefficient of government officers when obtaining approval and clearance	McAnulty & Baroudi (2010)
20.	Less Effective working hours due to extreme environments conditions (eg. hot weather in desert) and threat of wild animals.	Hancher and Abd-Elkhalek (1998)
21.	Increasing of aging population and skill shortage	Chittleborough et al. (2007)
22.	Shortage of skill and unskill labors in remote working sites	Sidawi (2012)
23.	Labors are working in the industrial sector rather than the construction sector both remote and regional area.	McKenzie (2010) & Aljohani, Ahiaga-Dagbui & Moore (2017)
24.	Continuous shortage of materials due to difficulty in logistic support	(Kestle and London 2002, 2003)
25.	Frequent breakdowns which are occurred at the construction plant and the machinery equipment and delaying of restoration works	Sidawi (2012) & Kestle, L and London, K. (2002).
26.	High level of labor absenteeism	Ahuja, Yang Jay, Shankar Ravi (2010).
27.	Delaying logistic facility due to National security measures	Arayici, Egbu, & Coates (2012).
28.	Low level of equipment and Machine operator`s skill	Bowden (2005)
29.	Excessive alcohol consumption by the workers	(Deng et al. 2001).
30.	Loss of materials due to Poor security at remote construction sites	Kestle (2009) & Brunes & Lind (2014).

2.7 Mitigation Measures for Construction Time and Cost Overruns

Most studies available in the literature have ended up identifying delay and cost overrun causes without mitigation measures or practical recommendations to prevent the causes of time and cost overrun, which are relevant and important. A recent study by Al-Sehaimi (2017) concluded that most of the time and cost overrun studies had not recommended any solution, and even the suggested recommendations do not match with then findings; subsequently, they ended up providing recommendations which are non-practical. However, according to Emam, Farrell, and Abdelaala (2015), the

allocation of adequate funds, appointing highly-experienced contractors, proper arrangements for flood and rainy seasons, and considering harvesting seasons and social/cultural aspects when preparing project programs are mitigation measures for delays in rural construction projects. Identification of appropriate resources, locally available materials and their suppliers, hiring well-reputed consultants, selection of sub-contractors on an appropriate basis of merit was suggested by Amoatey, Ameyaw, Adaku, and Famiyeh (2015) to mitigate delays in a rural project. In addition, Bangash (2016) emphasis the importance of proper planning before the commencement of construction, the use of advanced technology, and appointing highly experienced design engineers that lead to compress the construction duration of projects. Furthermore, consideration of the uncertainties when pricing the bids, consideration of the rates of the previous projects, and allocating adequate contingency allowance for the bids are the best practices in the bidding stage of the projects (Odeh & Battaineh, 2002).

According to the findings of Chandler and Anderson (2010), the project bundling is one of the solutions for delaying and cost overrun of rural projects. They pointed out that the several small scale projects in same geographic location can be joined into single contract and have more effective and efficient use of staff by curtail the travel time for repetitive inspection and testing. Further to them, combining small scale projects into a one mega project can financially support to the project when ordering material through the bulk ordering. Obtaining contractors with all risk insurance with a high premium and establish an effective and efficient procurement system by the contractors have positively controlled the time and cost overrun in the projects in Saudi Arabia (Koushki, Al-Rashid, & Kartam, 2005).

Proper communication shall be maintained continuously between all stakeholders, who are involved with the project directly, and this strategy significantly effects the timely completion of the rural projects (Ceifetz et al., 2012). The site communication could be enhanced by arranging weekly or bi-weekly meetings to resolve probable delay issues, and assigning target dates or interim completion dates to the contractor. In the rural area of Morocco, the construction materials such as cement, aggregate, sand and steel are brought to the site by the contractors at a high price, which is an

unavoidable solution (Khaloufi, 2012). According to him, Contractors can use the materials which are mining from the lands and it can be avoided the material shortages at site and minimize the delay and cost overrun of the rural projects.

The delaying of mobilization is affected by the total construction period, and the arranging of infrastructure facilities is one of the challenges for project managers (Ahuja, Yang, & Shankar, 2010). To overcome this issue, they explained that the use of prefabricated houses is more convenient for rural areas, and the building components could be transported in kit forms and normally reduce the risk related with transport, coordination, on-site labor availability and other changeable issues. Further to them, this method of building construction controls the impacts of unpredictability like road barriers and permits for planning in a way that best fits with reasons and other common factors. That is absolutely correct with totally movable temporary buildings where contactors only have to take 5-6 days at site while carry out the work at the plant continuously.

Planning and monitoring are the primary tools used to avoid unnecessary delays and cost overrun in projects (Alshawi & Ingirige, 2003). According to them, accurate regular control and follow-up techniques must be applied for rural inspection of work quality, monitoring the productivity of site skill and unskilled workers, and calculation of material consumption quantity. Abbas and Gidado (2012) expressed that some practical issues seem to be generated during the project implementation stage, i.e., unavailability of skilled workers, problems in transportation of materials, and equipment breakdown. As per their argument, these shall be studied further and solved at the initial stage of the planning of the project.

Research performed to identify the mitigation measures of time and cost overrun factors in the Saudi Arabian rural construction industry concluded mitigation measures such as using advanced technology for communication and establishing high accuracy weather forecast systems as suitable (Ade, Aftab, Ismail, & Ahmad 2013). Further, a study by Awolesi, Fabi, and Akinseinde (2015) recognized mitigation Measures through conducting the semi-structured interviews for contractors to identify the delays and cost overrun. The study revealed mitigation measures such as arranging

regular round-table meetings with all project stakeholders, obtaining all-risk insurance from the contractor with a high premium, and appointing contractors with experience in similar nature. Mason (2008) suggested that providing infrastructure, recreational and welfare facilities to the workers, and arranging workshops and onsite training sessions to them are more effective strategies when attracting and retaining workers.

Table 2. 3: Summery of the mitigation measures under literature review

No.	Mitigation Measures	Source
01.	Allocation of adequate funds on time by the Client and releasing funds on time while implementing the project.	Manthar A., Mangi, S.A, Sohu, S., Jamali, Q.B. and Ullah, K. (2017)
02.	Give some financial authority to site officers for purchasing of material and equipment in urgency basis.	I. A. Rahman, A. H. Memon, S. Nagapan, Q. B. A. I. Latif, and A. A. A. Azis (2012)
03.	Select Contractor who having capability, past performance and experience in similar nature construction projects in remote locations	Abdullah, Azis & Rahman (2009)
04.	Use advance technology to foreseen the adverse weather conditions, Climatic conditions and changes of site conditions (eg. Flood forecasting system).	Ahady, S., Gupta, S. and Malik, R.K. (2017)
05.	Implement the concept of project bundling (combine few small scale projects to single project)	A. Rahman, I. Ismail, and A. H. Memon (2013)
06.	Social/cultural events and harvesting periods shall be taken in to account when preparing the Project Scheduling.	Azhar, N., Farooqui, R.U. and Ahmed, S.M. (2008)
07.	Obtain the Contractors all risk insurance with high premium due to remoteness	T. Abdul Rahman, I., Memon, A.H., Abd.KArim, A (2013)
08.	Consider the lesson learned, past experience, information (eg. Rainfall, flood levels, etc.) when preparing the Construction schedule and programme.	Ali & Kamaruzzaman (2010)
09.	Consider the rates of the previous projects and prepare accurate initial estimates	Love, Li, Irani, Treloar, and Faniran (2000); Ng (2007); Chai, Yusof, and Habil (2015)
10.	Use advance and up dated technology utilization for communication between project stakeholders (eg. video conference, instant messaging, etc.)	Ameh, Soyingbe & Odusami (2010)
11.	Consider the uncertainties when pricing the bids	Mahamid, I. (2014)
12.	Allocate adequate contingency allowance	Enshassi, A., Al-Najjar, J., and Kumaraswamy (2009)
13.	Establish effective contract system with raw material suppliers and efficient procurement system.	Omoregie, A. and D. Radford (2006)
14.	Sufficient facilities such as infrastructure, recreational & welfare facilities to shall be provided to attracting and retaining of workers.	Olawale, Y.A. and M. Sun (2010)

No.	Mitigation Measures	Source
15.	Conduct the round table meetings with project team for frequent coordination between the project parties.	Azhar, Farooqui & Ahmed (2008)
16.	Conduct the workshop, onsite training sessions, seminars for village workers to develop human resource in remote construction industry.	Moura, Teixeira & Pires (2007)
17.	Identify suitable local materials and utilize them effectively.	Memon, A.H., I.A. Rahman, M.R. Abdullah and A.A.A. Azis (2010)
18.	Appointing highly experience Subcontractors, suppliers, design engineers, decision makers for remote project.	Olawale and Sun (2010)
19.	Arrangement for Providing of meals and beverages for site workers	Parn, E.A., Edwards, D.J. and Sing, M.C.P (2017)
20.	Laws, rules, regulations and frameworks of different departments need to be understood before starting of project	Santosh, K., Rakesh, G. and Makesh, P. (2016)
21.	Competent and knowledgeable staff need to be appointed for making comprehensive contract document	Nasir, Abdur Rehman, Hamza Farooq Gabriel, and Rafiq Muhammad (2011)
22.	Educate/enhance the knowledge of unskilled employees for their working scope	Kasimu, M.A (2012)
23.	Introducing realistic plans and schedules for the project	T. Al Hadi, O. Abdelnaser, and A. H. K. Pakir (2009)
24.	According to the agreed schedule, progress payments for the contractors need to be conducted	Ismail, Ismaaini, Aftab Hameed Memon, and Ismail Abdul Rahman (2014)
25.	Regular site meetings need to be arranged to discuss methods of working for ongoing activities	Y. N. & M. O. Murat Gunduz (2013)
26.	Payments related to progress for the sub-contractor/supplier need to be made on time	T. Al Hadi, O. Abdelnaser, and A. H. K. Pakir (2009)
27.	Availability of different resources should be investigated.	T. Abdul Rahman, I., Memon, A.H., Abd.KArim, A (2013)

CHAPTER 03

3.0 RESEARCH METHODOLOGY

3.1 Introduction

Chapter Two presented a detailed review of the literature, which emphasizes the issues in the construction industry and features of rural construction projects. Next, it illustrates the causes of time and cost overruns in construction projects and the mitigation measures have been listed down for such time and cost overruns. The methodological framework adopted to conduct the research is presented in Chapter Three. Accordingly, the philosophy of the research, its design and the process of the research have been widely discussed along with the demonstration of data collection techniques and data analysis.

3.2 Research Design

Saunders, Lewis, and Thornhill (2012) presented the research onion model, which has a significant influence on the methodology of this research work. The Research Onion model, illustrated in Figure 3.2, shows the different elements, involved in the proposed research.

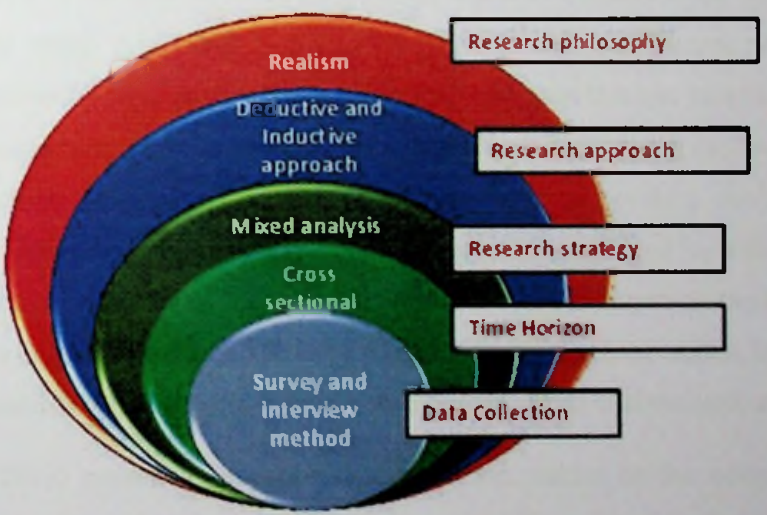

Figure 3. 1: The Research Onion

Source: Mark Saunders, Philip Lewis, and Adrian Thornhill (2012)

3.3 Research Approach

Saunders and Lewis (2012) differentiated the research approach into two parts as *inductive* and *deductive*. They defined that this deductive approach utilizes prevailing theories or knowledge for illustrating the hypothesis or solution connected to a specific situation and the inductive approach builds new theories by collecting and analyzing data.

This study used both inductive and deductive approaches. During the initial phase, the study used the deductive approach, which leads to verify the research questionnaire based on available literature through critically evaluating current knowledge referring to various published knowledge. Preliminary interviews were held with stakeholders in construction projects to capture essential insights of them to enrich the prepared questionnaire. Causes of time and cost overruns of rural projects were investigated and ranked as the deductive approach. However, Smith, Thorpe, and Jackson (2012), in their book, emphasized that this is beneficial to practice a combine arrangement of these two approaching technics as it tends to cover the limitations of each other's.

3.4 Methodological Choice

The emphasis of the next cover of the onion is research methods to be embraced to conduct the study. According to Punch (2013), it is the fundamental and critical decision pointer for any research. He describes two methods that can be utilized under this and specify them as *mono method* and *multi-method*. In the mono method, a single data collection technique is used, followed by a corresponding qualitative or quantitative analysis. In multi-method, multiple methods are utilized for collecting and analyzing data. According to Collis and Hussey (2013), in the multi-method, multiple quantitative or qualitative data collection techniques such as observations, interviews, or questionnaires can be used to corporate with relevant data analysis procedures.

Creswell (2013) presented another research method, named as the *mixed method*, which is a progressively popular mode of research as this method tends to neutralize the limitations and biasedness of utilizing a single method. As debated in the literature, the mixed research method has two specific strategies to progress, the concurrent procedures and sequential procedures.

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The present study uses the mixed research design, which includes of qualitative and quantitative data and administered sequentially. However, appropriate attention was given to qualitative data and quantitative data in data analysis.

3.5 Time focus

As per the finding of Bryman and Bell (2015), the design of the research could be differentiated into two categories, *longitudinal* and *cross-sectional*. As distinguished in the literature, most researchers worked on a cross-sectional time horizon, which means that it offers a snapshot of the selected sample eat a specific point in time. However, according to Punch (2013), a longitudinal time horizon implied a process of change studied throughout the period.

The current study adopted a cross-section research strategy, which identifies the opinions of the cross-section of the study population. Data collection was conducted from April 05, 2019 to July 05, 2019.

3.6 Data collection techniques

This study employed both questionnaires and semi-structured interviews. Questionnaires with a rating scale were used to collect data and rank the factors that cause time and cost overruns in rural construction projects. Svensson (2001), in his research, emphasized the need for ethical considerations in selecting appropriate rating scales in questionnaires and the choice of statistical methods utilized in the evaluation of scale assessments. According to the author, it is vital to use an appropriate scale for data collection if not it will tend to mislead the results in the analyzing phase. In this study, the five (05) point Likert scale has been selected as it is more appropriate for a homogeneous sample (Tarhini, 2015).

The aim of this research study is to investigate the most significant factors resulting in time and cost overruns in rural construction projects, and suggest practical recommendations to mitigate cost and time overruns involved. The aim of this study comprises three distinct objectives, and all received equal importance during the research. Data collection techniques and procedures followed to achieve intended objectives are discussed in detail in the following section.

3.7 Research process

This research was primarily conducted by reviewing the literature to investigate the factors affecting time and cost overruns in rural areas' construction projects. The study also attempts to promote practical recommendations to mitigate cost and time overruns. A proper research design minimizes not only errors that may occur during the research but also reduce the potential errors by the researcher. As per Figure 3.1, methodology of the research works which was used to address the objectives of the research can be identified as a combination of quantitative as well as qualitative methodologies. Combination of both quantitative and qualitative methodologies were more convenient for this study since these two methodologies are complemented to each other, yielded a complete picture, and a range of perspectives have been provided to enrich the analysis. The Simple Random Sampling used among subgroups in this study ensures the representation of the overall population and fair representation in subgroups of the population. According to Krishnaswami and Sathyaprasad (2010), this method provides better statistical efficiency than simple random sampling in this kind of research.

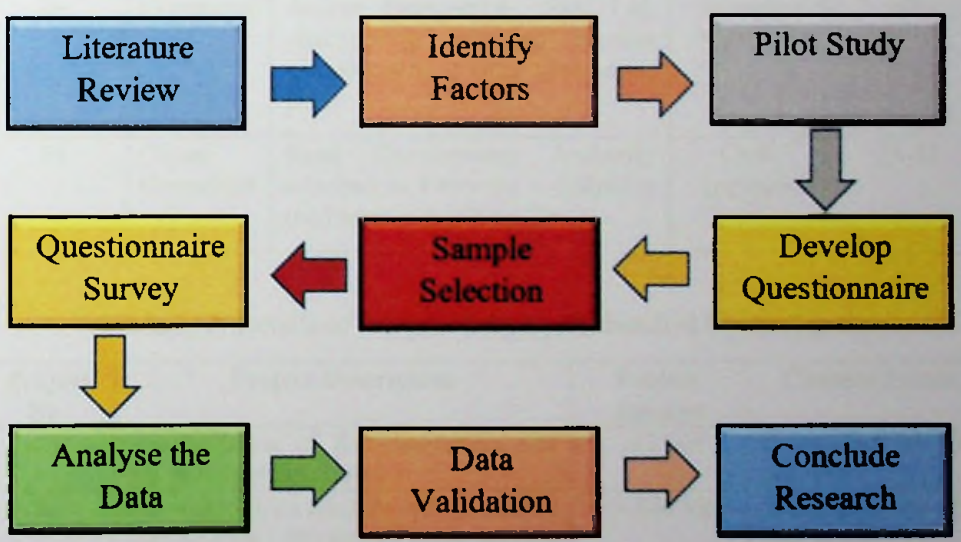

Figure 3. 2: Flow Chart of the Proposed Research Process

3.7.1 Pilot Survey

A pilot survey was performed with the participation of 05 experts proficient in rural construction projects to validate the literature findings and identify the most appropriate time and cost overrun factors related to rural projects in Sri Lanka.

The pilot survey was held with four experts, i.e., a Client, Consultant, Contractor's Representative Senior Engineer, and one Senior Quantity Surveyor. Table 3.1 and Table 3.2. tabulate the information related to experts, including their work experience and the details of the projects handled by them in the Puttalam district.

Table 3. 1: Details of the expertise involved in the pilot survey interview

Expertise No.	Category	Workplace	Profession	Years of Experience
01	Client/ Consultant	Irrigation Department, Divisional office, Puttalam	Civil Engineer	20-25
02	Consultant	Aruwakkaduwa sanitary landfill project	Civil Engineer	20-25
03	Contractor	Maga Engineering (Pvt) Ltd. attached to Puttalam - Padeniya road rehabilitation Project	Civil Engineer	20-25
04	Contractor	Access Engineering (Pvt) Ltd. attached to proposed housing complex project under coal power plant	Quantity Surveyor	30>
05	Client/ Consultant	Road Development Authority attached to Palawiya – Kalpitiya road improvement project.	Civil Engineer	25-30

Table 3. 2: Details of the selected projects handled by the Experts

Project No.	Project Description	Project amount	Current Status
01	Rehabilitation of Kottukachchiya and Kachchimaduwa Tanks	152 Mn	Completed in the year 2017
02	Aruwakkaduwa sanitary landfill project that handles 1200 tons of waste per day	19,440 Mn	Completed in the year 2019
03	Puttalam - Padeniya road rehabilitation project, the length is 60 km	4,800 Mn	Completed in the year 2009
04	Proposed housing complex project under Norochchollei coal power plant	5,600 Mn	Work in progress
05	Palawiya – Kalpitiya road improvement project, the length is 23 km	1,950 Mn	Completed in the year 2014

The literature discussed 30 time and cost overrun factors with those experts. Their views were used to finalize the questionnaire and shortlisted up to 25 factors.

Further, 27 migratory measures, identified from research papers, articles, and publications, were critically reviewed to investigate their practicability to rural projects by doing the pilot survey and shortlisted up to 21 measures.

3.7.2 Develop the Questionnaire

The questionnaire consists of 03 sections. Section One is designed to collect the respondents' information, including their experience and working environment. The second part of the questionnaire focuses on identifying the time and cost overrun factors in rural construction projects. The pilot survey identified 25 time and cost overrun factors as the most affected factors in rural construction projects. They were structured with a 5-point Likert scale (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, and 5=strongly agree). The significance of those factors causing time and cost overruns has been evaluated through statistical analysis of collected data.

The third part of the questionnaire focused on establishing practical mitigation measures to avoid or minimize the time and cost overruns in rural construction projects.

3.7.3 Population Frame and Sampling method

A sample population is widely acknowledged as a group of subjects identified from a larger population as a representation. of the entire group. However, as stated by Creswell and Clark (2007), the sampling method adopted facilitates safe generalizations of research findings. The utilization of effective sampling methods related to research study ensures realistic opportunities for recognizing an even representative of the population subset. Bryman and Bells (2015) identified two primary principle means for selecting the research population as probability and non-probability Sampling.

The present study adopts a simple random sampling, and equal importance was given to each subgroup, such as Consultants, Contractors, and Clients in this study. This confirms the representation of the overall population and also fair representation in

subgroups of the population. According to Krishnaswami and Sathyaprasad (2010), this method gives greater statistical efficiency than simple random sampling in this research type.

A wide range of personnel involved in rural construction in the Puttalam District was targeted as a case study. The 70 Professionals, working in the Client, Consultant and Contractor organizations in the Puttalam District were selected as the simple random sample for this study. The sample consisted of Project Managers, Site Managers, Quantity Surveyors, Quality Control and Quality Assurance Engineers, Site Engineers, Procurement Engineers.

Table 3. 3: The number of questionnaires distributed among the respondents

Type of Respondents	**Total Number of Questionnaires distributed**
Consultant organization	20
Contractor organization	40
Client organization	10
Total	**70**

3.7.4 Data Analysis

After collecting data, the qualitative and quantitative data were analyzed separately. As illustrated in the literature, there is a range of qualitative data analysis methods. It was decided to use the Chi-square test to analyze the quantitative data by considering the sample size and the purpose of analysis. A Chi-square ($\chi 2$) statistic is a test that measures how expectations compare to actual observed data (or model results). In this study, the time and cost overrun are the two variables in the same sample.

Further, the Chi-square is determined by comparing the cell frequencies that include the predicted frequencies in these types of cases where there is no correlation between the variables and the null hypothesis, as there is no association between the two variables observed in the sample.

If there is no association between the two variables observed in the sample, it means that time overrun factors in Rural Construction Projects are not affected by the delays.

If there is an association between the two variables observed in the sample, it means that time overrun factors in Rural Construction Projects are affected by the delays.

The person Chi-Square value (P Value) is used to determine this association. If the P Value is less than 0.05, it means there is an association between two variables. Then, Cross tabulation and clustered bar charts are used to explain the association between the two variables observed in the sample. Cross tabulation is a numerical method that evaluates two categorical variables. Categorical data is information or attributes divided into different categories that are mutually exclusive. Hence, data gathered from questionnaires with the rating scale was analyzed with this method.

According to Krippendor (2004), this method will visualize quantitative data in a way that makes it convenient to conducts statistical analysis too produce then findings. Descriptive statistics were utilized to analyze qualitative data.

According to Kings and Brookal (2018), thematic analysis is also a popular qualitative data analysis method. Here the researcher identified common themes within the data and sorted the data accordingly into those themes. These themes can then constitute a template that enables a structured approach to data interpretation. According to Miles and Huberman (2014), this technique tends to be reasonably flexible and hence, appropriate for most research questions. Data collected through the semi-structured interview with senior Engineers and Project Managers were analyzed through this thematic analysis in this dissertation. This led to a systematic organization of the entire data set and offered a firm platform for comparing all respondent comments on particular issues and identification of patterns within. Further, this produces an overall picture of the experiences of every respondent concerning a specific question.

This study used pie chats diagrams to illustrate the data collected from the survey and the questioner. It is an attractive and impressive mode to explain specific facts or phenomena and tends to reveal hidden relationships among data.

3.7.5 Data Validation

The questionnaire survey findings were presented to 05 experts to validate the results in the rural projects in Sri Lanka. Since data collection was limited to the Puttalam district, the experts' views were sought to generalize the findings.

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CHAPTER 04

4.0 DATA ANALYSIS

4.1. Introduction

This chapter mainly focuses on finding the significant factors affected for time and cost overruns in rural construction projects. It also focuses on mitigation measures that avoid or minimize these time and cost overruns and such measures identified through the literature review and semi-structured interviews.

This chapter consists of five sections. Section 4.2 presents the preliminary survey results, Section 4.3 presents the distribution of the questionnaire and level of respondents, Section 4.4 describes the information of respondents using frequency analysis and pie charts, and Section 4.5 identifies the factors causing the time and cost. overrun in rural construction projects, by using Chi-square analysis. Section 4.6 identifies the mitigation measures. for time and cost overruns in rural projects again using the Chi-Square analysis method. Finally, section 4.7 and 4.8 summarize the expert interviews done with the same panel to validate the most significant time and cost overrun factors and mitigation measures for rural construction projects.

4.2. Results of the Piolet Survey

The pilot survey ensured the validity of the factors affecting time and cost overruns of rural construction projects in the local context. Further, the applicability of mitigation actions for those time and cost overruns, identified in the literature, were reviewed. Based on the expert views, some factors were modified to strengthen its idea, while a few were eliminated due to their low significance and applicability for Sri Lanka. Further, some factors and measures were added based on experts' suggestions. The results of the piolet survey are tabulated in Table 4.1, Table 4.2 and Table 4.3.

Table 4. 1: Time and cost overrun factors summarized under the pilot survey

Item No.	Factors identified from the literature	Comment by interviewees	Factors selected after Pilot survey
	Time and Cost Overrun Factors		
01	Lack of availability of historical, climate and other required data for project feasibility study in remote areas.	Five experts accepted	Lack of availability of historical, climate and other required data for project feasibility study in remote areas.
02	Unavailability of high speed internet connections and network coverage in remote locations.	Four experts accepted	Unavailability of high speed internet connections and network coverage in remote locations.
03	Lack of communication between the parties. Communications in between the site of the work and decision making office can be considered as critical for the success of the project	Four experts accepted with modifications	Communication gap between stakeholders due to extensive physical distance.
04	Less productivity due to damaged and narrow access roads to the remote working sites.	Five experts accepted with modifications	Damaged and narrow access roads to the remote working sites
05	Unawareness of project benefit and negative impact by the villages	Five experts accepted with modifications	Objections from the villagers due to less communication and unawareness of their project benefits.
06	Lengthy process of obtain approval for scenic and history value of lands.	Three experts accepted	Lengthy process of obtain approval for scenic and history value of lands.
07	Unavailability of flood data (flood level) in remote areas.	Three experts accepted	Unavailability of flood data (flood level) in remote areas.
08	Insufficient regional infrastructure facilities	Five experts accepted with modifications	Lack of adequate infrastructure facilities for project staff (e.g., hospitals, schools, supermarkets, etc,)
09	Difficulty in Procure construction materials, hardware items.	Four experts accepted with modifications	Less availability of hardware shops and no credit facilities to purchase construction materials

10	Construction Equipment & Machinery unavailability	Four experts accepted with modifications	Less availability of construction materials and equipment/Machinery in rural areas.
11	Difficult to mobilize resources to the remote sites. eg. construction materials, equipment and machinery etc.	Four experts accepted with modifications	Difficulties in mobilizing construction materials and machinery due to poor accessibility to the remote sites.
12	Barriers in regulation policy in rural transport (limited axial load in some road)	Three experts accepted	Barriers in regulation policy in rural transport (limited axial load in some road)
13	Shortage of spare parts of Plant/equipment	Five experts accepted with modifications	Lak of availability of spare parts shop and workshops for machine and equipment repair.
14	Additional cost for mobilization due to remoteness.	Five experts accepted	Additional cost for mobilization due to remoteness.
15	lack of motivation due to homesickness	Three experts accepted with modification	Lack of motivation of site staff due to homesickness
16	Social and cultural constrains and labore absenteeism	Four experts accepted with modifications	Labor absenteeism in harvesting seasons and cultural events
17	Inadequate of education, experienced and incompetence neighborhood workers	Three experts accepted	Inadequate of education, experienced and incompetence neighborhood workers
18	Inadequate laboratory facilities and qualified lab technicians for material sample testing and required onsite testing.	Five experts accepted	Inadequate laboratory facilities and qualified lab technicians for material sample testing and required onsite testing.
19	Inefficient of government officers when obtaining approval and clearance	Four experts accepted with modifications	Less coordination in government officers when obtaining necessary project approval/clearance.
20	Less Effective working hours due to extreme environments conditions (eg. hot weather in desert) and threat of wild animals.	Three experts accepted with modifications	Less effective working hours due to threat of wild animal. (Eg. wild elephant)

21	Shortage of skill and unskill labors in remote working sites	Five experts accepted with modifications	Difficulties in attracting and retaining skilled workers due to remoteness
22	Excessive alcohol consumption by the workers	Three experts accepted with modifications	Excessive alcohol consumption of local labor
23	Loss of materials due to Poor security at remote construction sites	Three experts accepted with modifications	Loss of materials and equipment due to Inadequate site security and employing unqualified security personal form the neighborhood villages.
24	Increasing of aging population and skill shortage	Not accepted by the experts	
25	Labors are working in the industrial sector rather than the construction sector both remote and regional area.	Comply with Factor No. 22	
26	Continuous shortage of materials due to difficulty in logistic support	Comply with Factor No. 11	
27	Common breakdowns of construction plant and the associated equipment and delaying of rectification works	Comply with Factor No. 13	
28	High level of labor absenteeism	Comply with Factor No. 16	
29	Delaying logistic facility due to National security measures	Not accepted by the experts	
30	Low level of equipment and Machine operator's skill	Comply with Factor No. 17 & 22	

As a summery, the 23 time and cost overrun factors were accepted by the experts out of 30 factors identified under literature review. There were 05 factors which were complied with the selected factors and 02 factors were rejected by the experts due to not applicability for Sri Lankan contexts and they were not only affected for rural projects.

Table 4. 2: Mitigation measures summarized under the pilot survey

Item No.	Measures identified from the literature	Comment by interviewees	Measures selected after Pilot survey
1	Allocation of adequate funds on time by the Client and releasing funds on time while implementing the project.	Five experts accepted	Allocation of adequate funds on time by the Client and releasing funds on time while implementing the project.
2	Give some financial authority to site officers for purchasing of material and equipment in urgency basis.	Five experts accepted	Give some financial authority to site officers for purchasing of material and equipment in urgency basis.
3	Select Contractor who having capability, past performance and experience in similar nature construction projects in remote locations	Four experts accepted with modifications	Appointing Contractor who have similar experience in working at remote locations or neighborhood Contractors.
4	Use advance technology to foresee the adverse weather conditions, Climatic conditions and changes of site conditions (eg. Flood forecasting system).	Five experts accepted with modifications	Use advance technology to forecast the adverse weather condition (eg. Flood forecasting system)
5	Implement the concept of project bundling (combine few small scale projects to single project)	Four experts accepted	Implement the concept of project bundling (combine few small scale projects to single project)
6	Social/cultural events and harvesting periods shall be taken into account when preparing the Project Scheduling.	Four experts accepted	Social/cultural events and harvesting periods shall be taken into account when preparing the Project Scheduling.
7	Obtain the Contractors all risk insurance with high premium due to remoteness	Three experts accepted	Obtain the Contractors all-risk insurance with high premium due to remoteness
8	Consider the lesson learned, past experience, information (eg. Rainfall, flood levels, etc.) when preparing the Construction schedule and programme.	Three experts accepted	Consider the lesson learned, gather information form villages (e.g. Rainfall, flood levels, etc.) when preparing the Construction schedule and program.
9	Consider the rates of the previous projects and prepare accurate initial estimates	Three experts accepted	Consider the rates of the previous projects when prepare the cost estimate in rural projects.
10	Use advance and up dated technology utilization for communication between project stakeholders (eg. video conference, instant messaging, etc.)	Five experts accepted with modifications	Use advance technology for communication between project stakeholders (e.g., video conference, instant messaging, etc.)
11	Consider the uncertainties when pricing the bids	Three experts accepted	Consider the uncertainties when pricing the bids

Item No.	Measures identified from the literature	Comment by interviewees	Measures selected after Pilot survey
12	Allocate adequate contingency allowance	Five experts accepted	Allocate adequate contingency allowance
13	Effective contract system need to be established with raw material suppliers and procurement system with good efficient.	Five experts accepted with modifications	Establish effective and efficient procurement system
14	Sufficient facilities such as infrastructure, recreational & welfare facilities to shall be provided to attracting and retaining of workers.	Four experts accepted with modifications	Provide infrastructure, recreational & welfare facilities to attracting and retaining of workers and maximize their productivity
15	Conduct the round table meetings with project team for frequent coordination between the project parties.	Three experts accepted with modifications	Conduct the round table meetings with project team and the members of government authorities to discuss the project progress, expedite the pending approval/clearance and avoid constrains.
16	Conduct the workshop, onsite training sessions, seminars for village workers to develop human resource in remote construction industry.	Three experts accepted with modifications	Conduct the workshop, onsite training sessions, seminars for village workers to uplift their knowledge level and areas of competent while implementing of the rural project.
17	Identify suitable local materials and utilize them effectively.	Four experts accepted with modifications	Identify suitable local materials which can be used as alternative materials for construction. (eg. Lime Stone for Road Bases)
18	Appointing highly experience Subcontractors, suppliers, design engineers, decision makers for remote project.	Three experts accepted with modifications	Appointing highly experience on site design engineers, Sub Contractors, etc. decision makers for remote project.
19	Arrangement for Providing of meals and beverages for site workers.	Four experts accepted with modifications	Provide and distribute meals and beverages for workers in the site during the working hours.
20	Laws, rules, regulations and frameworks of different departments need to be understood before starting of project	Not accepted by experts	
21	Competent and knowledgeable staff need to be appointed for making comprehensive contract document	Not accepted by experts	
22	Educate/enhance the knowledge of unskilled employees for their working scope	Comply with measure No.16	
23	Introducing realistic plans and schedules for the project	Comply with measure 6	

Item No.	Measures identified from the literature	Comment by interviewees	Measures selected after Pilot survey
24	According to the agreed schedule, progress payments for the contractors need to be conducted	Not accepted by experts	
25	Regular site meetings need to be arranged to discuss methods of working for ongoing activities	Comply with measure No. 15	
26	Payments related to progress for the sub-contractor/supplier need to be made on time	Not accepted by experts	
27	Availability of different resources should be investigated.	Comply with measure No. 17	

Again, as a summery, the 19 mitigation measures were accepted by the experts out of 27 measures identified under literature review. There were 04 measures which were complied with the above selected measures and 04 measures were rejected by the experts due to not applicability for Sri Lankan contexts and they were not only applicable for rural projects.

Further, the 02 time / cost overrun factors and 02 measures were suggested to add for the final questioner by experts according to their work experience when handling rural construction projects and they were illustrated in the Table 4.3.

Table 4. 3: The Time/Cost overruns, and Mitigation measures suggested by Experts

Factor No.	Factors / Measures Suggested by Experts	Comment by interviewees
Time and Cost Overrun Factors		
01	Delaying of obtaining approval for establish borrow pits, quarry, etc. to obtain construction materials from rural areas.	Proposed by two expert and accepted by all others
02	Changing of position of local politicians and government officers.	Proposed by three expert and accepted by all others
Mitigation Measures		
01	Obtain the approval for barrow pits, quarries and material transportation by the Client before commence the work by the Contractor	Proposed by two experts and accepted by all others
02	Take immediate precaution for avoid/spreading of deceases among working staff in remote site. (eg. Dengue)	Proposed by one expert and accepted by all others

Finally, as the results of piolet survey, the 25 time / cost overrun factors and 21 mitigation measures were selected for final Questionnaire Survey.

4.3. Findings of Questionnaire Survey

Table 4.4 shows the number of Questionnaires distributed among the Contractors, Consultants, and Client organizations in the construction industry and the numbers received.

Table 4. 4: Distribution of the Questionnaire and the Numbers Received

Type of Respondents	Total Number of Questionnaires distributed	Number of respondents			Respond rate
		After 1st reminder	After 2nd remainder	After 3rd remainder	
Consultant organization	20	8	12	14	70%
Contractor organization	40	11	27	31	77.5%
Client organization	10	4	5	5	50%
Total	**70**	**23**	**44**	**50**	**71.4%**

4.4. Demographic Characteristics of Respondents

4.4.1 Designation of Respondents

Figure 4.1 indicates that research respondents are consistent with 56% contractors, 28% consultants and 14% clients. The researcher collected data from stakeholders who have experience in rural construction projects.

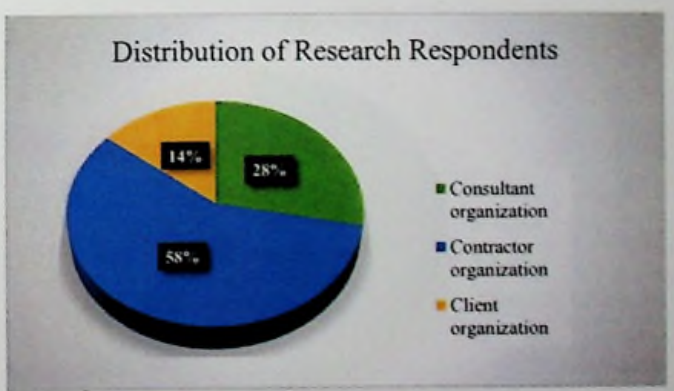

Figure 4. 1: Distribution of Research Respondents

4.4.2 Experience of Respondents

Figure 4.2 indicates that 36% of research respondents have work experience with duration 10 - 20 years while 72% of research participants have more than ten (10) years of their work experience. Then researcher collected data from stakeholders who have experience in construction projects.

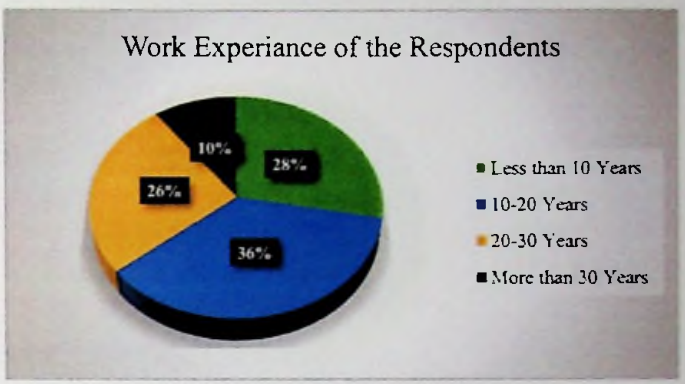

Figure 4. 2: Work Experience of Research Respondent

4.4.3 Experience of time overrun in rural construction projects

Figure 4.3 indicates that 98% of research respondents experience project time overrun in rural areas. The researcher collected data from stakeholders who have experience in construction project time overrun in rural areas.

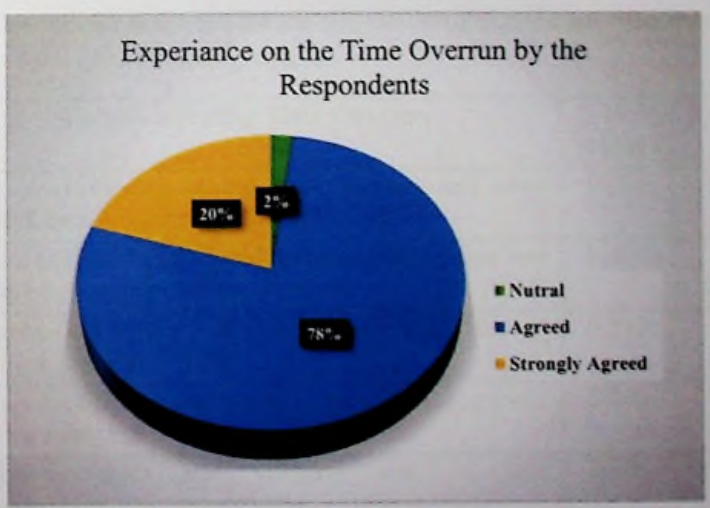

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Figure 4. 3: Experience on the time overrun by the Research Respondents

4.4.4 Experience of cost overrun in rural construction projects

Figure 4.4 point out that 88% of research respondents have experienced project cost overrun in rural areas. The researcher collected data from stakeholders who have experience in construction projects cost overrun in rural areas.

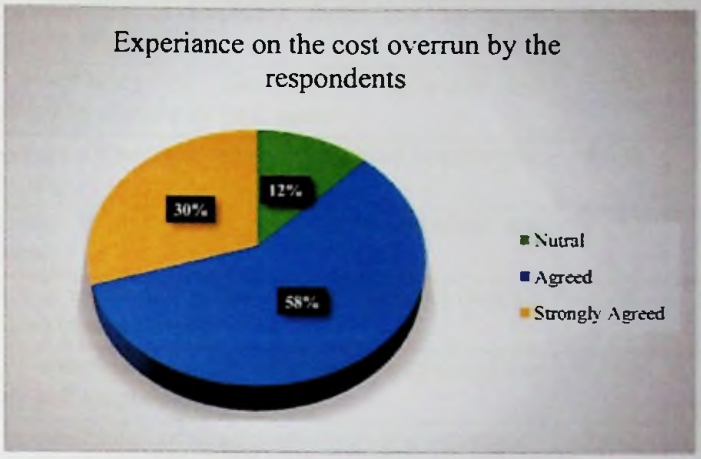

Figure 4. 4: Experience on the cost overrun by the Research Respondents

4.5. Factors Affecting the time and cost overrun in Rural Construction Projects

Out of 25 cost overrun factors intended to affect the time overrun in the rural construction project are illustrated in Table 4.5 with their P-values, which was described in the section 3.8 under methodology chapter, after the Chi-Square test.

Table 4. 5: Chi-Square test rests for identification of significant time overrun factors in rural construction projects.

Item No.	Factors affecting Time Overrun	P-value	Decision
1.	Lack of availability of historical, climate, and other required data for project feasibility	0.006	Supported
2.	Unavailability of high-speed internet connections and network coverage in remote locations	0.101	Not Supported
3.	Communication gap between stakeholders due to extensive physical distance	0.282	Not Supported
4.	Damaged and narrow access roads to the remote working sites	0.000	Supported
5.	Objections from the villagers due to less communication and unawareness	0.004	Supported
6.	A lengthy process of obtaining approval for the scenic and historical value of lands	0.005	Supported

Item No.	Factors affecting Time Overrun	P-value	Decision
7.	Unavailability of flood data (flood level) in remote areas	0.170	Not Supported
8.	Lack of adequate infrastructure facilities for project staff	0.098	Not Supported
9.	Less availability of hardware shops and no credit facilities for purchasing	0.025	Supported
10.	Less availability of construction materials and equipment/Machinery in rural areas	0.000	Supported
11.	Delaying of obtaining approval to establish borrow pits, quarry, etc.	0.002	Supported
12.	Difficulties in mobilizing construction materials and machinery	0.030	Supported
13.	Barriers in regulation policy in rural transport (limited axial load in some road)	0.000	Supported
14.	Loss of materials and equipment due to Inadequate site security and unqualified security	0.163	Not Supported
15.	Lack of availability of spare parts shops and workshops for machine and equipment repair	0.018	Supported
16.	Additional cost for mobilization due to remoteness	0.906	Not Supported
17.	Lack of motivation of site staff due to homesickness	0.184	Not Supported
18.	Excessive alcohol consumption of local labor	0.964	Not Supported
19.	Difficulties in attracting and retaining skilled workers due to remoteness	0.000	Supported
20.	Labor absenteeism during harvesting seasons and cultural events	0.000	Supported
21.	Inadequate education, experience, and incompetence of neighborhood workers	0.000	Supported
22.	Inadequate laboratory facilities and qualified lab technicians for material sample testing	0.001	Supported
23.	Less coordination in government officers when obtaining approval/clearance	0.012	Supported
24.	Changing the position of local politicians and government officers	0.007	Supported
25.	Less effective working hours due to the threat of wild animals (e.g., wild elephants)	0.303	Not Supported

Accordingly, 16 out of 25 factors widely affect the time overrun in rural construction projects.

Similarly, the 25 factors which intend to affect the cost overrun in the rural construction projects are illustrated in Table 4.5 with their P-values after performing the Chi-Square test.

Table 4. 6: Chi-Square test rests for identification of significant cost overrun factors in rural construction projects.

Item No.	Factors affecting Cost Overrun	P-value	Decision
1.	Lack of availability of historical, climate, and other required data for project feasibility in rural areas	0.304	Not Supported
2.	Unavailability of high-speed internet connections and network coverage in remote locations	0.204	Not Supported
3.	The communication gap between stakeholders due to extensive physical distance	0.000	Supported
4.	Damaged and narrow access roads to the remote working sites	0.311	Not Supported
5.	Objections from the villagers due to less communication and unawareness	0.002	Supported
6.	The lengthy process of obtaining approval for the scenic and historical value of lands	0.210	Not Supported
7.	Unavailability of flood data (flood level) in remote areas	0.308	Not Supported
8.	Lack of adequate infrastructure facilities for project staff (e.g., hospitals, schools, supermarkets, etc.)	0.011	Supported
9.	Less availability of hardware shops and no credit facilities to purchase construction materials	0.830	Not Supported
10.	Less availability of construction materials and equipment/machinery in rural areas	0.001	Supported
11.	Delaying of obtaining approval to establish borrow pits, quarry, etc.	0.000	Supported
12.	Difficulties in mobilizing construction materials and machinery due to poor accessibility	0.010	Supported
13.	Barriers in regulation policy in rural transport (limited axial load in some road)	0.108	Not Supported
14.	Loss of materials and equipment due to Inadequate site security and employing unqualified security	0.000	Supported
15.	Lack of availability of spare parts shop and workshops for machine and equipment repair	0.000	Supported
16.	Additional cost for mobilization due to remoteness	0.004	Supported
17.	Lack of motivation of site staff due to homesickness	0.328	Not Supported
18.	Excessive alcohol consumption of local labor	0.053	Not Supported

Item No.	Factors affecting Cost Overrun	P-value	Decision
19.	Difficulties in attracting and retaining skilled workers due to remoteness	0.001	Supported
20.	Labor absenteeism in harvesting seasons and cultural events	0.008	Supported
21.	Inadequate education, experience, and incompetence of neighborhood workers	0.005	Supported
22.	Inadequate laboratory facilities and qualified lab technicians for material sample testing	0.111	Not Supported
23.	Less coordination in government officers when obtaining necessary project approval/clearance	0.005	Supported
24.	Changing the position of local politicians and government officers	0.206	Not Supported
25.	Less effective working hours due to the threat of wild animals (e.g., wild elephants)	0.000	Supported

Accordingly, 14 out of 25 factors widely affect the cost overrun in rural construction projects.

As per the results shown in the, Tables 4.5 and 4.6 it was found 09 common factors that affect both time and cost overruns in rural projects. Hence, identifying these common factors is more beneficial for all the project proponents to develop remedial actions before implementing the projects in rural areas.

Table 4. 7: The common factors that affect the time and cost overrun in rural construction projects

Item No	Factor No.	Factors affecting both Time and Cost Overrun
1.	5.	Objections from the villagers due to less communication and unawareness of their project benefits
2.	10.	Less availability of construction materials and equipment/Machinery in rural areas
3.	11.	Delaying of obtaining approval to establish the borrow pits, quarry, etc. to obtain construction materials from rural areas
4.	12.	Difficulties in mobilizing construction materials and machinery due to poor accessibility to the remote sites
5.	15.	Lack of availability of spare parts shop and workshops for machine and equipment repair
6.	19.	Difficulties in attracting and retaining skilled workers due to remoteness
7.	20	Labor absenteeism in harvesting seasons and cultural events

8.	21.	Inadequate education, experienced and incompetence neighborhood workers
9.	23.	Less coordination in government officers when obtaining necessary project approval/clearance

4.6. Mitigation measures for time and cost overrun in Rural Construction Projects

By using literature review and semi-structured interviews, the researcher identified 21 factors that can be considered as the mitigation actions for time overrun and cost overrun in rural construction projects. All mitigation factors and experiences of respondents for these factors were measured using 5-point Likert-scale questions. Next, these 21 factors were checked to determine whether they can be considered as the mitigation actions for time and cost increment in Rural construction Projects using the Chi-square test.

Then, the 21 mitigation factors for time overrun were tabulated in Table 4.6 with their P Values according to their significance.

Table 4. 8: Significant mitigation measures for time overrun in the rural construction project area

Item No.	Mitigation Measures for Time Overrun	P-value	Decision
1.	The mitigation method for the delay is the Allocation of adequate funds and releasing funds	0.000	Supported
2.	The mitigation method for the delay is Give some financial authority to site officers	0.000	Supported
3.	The mitigation method for the delay is Appointing a Contractor who has similar experience	0.000	Supported
4.	The mitigation method for the delay is Use advance technology to forecast the adverse weather	0.005	Supported
5.	The mitigation method for the delay is to Implement the concept of project bundling	0.000	Supported
6.	The mitigation method for the delay is Social/cultural events and harvesting periods	0.000	Supported
7.	The mitigation method for the delay is to Obtain the Contractors all risk insurance with high premium	0.130	Not Supported
8.	The mitigation method for the delay is Consider the lesson learned, gather information	0.021	Supported
9.	The mitigation method for the delay is Consider the rates of the previous projects	0.481	Not Supported

Item No.	Mitigation Measures for Time Overrun	P-value	Decision
10.	The mitigation method for the delay is Use advance technology for communication	0.000	Supported
11.	The mitigation method for the delay is Consider the uncertainties when pricing the bids	0.410	Not Supported
12.	The mitigation method for the delay is to Allocate an adequate contingency allowance	0.594	Not Supported
13.	The mitigation method for the delay is to Establish an effective and efficient procurement system	0.431	Not Supported
14.	The mitigation method for the delay is Provide infrastructure, recreational & welfare facilities	0.010	Supported
15.	The mitigation method for the delay is to Conduct the round table meetings with the project team	0.000	Supported
16.	The mitigation method for the delay is to Conduct the workshop, on-site training sessions	0.000	Supported
17.	The mitigation method for the delay is to Identify suitable local materials	0.008	Supported
18.	The mitigation method for the delay is Appointing highly experienced on-site design engineers	0.983	Not Supported
19.	The mitigation method for the delay is to Obtain the approval for borrow pits, quarries	0.055	Not Supported
20.	The mitigation method for the delay is to take immediate precautions for diseases	0.196	Not Supported
21.	The mitigation method for the delay is to Provide and distribute meals and beverages	0.595	Not Supported

As per Table 4.8, the mitigation measures with a Chi-square test value less than 0.05 were taken as one of the significant factors which can be applied to avoid or minimize the time overruns in rural construction projects. Accordingly, 12 out of 21 measures can be used as mitigation measures to minimize or prevent time overruns in rural construction projects.

Similarly, the 21 measures which are intended to positively affect the cost overrun in a rural constructions project are illustrated in Table 4.9 with their P-values after the Chi-square test.

Table 4. 9: Mitigation measures applicable for the cost overrun in the rural construction project area

Item No.	Mitigation Measures for Cost Overrun	P-value	Decision
1.	The mitigation method for cost overrun is the *Allocation of adequate funds*	0.000	Supported
2.	The mitigation method for cost overrun is *Give some financial authority to site officers*	0.000	Supported
3.	The mitigation method for the delay is Appointing a Contractor who has similar experience	0.157	Not Supported
4.	The mitigation method for cost overrun is to *Use advance technology to forecast weather*	0.227	Not Supported
5.	The mitigation method for cost overrun is to *Implement the concept of project bundling*	0.000	Supported
6.	The mitigation method for the delay is Social/cultural events and harvesting periods	0.312	Not Supported
7.	The mitigation method for cost overrun is to *Obtain the Contractor's all-risk insurance*	0.306	Not Supported
8.	The mitigation method for cost overrun is *Consider the lesson learned*	0.000	Supported
9.	The mitigation method for cost overrun is *Consider the rates of the previous projects*	0.003	Supported
10	The mitigation method for the delay is Use advance technology for communication	0.895	Not Supported
11.	The mitigation method for cost overrun is *Consider the uncertainties when pricing the bids*	0.001	Supported
12.	The mitigation method for cost overrun is to *Allocate an adequate contingency allowance*	0.011	Supported
13.	The mitigation method for cost overrun is to *Establish a procurement system*	0.030	Supported
14.	The mitigation method for cost overrun is *Provide infrastructure and recreational & welfare facilities*	0.000	Supported
15.	The mitigation method for cost overrun is to *Conduct round table meetings*	0.000	Supported
16.	The mitigation method for cost overrun is to *Conduct workshops and onsite training programs*	0.001	Supported
17.	The mitigation method for cost overrun is to *Identify suitable local materials*	0.078	Not Supported
18.	The mitigation method for cost overrun is *Appointing highly experienced design engineers*	0.672	Not Supported
19.	The mitigation method for cost overrun is to *Obtain the approval for borrow pits, quarries*	0.287	Not Supported
20.	The mitigation method for cost overrun is to *Take immediate precaution for diseases (e.g., Dengue)*	0.004	Supported

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21.	The mitigation method for cost overrun is to *Provide and distribute meals and beverages*	0.334	Not Supported

As per Table 4.9, the mitigation measures with a Chi-square test value less than 0.05 were taken as the significant factors which can be applied to avoid or minimize the cost overruns in rural construction projects. Accordingly, 12 out of 21 measures can be used as mitigation measures to minimize or prevent cost overruns in rural construction projects.

Tables 4.8 and 4.9 disclose 07 common measures that can be used as mitigation measures for both time and cost overruns in rural projects. Identifying these common factors benefit all project proponents to obtain remedial actions before implementing the projects in a rural area.

Table 4. 10: The common measures for time and cost overruns in rural construction projects

Serial No.	Item No.	Significant Mitigation Measures for Time & Cost Overrun
1.	1.	The mitigation method for the delay is the *Allocation of adequate funds and releasing funds on time while implementing the project*
2.	2.	The mitigation method for the delay is to *Give some financial authority to site officers for purchasing material and equipment on an urgency basis*
3.	5.	The mitigation method for the delay is to *Implement the concept of project bundling (combine few small-scale projects to a single project)*
4.	8.	The mitigation method for the delay is to *Consider the lesson learned, gather information from villages*
5.	14.	The mitigation method for the delay is to *Provide infrastructure, recreational & welfare facilities to attract and retain workers*
6.	15.	The mitigation method for the delay is to *Conduct round table meetings with the project team and the members of government authorities*
7.	16.	The mitigation method for the delay is to *Conduct workshops, on-site training sessions, and seminars for village workers to uplift their knowledge level*

4.7. Discussion

Experts validated findings of the questionnaire survey. Following section discusses the common factors affects for time and cost overrun

Factor 05: Objections from the villagers due to less communication and unawareness of their project benefits

The surrounding community is a major stakeholder of a project. Although this community is a more critical factor, it does not participate during the initial stage of the feasibility study level of the project. At the initial stage, the community has less awareness regarding the benefits of the upcoming project. Initially, most individuals representing the community pay their special attention to the negative impacts of the project. Without considering the real time situation, people start to object by protesting, road blocking and strikes. A good example of such a situation was the Aruwakkaru landfill project site at Puttalam District.

To overcome these conditions, the project officials must be constantly aware of the above scenarios if not, it will negatively impact the completion of the ongoing project on time. Delays for completing the project incur additional expenditures, leading to exceeding the approved budget, for idling of labor, machinery, and additional compensation.

Factor 10: Less availability of construction material and equipment/Machinery in rural areas

The construction materials are mainly coarse and fine aggregates, filling materials, and cement, etc. that are not readily available in rural construction sites. Mostly, good quality sand comes from the Mahiyanganaya or Manampitiya sand mining areas, which involves high transportation costs. In some instances, the filling materials (Subbase & Sub Grade material) with good compaction could not be found within the project area. Hence most contractors hire the construction equipment and machinery for their projects to avoid the high overhead cost. A severe challenge they face in a rural area is finding equipment and machinery, which involves high transportation and maintenance expenses.

Factor 11: Delaying of obtaining approval to establish borrow pits, quarry, etc. to obtain construction materials from rural areas

There is a lengthy process for obtaining approval to establish barrow pits and quarries. The applications shall be raised through the relevant "Pradeshiya Saba" or Municipal Councils. If the mining area belongs to a third party such as Irrigation Department, Wildlife and Conservation Department, Forest Department, etc., then they refer relevant authorities to obtain their consent. In that sense, the proper corporation, communication, and awareness are needed to speed up the approval process. On the other hand, political influence is very high for these approval processes, and the changing of government policies for the mining of construction materials are important facts.

The delaying of construction activities due to the unavailability of material on time, additional costs for labor and machinery idling, and high transportation cost due to alternative material sources are the negative outcomes of this time and cost overrun factors.

Factor 12: Difficulties in mobilizing construction materials and machinery due to poor accessibility to the remote sites.

At the initial stages of the tender procedures, bidders do not pay their attention to the accessing methods and currently available facilities at the project site, and most bidders completely neglect these factors during the bidding stage. This negligence negatively affects the contractors at the implementation stage of the project because they face many difficulties while transporting construction materials and required machinery to the project site. The poor access roads cause frequent damages to the heavy and valuable machinery and instigate additional expenses for the unpredicted repair works for the contractors. This is an unnecessary loss for the project.

In some instances, limitations occur to the axial load of transportation, which can be transported in some rural roads. If such roads were damaged due to the transportation of heavy machinery and equipment, the additional cost is necessary for repairing such damages.

Factor 15: Lack of availability of spare parts shop and workshops for machine and equipment repair

Although hardware shops are common in Sri Lanka, most targets the general public's requirements. Hence many equipment and machinery required for large-scale projects are not available in these hardware shops. Therefore, officials of the projects must cooperate with the limited number of specialized suppliers in specific locations of the country. Spare parts, machines, equipment, workshops, repair stations, etc. all together hinder the smooth operation of the project works.

For that reason, completion of the project within the scheduled time frame is very difficult to predict due to the unforeseen shortages of the above requirements.

Factor 19: Difficulties in attracting and retaining skilled workers due to remoteness

According to the recent trend of Sri Lanka, many infrastructure development projects are in urban areas than the remote areas. Since there are many job opportunities in this field in urban areas, skilled and unskilled laborers and other associated employees get always attracted to the urban regions. The attractive salary is a triggering factor for such labor dislocations. This will bring about inadequate labor supply to the projects in rural areas.

On the other hand, the young generation of the country is always directed towards white color job opportunities. Most of the time, they do not prefer heavy works such as blue color jobs. The young generation believes that working in a construction site at their own village, like labor, is a humiliation, and working in such a construction site is a shame. Lack of experience regarding the carrier opportunities and absence of the directives and guidance for the younger generation is a major drawback for the success of their future careers.

Factor 20: Labor absenteeism in harvesting seasons and cultural events

Most of the time, main occupations of the village workers in rural areas are farming, or fishing. They join the construction projects when they have free time in their livelihoods. They are not present in a construction site, especially during the seeding, fertilizing, or harvesting periods.

The people in the area are a mix of ethnic groups. Their social and cultural lifestyles vary, and they highly engage in their social and cultural events throughout the year. Hence, poor attendance could be noted in the construction sites during festival seasons and in times of social and cultural events.

Therefore, the labor absenteeism in harvesting seasons and during cultural events will delay the activities at the site and cause for the lower performance of labor, which will negatively affect for the total project duration. On the other hand, the low attendance of labor affects the idling charges of construction machinery and equipment, and finally, it causes cost overrun in rural construction projects.

Factor 21: Inadequate education, experience, and incompetence of neighborhood workers

The educated community who possesses relevant hand-on experience in the surrounding area of the project site is an added advantage for the success of a project. If necessary human resources can be found from the vicinity of the site, it will help reduce the transportation cost for human resources. According to the current situation of Sri Lanka, it is exceedingly difficult to find the educated, skillful employees from the vicinity of the project site, especially in the rural areas. Many drawbacks arise when unskilled laborers are utilized for the fulfillment of the above requirements. Re-work, repair works, and omitting of works of the employees due to their incompetence are the example for the above issue. It will make additional unnecessary costs for the re-works, defect rectification, and supervisions.

The efficiency and effectiveness of the unskilled laborers for the given works are comparatively lower. The productivity of construction works also becomes lower due to the lack of experience and knowledge. Arrangement of training sessions could be a recommended solution for such events. However, it again negatively influences the allocated budget of the project. Additional costs need to be borne by the contractors, and time delays should be expected in such projects.

Factor 23: Less coordination of government officers when obtaining necessary project approval/clearance

The necessary approvals must be taken throughout the project life cycle. The environment clearance, building approval / Council approval form "Pradeshiya saba," and Municipal or Urban council are necessary at the initial stage. Any alteration, change, or modification that arises during construction should have the approval of the relevant authority. At the final stage, the certification of completion must be obtained from the appropriate authority. The government officers' lack of coordination, the shortage of office staff, political influence, transferring of staff, and changing government policies also affect the timely obtaining of Approval/Clearances in rural construction projects.

The following section discusses the validated common mitigation measures which could be applied to overcome both time and cost overrun in rural construction projects

Measure 01: The mitigation method for the delay in allocating adequate funds and releasing funds on time while implementing the project

Allocated funds for a project is the major component which triggers the success of the project. Adequate Finance. is then hub" around which revolves everything else. Well established finance management procedures reveal the future directives of the project, and a lack of sufficient cash flow will adversely affect everybody and everything associated with construction works.

It is noted that many government projects initiate without proper budget allocation. Primary factors for such a situation are the political influences, underestimation, and without having a priority order for the project. All these factors negatively affect the maintenance of adequate funds for the project. Thus, the project drags at its implementation stage, and finally, it causes ceasing the project or changing the project scope. All these are negative impacts on the success and effectiveness of a project. Hence, it is more beneficial to allocate adequate funds for the project at the planning stage. Estimations must be prepared after considering all these factors, and predictions based on real time situations are critical.

Releasing funds on time is also essential for the smooth running of the projects. Timeliness of completing the project is mainly based on the availability of adequate funds, which can be utilized on time. It is recommended to ensure that sufficient funds are available for uninterrupted payments before awarding the contract to realize this target. Due to these reasons, clients should forward the cash flow forecasting to the Treasury in advance, and thereafter, should follow it up to get the payments released on scheduled time.

Measure 02: The mitigation method for the delay is to give some financial authority to site officers for purchasing material and equipment on an urgency basis

One of the factors which bear the success of the project is the well-established pre-defined cash flow within the organizational structure. If there is no such establishment, the outcome will be the failure to pay sub-contractors to associate with the main contractor, delays for material and machinery suppliers, impedes timely progress, and delay in rural construction projects. In some instances, site officers do urgent purchasing of services and materials such as labor and machinery hire, and material purchasing, considering the smooth operation of the projects.

Most construction projects are associated with rural areas, and there is no authorized personnel who possess financial authority on-site. Some lagging of routine works happens when handling financial matters at the site. Further, when considering site overhead, it is not beneficial to the contactor to send an external person to handle financial matters at the site level; it is better to give the financial authority to the relevant site engineer, site manager, or project engineer who possess sound knowledge regarding the scope of the project. In such a situation, officials already engaged with the project can maintain priority order when making the site payments as suited to the construction program.

Measure 05: The mitigation method for the delay is to implement the concept of project bundling (combine few small-scale projects to a single project)

The Google definition of Project bundling is 'a process by which a single contract award is used to contract for the preservation, rehabilitation, or replacement of multiple projects. The contract may be procured in several different ways and may

include both design and construction in the overall scope, depending on the procurement method. A good example for project bundling, which can be identified within the Sri Lankan scenario, is implementing the Integrated Road Investment Program in rural areas, funded by the ADB (iRoad Packages). "iRoad" is a project to improve the inter-connectivity among rural communities and associated centers of socioeconomic through improving the efficiency of transport facilities by enhancing the quality of selected rural road networks.

Implementation of such a project bundling process will save time to spend on the procurement work of individual projects when they are considered as a single project initially. Further, the Contractor, who has the capability to handle large-scale projects with the most advanced technologies and skilled human resources, is not mobilized to such small-scale projects in rural or remote areas. Therefore, the client can attract those contractors through bundling several projects with limited project scopes. On the other hand, the selection of well-experienced contractors in top-ranking levels will help not only for the timely completion of the projects but also for the improved quality of the outcomes.

Measure 08: The mitigation method for the delay is to consider the lessons learned, gather information from villages (e.g., Rainfall, flood levels, etc.) when preparing the construction schedule, and program

Hands-on experience of the team members, gathered through trial and error during field works, is a leading factor deciding a project's success. Sharing lessons or the experiences among the members in project team prevents an organization from same mistakes which are occurring repeatedly, and it can be invested to improve the quality of upcoming projects and awaiting stages of currently ongoing projects. When handling rural projects, it is imperative to use the past lessons learned through completed projects to make managerial decisions such as how to solve the problems encountered when handling rural labor, finding raw material, transportation in such remote areas, land acquisitions, and compensations, etc.

The experience associated with the natural environment is also an important factor. At the feasibility studying stage of the project, it is vital to gather information such as rainfall patterns, flood levels, monsoon periods and their changes, and social and

cultural behaviors in that area from the older people in the village, as they are the ones who know those details well. People who associate in that environment for several years have the most valuable database gathered through experience, and acquiring such knowledge is the most successful way to gather the information. For example, a social impact assessment was performed for the Lakvijaya Coal Power Project after collecting data and information from the families living in the Kalpitiya peninsula. Following such community-based procedures for the gathering of data and information will save unnecessary financial expenses and time at the implementation stage of rural projects.

Measure 14: The mitigation method for the delay is to provide infrastructure, recreational & welfare facilities to attracting and retaining workers, and maximize their productivity

Providing welfare facilities for project staff can be considered as a significant challenge for a client who live in rural construction projects. According to the current situation of Sri Lanka, it is difficult to find facilities in remote areas equal to the urban areas of the country. Obtaining essential services such as health facilities, good quality drinking water, schools, and telecommunication facilities are a top priority and are the challenges for the project owners. The project staff is always reluctant to stay at project site premises due to fewer facilities in the vicinity of the project site. Hence the project owners must provide all necessary facilities to residential employees within the project site. Some staff members visit the site regularly from their home places, and it adds more cost for the project to arrange transport facilities.

Due to these reasons, considering the volume of the project, it is more advantageous for the rural project to allocate funds at the initial stage of the project to provide infrastructure and recreational and welfare facilities to the project staff. It will reduce the long-term financial impacts on the overall project.

Measure 15: The mitigation method for the delay is to conduct round-table meetings with the project team and the members of government authorities to discuss the project progress, expedite the pending approval/clearance, and avoid constraints

Government and non-government organizations, other interested parties, religious leaders of the area, NGOs, and residents of the project area are the direct and indirect

stakeholders of rural projects. Well-established communication methodologies and mutual understanding among the stakeholders are essential to cooperate with these parties, especially during the project's feasibility and implementation stages. For example, during land clearance for the project, the project team must incorporate with government organizations such as the Forest Department, Department of Wildlife Conservation and Management, Department of Coastal Conservation and Coastal Resources Management, Water Resources Board, and Water Supply and Drainage Board. When compensating for the land clearance of the project site, the local government authorities must be involved in the process.

During the implementation stage of the project, the necessary approval and clearance for various operational activities of the projects such as material transportation to the project site, mining and discharging of outputs generated through mining, the usage of blasting materials, and obtaining environment clearance must be obtained from the relevant government organizations.

The success of the above processes is based on proper communication with the relevant authorized parties. Regular project progress meetings must be held with the participation of relevant stakeholders to achieve this target, and make an onsite decision at the implementation stage of the projects.

Measure 16: The mitigation method for the delay in conducting the workshop, on-site training sessions, and seminars for village workers to uplift their knowledge level and areas of competence while implementing the rural project

Rural unskilled laborers do not possess adequate knowledge and experience regarding construction works. On the other hand, skilled laborers who live in rural areas always move to urban areas seeking job opportunities because many construction projects are operating in urban areas compared to rural areas. This incurs a higher probability of having errors, repeat work, wasting materials, machine breakdown, etc. Implementing rural projects with local unskilled laborers will negatively affect the scheduled dates of project completion and increase costs.

Onsite training programs, workshops, seminars, etc. can be arranged at the project site to educate the unskilled laborers to overcome these issues. Arranging such programs will be beneficial to increase the productivity and efficiency of their work. It is also an

investment for the rural unskilled laborers to engage with better future career opportunities. For example, at the Norochcholei Coal Power Plant Project, many local laborers in and around the Norochcholei area have been employed with well-experienced and skillful Chinese workers. They gained good work experience in construction works such as how to simplify the work, special technics for construction activities, how to use materials effectively, and how to arrange safety measures. This is a successful event to express the effectiveness of such innovative methodologies.

CHAPTER 05

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Chapter Five summarizes the most significant factors affecting time and cost overrun in rural construction projects. It provides recommendations for mitigation measures identified to overcome the above time and cost overruns. Further, the chapter summarizes the study's limitations and provides recommendations for future research in this particular area.

5.2 Objective 1 – Identify the factors affecting time and cost overruns in rural construction projects.

Thirty factors that affect time and cost overruns in rural construction projects and Twenty-Seven of mitigation measures were listed as the literature survey findings. It was further summarized into 25 time and cost overrun factors and 21 mitigation measures after having semi-structured interviews with the persons involved with and having experience in construction projects in rural areas.

5.3 Objective 2 – Establish the significance of factors identified for time and cost overruns in rural construction projects.

The Chi-square test analysis method helped to determine the most significant factors contributed to time and cost overruns and the mitigation measures to overcome these factors. The analysis was able to identify 09 significant factors caused to time and cost overrun among the 25 factors.

5.4 Objective 3 – Establish mitigation measures to avoid or minimize the time and cost overrun in projects operating in rural areas

Again, the Chi-square test analysis method was used to establish the most significant mitigation measures to overcome the factors affected by time and cost overrun in rural construction projects. As per the analysis results, 07 Nos of significant measures were identified among the 21 Nos of measures.

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5.5 Practical implications identified in this study

The following practical implications were identified in this study. Utilization of these practices by the contractors would be beneficial to get an idea on how to successfully manage the material and machinery related issues, such as unavailability of construction materials to be utilized for the upcoming projects, delaying of source approvals, difficulties associated with transporting materials to the rural sites, and unavailability of spare parts at the bidding stage, to show the contractor's capability of achieving the tasks at the implementation stage of rural projects. Successful project time schedules can be synthesized by the bidders, and reasonable costs can be allocated for the upcoming projects considering the above issues at the initial stage of the projects. Considering the value of the human resources associated with the ongoing projects, contractors shall pay their special attention to introduce some attractive benefits for employing skilled and unskilled laborers throughout the project implementation stage with the presence of the highest job satisfaction. Further, the seasonal and annual harvesting periods of agricultural crops, cultural events associated with the relevant communities, etc., need to be identified through scrutinizing the social infrastructure and shall be considered when the Planning Engineer prepares the project schedule.

As per this study, financial constraints are an essential factor that may lead to time overrun and cost overruns of rural projects. Successful and applicable measures such as the project bundling concept, allocating appropriate funds, maintaining the cash flow with the project schedule, and decentralizing the financial authority to the site manager can be considered by the consultant/client of a project to overcome these interrogations.

Addressing the public and socio-economic issues can be identified as the most important triggering factor for the implementation of rural projects. Introducing and explaining the project proposal and project scope to the public, expedite the valuation, satisfied compensation processes, the proper collaboration of government and non-government authorities, and providing job opportunities are the practical measures identified in this study for the successful completion of a project with overall satisfaction.

5.6 Recommendations for future research

The project amount varies with the project scope. According to the usual practice, Local Government Authorities such as Pradeshiya Sabha handle small-scale infrastructure development projects annually. The value of this kind of project varies between the amounts of one million rupees to 100 million rupees. Large-scale project development organizations directly handle foreign-funded projects like the Norochchollei Coal Power Project, Sanitary Landfill Project at Aruwakkaru, and Highway Projects with the supervision and guidance of the relevant state Ministry. With the empowered authority of the associated government authorities, the factors affecting time and cost overruns for the small-scale projects in a rural area are being differentiated from the factors involved in the mega projects in the same area.

Further, mitigation actions should be taken to minimize or avoid the above factors, which also differ between small-scale projects to mega-scale projects. Hence, the project volume is a factor to be considered in future research work when investigating the factors affecting time and cost overruns in rural projects.

It is beneficial for the Clients, Consultants, and Contractors to separately identify the factors affecting the whole project life. The involvement of the stakeholders in the project varies throughout the project span. The factors identified for the time and cost overruns during the stages of feasibility and planning of the projects are not valid for the implementation. stage of the. project; at the project closing stage, the project proponent will identify a completely different set of factors. Hence, it is recommended to consider the entire project life cycle when researching these similar areas, and it will be convenient for project participants to overcome time and cost overruns during different stages of the relevant projects.

5.7 Limitations of this study

This investigation project cannot be considered as a national cross-section because construction projects operated only within the Puttalam District were considered as a sample. Political influences and preferences, environmental, climatic, and geological factors, socio-economic factors, and religious and ethnic groups also differ in different regions of the country. Fluctuations of these factors make variable influencing factors

for the overall structure and scope of the projects. However, this was eliminated to a certain extent using the validation of the findings with group of experts.

This construction sector has several indirect stakeholders, such as the general public, religious leaders, and community associations, and they have different perspectives regarding the implementation of rural construction projects. All factors which influence the projects, their practical applicability, influences of financial constraints on the projects, and lack of sound technical backgrounds were not considered during this study.

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ANNEXURE 01

Questionnaire - Factors Affecting Time and Cost Overruns in Rural Construction Projects and Mitigation Measures

1. Name with initials: .....

2. Designation: .....

3. Employment Category:

Client		Consultant		Contractor		Client & Consultant	

4. Organization / Company Name: .....

5. Work Experience in the construction industry:

Less than 10 Years		10-20 Years		20-30 Years		More than 30 years	

6. According to your opinion, there is a Time in the projects operating in rural areas.

Strongly Agreed		Agreed		Neutral		Disagree		Strongly Disagree	

7. In your opinion, there is a cost overrun in the projects operating in rural areas.

Strongly Agreed		Agreed		Neutral		Disagree		Strongly Disagree	

8. In your experience, do you agree or disagree with the following factors affecting Time and cost overrun in rural construction projects?

Item No.	Description	Delays					Cost Overrun				
		Strongly Agreed	Agreed	Neutral	Disagree	Strongly Disagree	Strongly Agreed	Agreed	Neutral	Disagree	Strongly Disagree
1.	Lack of availability of historical, climate, and other required data for project feasibility in rural areas.										
2.	Unavailability of high-speed internet connections and network coverage in remote locations.										
3.	The communication gap between stakeholders due to extensive physical distance.										
4.	Damaged and narrow access roads to the remote working sites.										
5.	Objections from the villagers due to less communication and their unawareness of project benefits.										

Item No.	Description	Delays					Cost Overrun				
		Strongly Agreed	Agreed	Neutral	Disagree	Strongly Disagree	Strongly Agreed	Agreed	Neutral	Disagree	Strongly Disagree
6.	The lengthy process of obtaining approval for the scenic and historical value of lands.										
7.	Unavailability of flood data (flood level) in remote areas.										
8.	Lack of adequate infrastructure facilities for project staff (e.g., hospitals, schools, supermarkets, etc.)										
9.	Less availability of hardware shops and no credit facilities to purchase construction materials										
10.	Less availability of construction materials and equipment/Machinery in rural areas.										
11.	Delaying of obtaining approval for establishing borrow pits, quarry, etc., to obtain construction materials from rural areas.										
12.	Difficulties in mobilizing construction materials and machinery due to poor accessibility to the remote sites.										
13.	Barriers in regulation policy in rural transport (limited axial load in some roads).										
14.	Loss of materials and equipment due to inadequate site security and employing unqualified security personal from the neighboring villages.										
15.	Lack of availability of spare parts shops and workshops for machine and equipment repair.										
16.	Additional costs for mobilization due to remoteness.										
17.	Lack of motivation of site staff due to homesickness.										
18.	Excessive alcohol consumption of local labor.										
19.	Difficulties in attracting and retaining skilled workers due to remoteness.										
20.	Labor absenteeism during harvesting seasons and cultural events.										
21.	Inadequate education, experience, and incompetence of neighborhood workers.										
22.	Inadequate laboratory facilities and qualified lab technicians for material sample testing and required onsite testing.										

Item No.	Description	Delays					Cost Overrun				
		Strongly Agreed	Agreed	Neutral	Disagree	Strongly Disagree	Strongly Agreed	Agreed	Neutral	Disagree	Strongly Disagree
23.	Less coordination in government officers when obtaining necessary project approval/clearance.										
24.	Change of the position of local politicians and government officers.										
25.	Less effective working hours due to the threat of wild animals (e.g., wild elephants).										

9. Please mention other factor(s) affecting Time and Cost overrun in rural construction projects in addition to the above list.

10. According to your previous experience, do you agree or disagree with the following measures to take as the mitigation method for Time and cost overrun in rural construction projects?

Item No.	Description	Delays					Cost Overrun				
		Strongly Agreed	Agreed	Neutral	Disagree	Strongly Disagree	Strongly Agreed	Agreed	Neutral	Disagree	Strongly Disagree
1.	Allocate adequate funds and releasing funds on time while implementing the project.										
2.	Give some financial authority to site officers for purchasing material and equipment on an urgent basis.										
3.	Appoint a Contractor with similar experience in working at remote locations or neighborhood Contractors.										
4.	Use advanced technology to forecast the adverse weather condition (e.g., Flood forecasting system).										

5.	Implement the concept of project bundling (combine few small-scale projects into a single project).										
6.	Social/cultural events and harvesting periods shall be taken into account when preparing the Project Schedule.										
7.	Obtain the Contractors all-risk insurance with a high premium due to remoteness										
8.	Consider the lesson learned, gather information from villages (e.g., Rainfall, flood levels, etc.) when preparing the Construction schedule and program.										
9.	Consider the rates of the previous projects when preparing the cost estimate in rural projects.										
10.	Use advanced technology for communication between project stakeholders (e.g., video conference, instant messaging, etc.)										
11.	Consider the uncertainties when pricing the bids.										
12.	Allocate adequate contingency allowance.										
13.	Establish an effective and efficient procurement system.										
14.	Provide infrastructure, recreational, and welfare facilities to attract and retain workers and maximize their productivity.										
15.	Conduct round table meetings with the project team and the members of government authorities to discuss the project progress, expedite the pending approval/clearance and avoid constraints.										
16.	Conduct workshops, onsite training sessions, and seminars for village workers to uplift their knowledge level and areas of competence while implementing the rural project.										
17.	Identify suitable local materials that act as alternative materials for construction. (e.g., Limestone for Road Bases).										
18.	Appoint highly experienced on-site design engineers and decision-makers for remote projects.										

Item No.	Description	Delays					Cost Overrun				
		Strongly Agreed	Agreed	Neutral	Disagree	Strongly Disagree	Strongly Agreed	Agreed	Neutral	Disagree	Strongly Disagree
19.	Obtain the approval for borrow pits, quarries, and material transportation by the Client before the Contractor commences the work.										
20.	Take immediate precautions to avoid/spread diseases among working staff in the remote sites (e.g., Dengue).										
21.	Provide and distribute meals and beverages for workers on the site during working hours.										

11. Please mention any mitigation method for Time and cost overrun in rural construction projects other than the above list.

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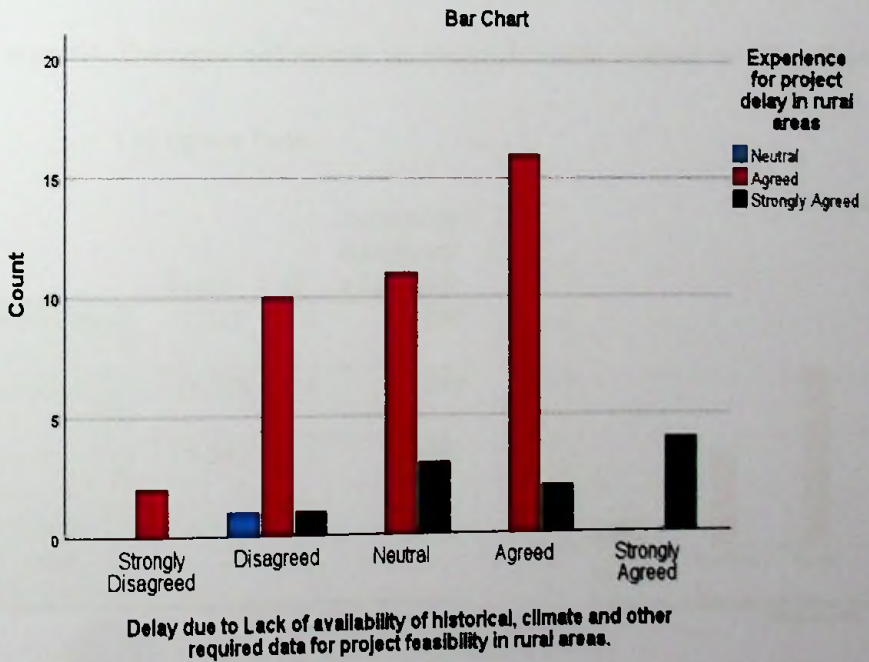
ANNEXURE 02

Chi-Square Test Results: Factors affecting Time Overrun in Rural Construction Project

Factor 01. lack of availability of historical, climate and other required data for project feasibility in rural areas.

Chi square test

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	21.471[a]	8	.006
Likelihood Ratio	18.701	8	.017
Linear-by-Linear Association	6.755	1	.009
N of Valid Cases	50		



Factor 02. Unavailability of high-speed internet connections and network coverage in remote locations.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10.627[a]	6	.101
Likelihood Ratio	9.498	6	.147
Linear-by-Linear Association	6.639	1	.010
N of Valid Cases	50		

Factor 03. Communication gap between stakeholders due to extensive physical distance

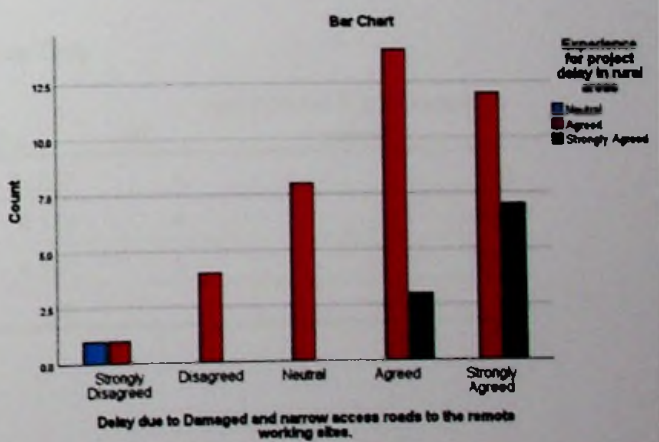
Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	7.441[a]	6	.282
Likelihood Ratio	8.512	6	.203
Linear-by-Linear Association	5.356	1	.021
N of Valid Cases	50		

Factor 04. Damaged and narrow access roads to the remote working sites

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	31.065[a]	8	.000
Likelihood Ratio	15.768	8	.046
Linear-by-Linear Association	9.542	1	.002
N of Valid Cases	50		



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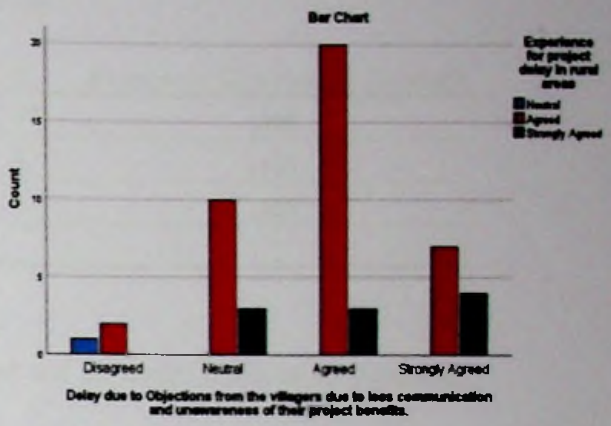
Factor 05. Objections from the villagers due to less communication and unawareness of their project benefits.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	18.936[a]	6	.004
Likelihood Ratio	9.296	6	.158
Linear-by-Linear Association	2.966	1	.085
N of Valid Cases	50		



Factor 06. A lengthy process of obtain approval for scenic and history value of lands

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	11.424[a]	6	.005
Likelihood Ratio	9.854	6	.131
Linear-by-Linear Association	6.603	1	.010
N of Valid Cases	50		

Factor 07. Unavailability of flood data (flood level) in remote areas

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	9.059[a]	6	.170
Likelihood Ratio	9.342	6	.155
Linear-by-Linear Association	4.552	1	.033
N of Valid Cases	50		

Factor 08. lack of adequate infrastructure facilities for project staff (eg hospitals, schools, supermarkets, etc,)

Chi-Square Tests

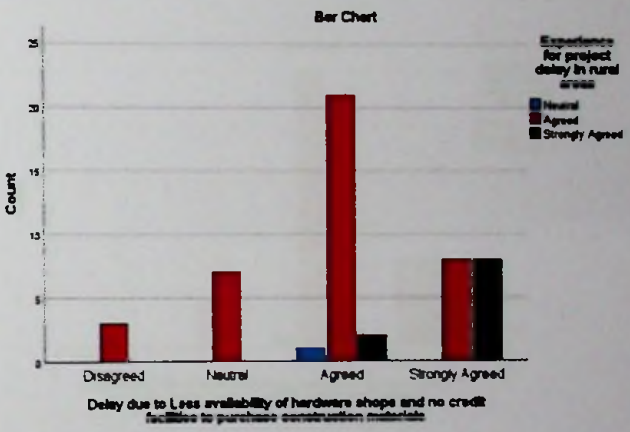
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	7.841[a]	4	.098
Likelihood Ratio	7.016	4	.135
Linear-by-Linear Association	2.627	1	.105
N of Valid Cases	50		

Factor 09. Less availability of hardware shops and no credit facilities to purchase construction materials

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	14.423[a]	6	.025
Likelihood Ratio	15.308	6	.018
Linear-by-Linear Association	8.349	1	.004
N of Valid Cases	50		

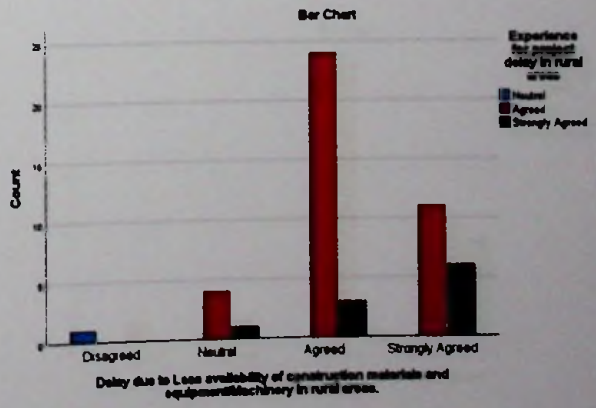
a. 9 cells (75.0%) have expected count less than 5. The minimum expected count is .06.



Factor 10. Less availability of construction materials and equipment/Machinery in rural areas

Chi-Square Tests

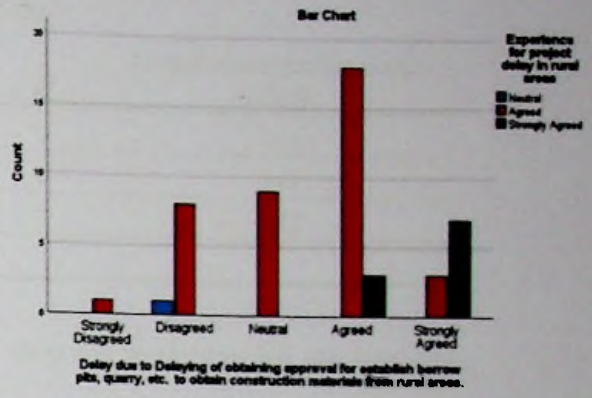
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	53.833[a]	6	.000
Likelihood Ratio	13.477	6	.036
Linear-by-Linear Association	5.886	1	.015
N of Valid Cases	50		



Factor 11. Delaying obtaining approval for establish borrow pits, quarry, etc. to obtain construction materials from rural areas

Chi-Square Tests

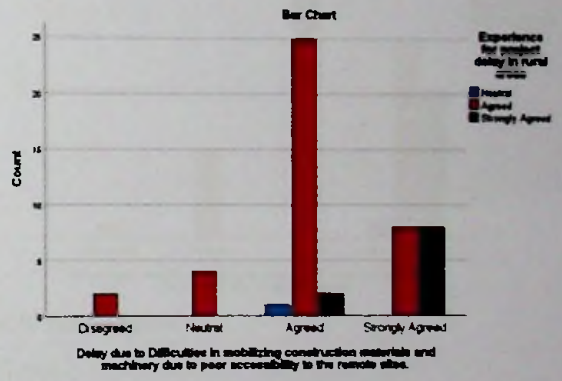
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	25.070[a]	8	.002
Likelihood Ratio	23.672	8	.003
Linear-by-Linear Association	14.810	1	.000
N of Valid Cases	50		



Factor 12. Difficulties in mobilizing construction materials and machinery due to poor accessibility to the remote sites

Chi-Square Tests

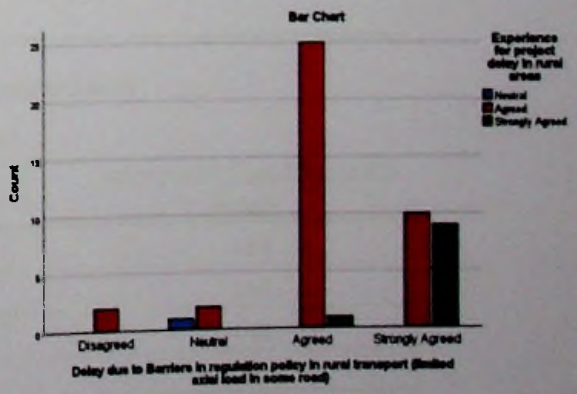
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	13.938[a]	6	.030
Likelihood Ratio	14.325	6	.026
Linear-by-Linear Association	8.413	1	.004
N of Valid Cases	50		



Factor 13. Barriers in regulation policy in rural transport (limited axial load in some road)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	30.014[a]	6	.000
Likelihood Ratio	20.810	6	.002
Linear-by-Linear Association	11.840	1	.001
N of Valid Cases	50		



Factor 14. Loss of materials and equipment due to Inadequate site security and employing unqualified security personal form the neighborhood villages

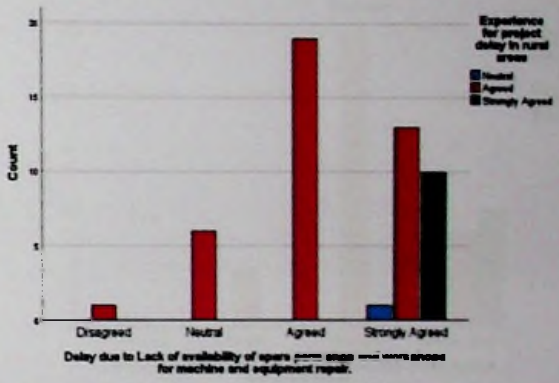
Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	9.195[a]	6	.163
Likelihood Ratio	7.958	6	.241
Linear-by-Linear Association	3.779	1	.052
N of Valid Cases	50		

Factor 15. Lack of availability of spare parts shop and workshops for machine and equipment repair

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	15.278[a]	6	.018
Likelihood Ratio	19.587	6	.003
Linear-by-Linear Association	6.775	1	.009
N of Valid Cases	50		



Factor 16. Additional cost for mobilization due to remoteness

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.142[a]	6	.906
Likelihood Ratio	3.348	6	.764
Linear-by-Linear Association	1.027	1	.311
N of Valid Cases	50		

Factor 17. Lack of motivation of site staff due to homesickness

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	11.319[a]	8	.184
Likelihood Ratio	12.037	8	.150
Linear-by-Linear Association	2.095	1	.148
N of Valid Cases	50		

Factor 18. Excessive alcohol consumption of local labour

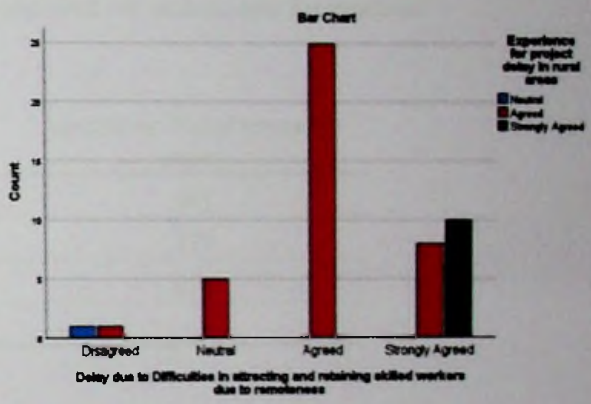
Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.596[a]	4	.964
Likelihood Ratio	.961	4	.916
Linear-by-Linear Association	.021	1	.885
N of Valid Cases	50		

Factor 19. Difficulties in attracting and retaining skilled workers due to remoteness

Chi-Square Tests

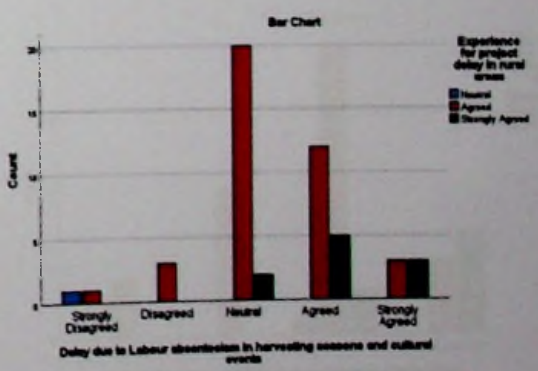
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	46.439[a]	6	.000
Likelihood Ratio	31.890	6	.000
Linear-by-Linear Association	19.157	1	.000
N of Valid Cases	50		



Factor 20. Labour absenteeism in harvesting seasons and cultural events

Chi-Square Tests

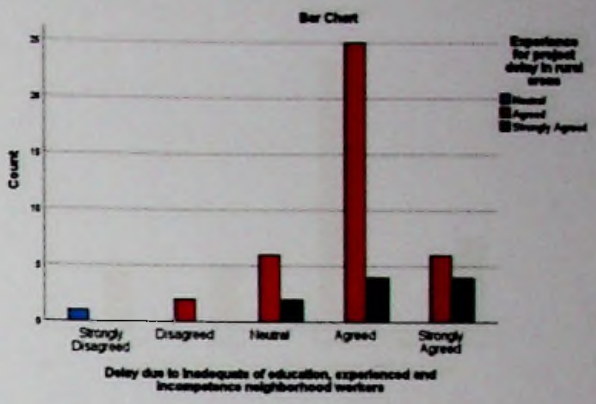
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	31.342[a]	8	.000
Likelihood Ratio	14.301	8	.074
Linear-by-Linear Association	10.088	1	.001
N of Valid Cases	50		



Factor 21. Inadequate of education, experienced and incompetence neighborhood workers

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	53.838[a]	8	.000
Likelihood Ratio	13.666	8	.091
Linear-by-Linear Association	5.271	1	.022
N of Valid Cases	50		



Factor 22. Inadequate of laboratory facilities and qualified lab technicians for material sample testing and required on site testing

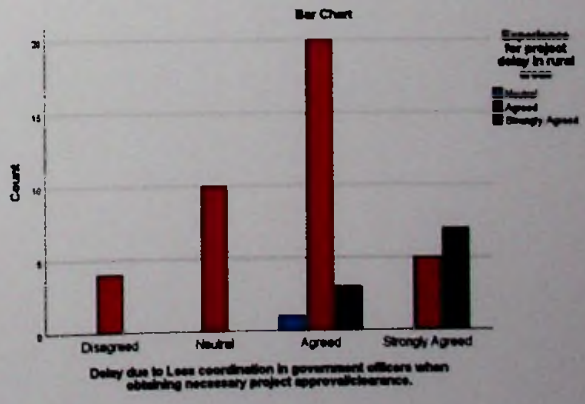
Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10.093[a]	6	.001
Likelihood Ratio	8.969	6	.175
Linear-by-Linear Association	3.822	1	.051
N of Valid Cases	50		

Factor 23. Less coordination in government officers when obtaining necessary project approval/clearance

Chi-Square Tests

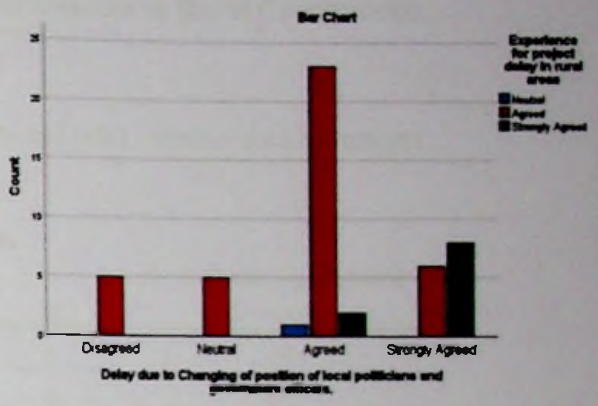
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	16.362[a]	6	.012
Likelihood Ratio	16.967	6	.009
Linear-by-Linear Association	9.148	1	.002
N of Valid Cases	50		



Factor 24. Changing of position of local politicians and government officers

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	17.751[a]	6	.007
Likelihood Ratio	17.856	6	.007
Linear-by-Linear Association	8.967	1	.003
N of Valid Cases	50		



Factor 25. Less effective working hours due to threat of wild animal

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	7.193[a]	6	.303
Likelihood Ratio	9.671	6	.139
Linear-by-Linear Association	4.536	1	.033
N of Valid Cases	50		

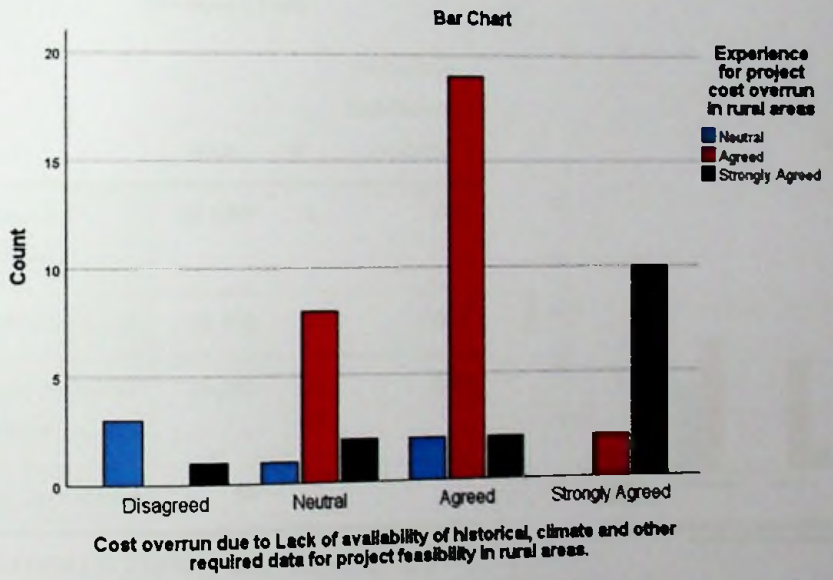
ANNEXURE 03

Chi-Square Test Results: Factors Affecting Cost Overrun in Rural Construction Projects.

Factor 01. lack of availability of historical, climate and other required data for project feasibility in rural areas.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	39.027[a]	6	.304
Likelihood Ratio	34.335	6	.000
Linear-by-Linear Association	13.523	1	.000
N of Valid Cases	50		



Factor 02. Unavailability of high speed internet connections and network coverage in remote locations

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	22.754[a]	8	.204
Likelihood Ratio	18.930	8	.015
Linear-by-Linear Association	9.191	1	.002
N of Valid Cases	50		

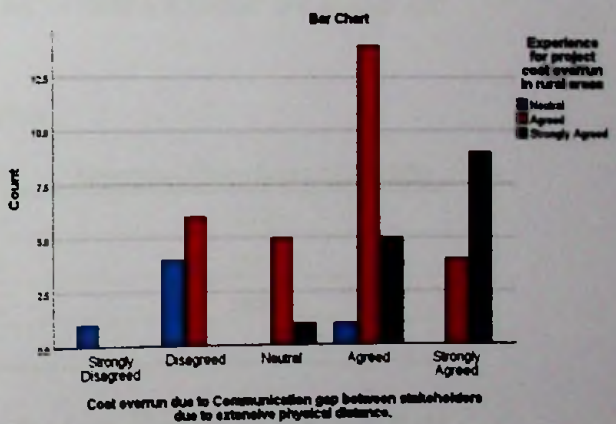
a. 11 cells (73.3%) have expected count less than 5. The minimum expected count is .24.

Factor 03. Cost overrun due to communication gap between stakeholders due to extensive physical distance

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	29.984[a]	8	.000
Likelihood Ratio	28.400	8	.000
Linear-by-Linear Association	19.250	1	.000
N of Valid Cases	50		

a. 11 cells (73.3%) have expected count less than 5. The minimum expected count is .12.



Factor 04. Cost overrun due to damaged and narrow access roads to the remote working sites.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	17.751[a]	6	.311
Likelihood Ratio	11.979	6	.062
Linear-by-Linear Association	8.795	1	.003
N of Valid Cases	50		

Factor 05. Cost overrun due to objections from the villagers due to less communication and unawareness of their project benefits.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	7.997[a]	6	.002
Likelihood Ratio	9.015	6	.173
Linear-by-Linear Association	2.344	1	.126
N of Valid Cases	50		

Factor 06. Cost overrun due to lengthy process of obtain approval for scenic and history value of lands

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	16.841[a]	6	.210
Likelihood Ratio	19.048	6	.004
Linear-by-Linear Association	14.217	1	.000
N of Valid Cases	50		

Factor 07. Cost overrun due to unavailability of flood data (flood level) in remote areas and experience for project cost overruns in rural areas

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	7.146[a]	6	.308
Likelihood Ratio	8.190	6	.225
Linear-by-Linear Association	.016	1	.899
N of Valid Cases	50		

Factor 08. Cost Overrun Due to lack of adequate infrastructure facilities for project staff (eg hospitals, schools, supermarkets, etc,)

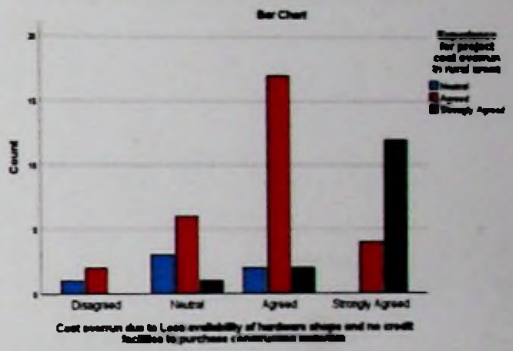
Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.443a	6	.011
Likelihood Ratio	3.882	6	.693
Linear-by-Linear Association	.004	1	.949
N of Valid Cases	50		

Factor 09. Cost Overrun Due to less availability of hardware shops and no credit facilities to purchase construction materials.

Chi-Square Tests

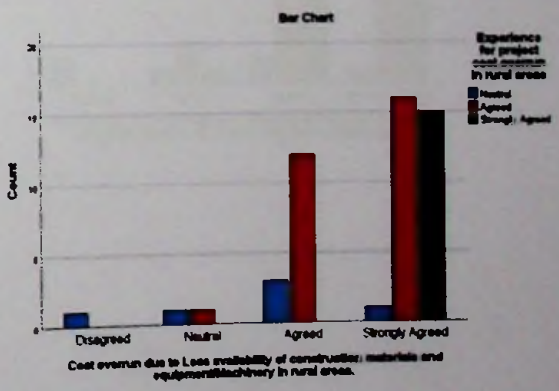
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	26.791[a]	6	.830
Likelihood Ratio	27.388	6	.000
Linear-by-Linear Association	17.033	1	.000
N of Valid Cases	50		



Factor 10. Cost Overrun Due to less availability of construction materials and equipment/Machinery in rural areas.

Chi-Square Tests

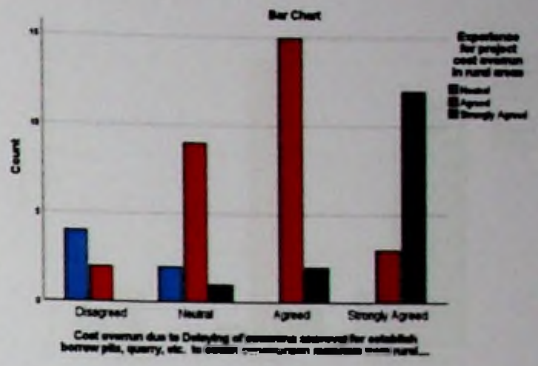
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	22.405[a]	6	.001
Likelihood Ratio	23.529	6	.001
Linear-by-Linear Association	16.204	1	.000
N of Valid Cases	50		



Factor 11. Cost Overrun Due to cost overrunning of obtaining approval for establish borrow pits, quarry, etc. to obtain construction materials from rural areas

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	44.703[a]	6	.000
Likelihood Ratio	40.876	6	.000
Linear-by-Linear Association	26.198	1	.000
N of Valid Cases	50		

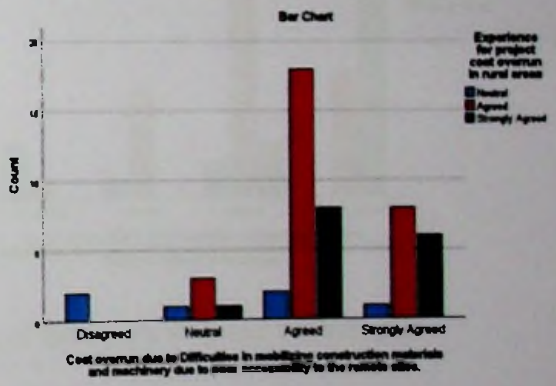


Factor 12. Cost Overrun Due to difficulties in mobilizing construction materials and machinery due to poor accessibility to the remote sites

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	16.776[a]	6	.010
Likelihood Ratio	10.678	6	.099
Linear-by-Linear Association	5.814	1	.016
N of Valid Cases	50		

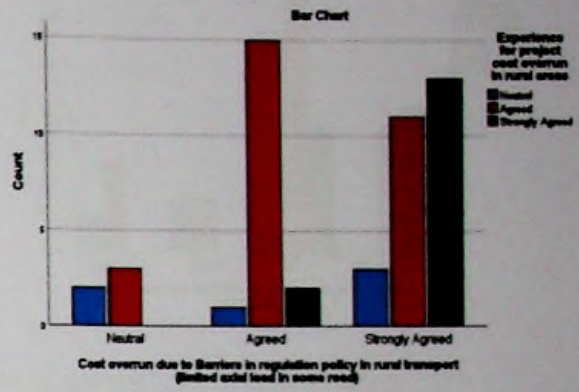
a. 9 cells (75.0%) have expected count less than 5. The minimum expected count is .24.



Factor 13. Cost Overrun Due to barriers in regulation policy in rural transport (limited axial load in some road)

Chi-Square Tests

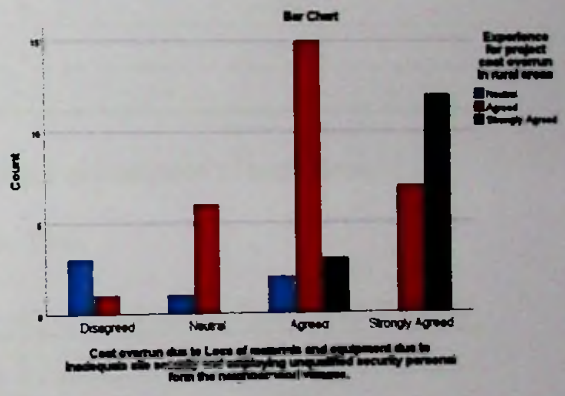
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	13.894[a]	4	.108
Likelihood Ratio	14.446	4	.006
Linear-by-Linear Association	7.323	1	.007
N of Valid Cases	50		



Factor 14. Cost Overrun Due to loss of materials and equipment due to Inadequate site security and employing unqualified security personal form the neighborhood villages

Chi-Square Tests

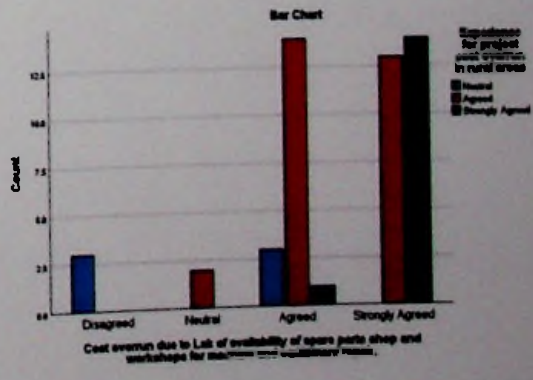
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	31.511[a]	6	.000
Likelihood Ratio	28.685	6	.000
Linear-by-Linear Association	20.271	1	.000
N of Valid Cases	50		



Factor 15. Cost Overrun Due to lack of availability of spare parts shop and workshops for machine and equipment repair

Chi-Square Tests

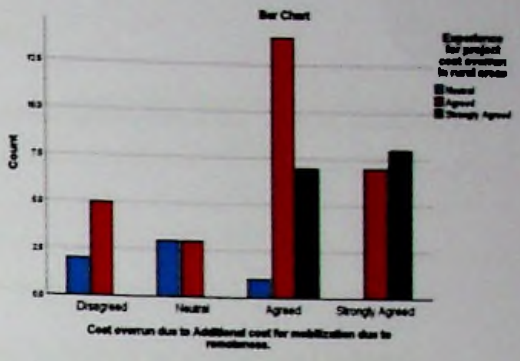
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	36.563[a]	6	.000
Likelihood Ratio	32.196	6	.000
Linear-by-Linear Association	20.576	1	.000
N of Valid Cases	50		



Factor 16. Cost Overrun Due to additional cost for mobilization due to remoteness

Chi-Square Tests

	Value	df	Asymptotic Significance
Pearson Chi-Square	19.024[a]	6	.004
Likelihood	20.866	6	.002
Linear-by-Linear	13.179	1	.000
N of Valid	50		



Factor 17. Cost Overrun Due to lack of motivation of site staff due to homesickness

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.919[a]	6	.328
Likelihood Ratio	6.594	6	.360
Linear-by-Linear Association	3.572	1	.059
N of Valid Cases	50		

Factor 18. Cost Overrun Due to excessive alcohol consumption of local labour

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	15.320[a]	8	.053
Likelihood Ratio	13.403	8	.099
Linear-by-Linear Association	5.702	1	.017
N of Valid Cases	50		

a. 10 cells (66.7%) have expected count less than 5. The minimum expected count is .12.

Factor 19. Cost Overrun Due to difficulties in attracting and retaining skilled workers due to remoteness

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10.640[a]	6	.001
Likelihood Ratio	13.441	6	.037
Linear-by-Linear Association	8.871	1	.003
N of Valid Cases	50		

Factor 20. Cost Overrun Due to labour absenteeism in harvesting seasons and cultural events

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	7.144[a]	6	.008
Likelihood Ratio	7.405	6	.285
Linear-by-Linear Association	2.381	1	.123
N of Valid Cases	50		

Factor 21. Cost Overrun Due to inadequate of education, experienced and incompetence neighborhood workers.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	11.505[a]	8	.005
Likelihood Ratio	9.752	8	.283
Linear-by-Linear Association	1.652	1	.199
N of Valid Cases	50		

Factor 22. Cost Overrun Due to inadequate of laboratory facilities and qualified lab technicians for material sample testing and required on site testing

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10.330[a]	6	.111
Likelihood Ratio	13.286	6	.039
Linear-by-Linear Association	.922	1	.337
N of Valid Cases	50		

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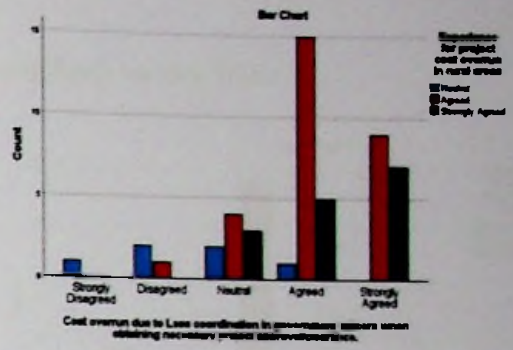
Factor 23. Cost Overrun Due to between less coordination in government officers when obtaining necessary project approval/clearance

Chi-Square Tests

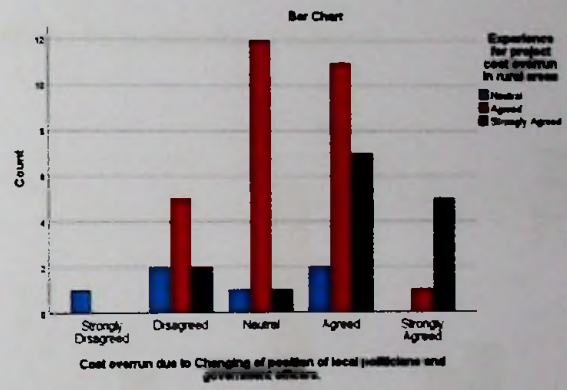
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	21.896[a]	8	.005
Likelihood Ratio	17.778	8	.023
Linear-by-Linear Association	9.828	1	.002
N of Valid Cases	50		



Factor 24. Cost Overrun Due to changing of position of local politicians and government officers

Chi-Square Tests

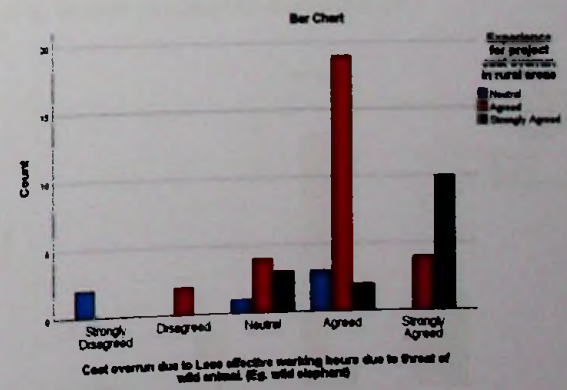
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	21.316[a]	8	.206
Likelihood Ratio	18.523	8	.018
Linear-by-Linear Association	9.171	1	.002
N of Valid Cases	50		



Factor 25. Cost Overrun Due to less effective working hours due to threat of wild animal

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	33.749[a]	8	.000
Likelihood Ratio	29.522	8	.000
Linear-by-Linear Association	11.490	1	.001
N of Valid Cases	50		



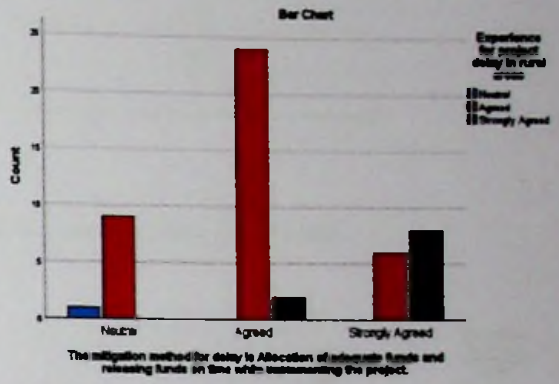
ANNEXURE 04

Chi-Square Test Results: Mitigation Measures for Time Overrun in Rural Construction Project.

Factor 01. Allocation of adequate funds and releasing funds on time while implementing the project

Chi-Square Tests

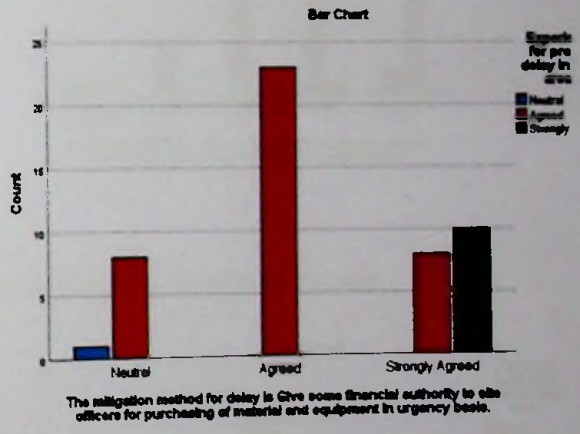
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	20.710[a]	4	.000
Likelihood Ratio	19.668	4	.001
Linear-by-Linear Association	15.124	1	.000
N of Valid Cases	50		



Factor 02. Give some financial authority to site officers for purchasing of material and equipment in urgency basis.

Chi-Square Tests

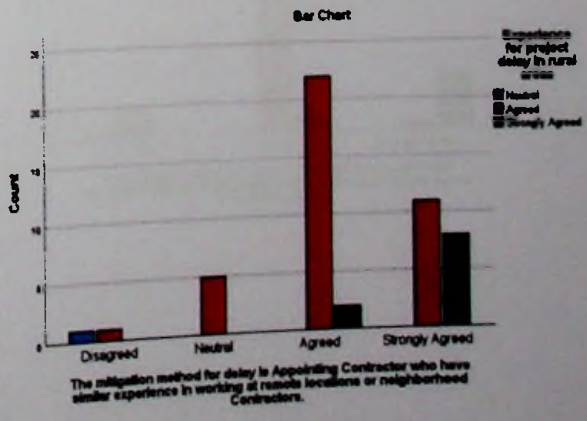
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	26.496[a]	4	.000
Likelihood Ratio	28.383	4	.000
Linear-by-Linear Association	18.110	1	.000
N of Valid Cases	50		



Factor 03. Contractor who have similar experience in working at remote locations or neighborhood Contractors.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	33.746[a]	6	.000
Likelihood Ratio	16.988	6	.009
Linear-by-Linear Association	11.708	1	.001
N of Valid Cases	50		



Factor 04. Use advance technology to forecast the adverse weather condition (eg. Flood forecasting system)

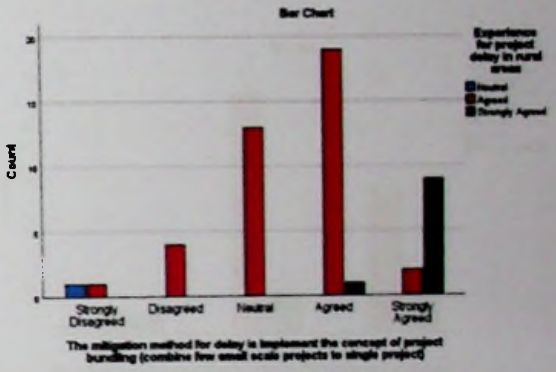
Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	11.699[a]	8	.005
Likelihood Ratio	12.379	8	.135
Linear-by-Linear Association	.908	1	.341
N of Valid Cases	50		

Factor 05. Implement the concept of project bundling (combine few small scale projects to single project)

Chi-Square Tests

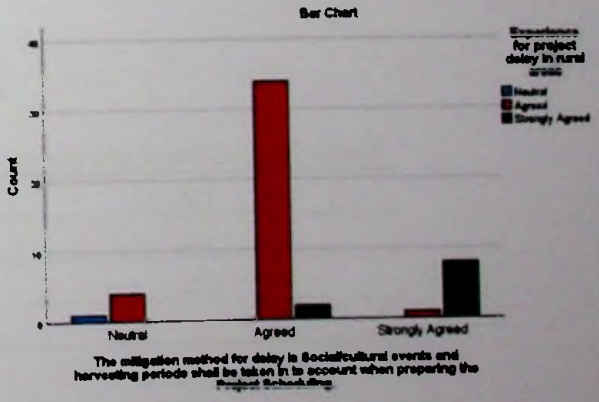
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	58.111[a]	8	.000
Likelihood Ratio	38.249	8	.000
Linear-by-Linear Association	21.873	1	.000
N of Valid Cases	50		



Factor 06. Social/cultural events and harvesting periods shall be taken in to account when preparing the Project Scheduling.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	41.524[a]	4	.000
Likelihood Ratio	32.662	4	.000
Linear-by-Linear Association	26.180	1	.000
N of Valid Cases	50		



Factor 07. Obtain the Contractors all risk insurance with high premium due to remoteness

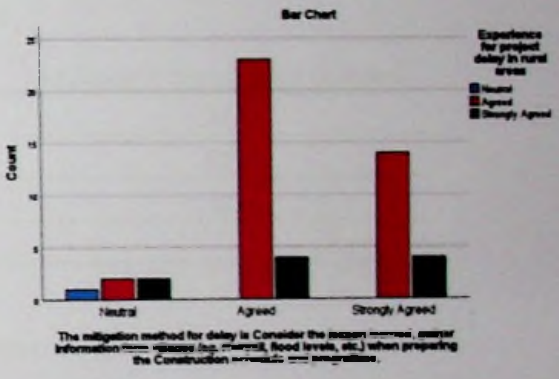
Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	9.875[a]	6	.130
Likelihood Ratio	10.417	6	.108
Linear-by-Linear Association	5.680	1	.017
N of Valid Cases	50		

Factor 08. Consider the lesson learned, gather information form villages (eg. Rainfall, flood levels, etc.) when preparing the Construction schedule and programme.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	11.512[a]	4	.021
Likelihood Ratio	7.122	4	.130
Linear-by-Linear Association	.116	1	.733
N of Valid Cases	50		



Factor 09. Consider the rates of the previous projects when prepare the cost estimate in rural projects.

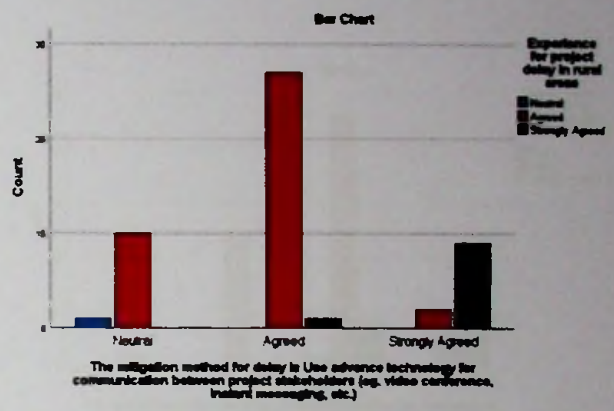
Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	5.507[a]	6	.481
Likelihood Ratio	7.389	6	.286
Linear-by-Linear Association	1.306	1	.253
N of Valid Cases	50		

Factor 10. Use advance technology for communication between project stakeholders (eg. video conference, instant messaging, etc.)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	37.043[a]	4	.000
Likelihood Ratio	33.631	4	.000
Linear-by-Linear Association	23.745	1	.000
N of Valid Cases	50		



Factor 11. Consider the uncertainties when pricing the bids

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	8.241[a]	8	.410
Likelihood Ratio	8.833	8	.357
Linear-by-Linear Association	2.488	1	.115
N of Valid Cases	50		

Factor 12. Allocate adequate contingency allowance

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.615[a]	6	.594
Likelihood Ratio	6.599	6	.360
Linear-by-Linear Association	.287	1	.592
N of Valid Cases	50		

Factor 13. Establish effective and efficient procurement system

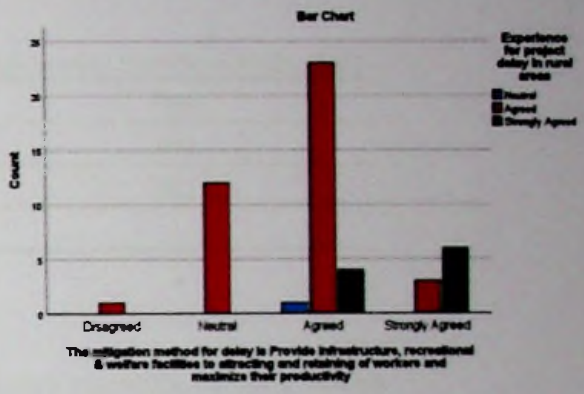
Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.817[a]	4	.431
Likelihood Ratio	4.444	4	.349
Linear-by-Linear Association	3.268	1	.071
N of Valid Cases	50		

Factor 14. Provide infrastructure, recreational & welfare facilities to attracting and retaining of workers and maximize their productivity

Chi-Square Tests

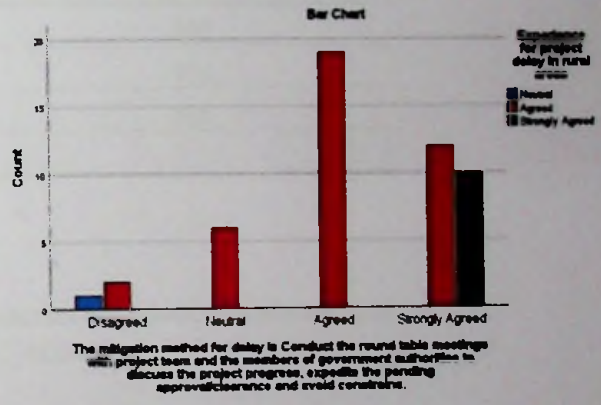
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	16.813[a]	6	.010
Likelihood Ratio	16.655	6	.011
Linear-by-Linear Association	10.151	1	.001
N of Valid Cases	50		



Factor 15. Conduct the round table meetings with project team and the members of government authorities to discuss the project progress, expedite the pending approval/clearance and avoid constrains.

Chi-Square Tests

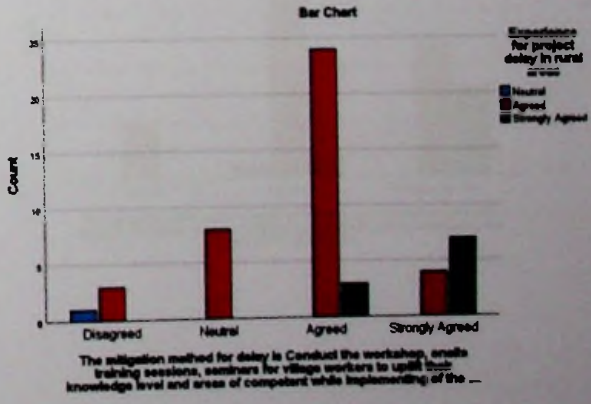
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	31.546[a]	6	.000
Likelihood Ratio	25.257	6	.000
Linear-by-Linear Association	14.302	1	.000
N of Valid Cases	50		



Factor 16. Conduct the workshop, onsite training sessions, seminars for village workers to uplift their knowledge level and areas of competent while implementing of the rural project.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	28.796[a]	6	.000
Likelihood Ratio	21.637	6	.001
Linear-by-Linear Association	14.840	1	.000
N of Valid Cases	50		



Factor 17. Identify suitable local materials which can be used as alternative materials for construction (eg. Lime Stone for Road Bases)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.022[a]	6	.008
Likelihood Ratio	2.731	6	.842
Linear-by-Linear Association	.981	1	.322
N of Valid Cases	50		

Factor 18. Appointing highly experience on site design engineers, decision makers for remote project.

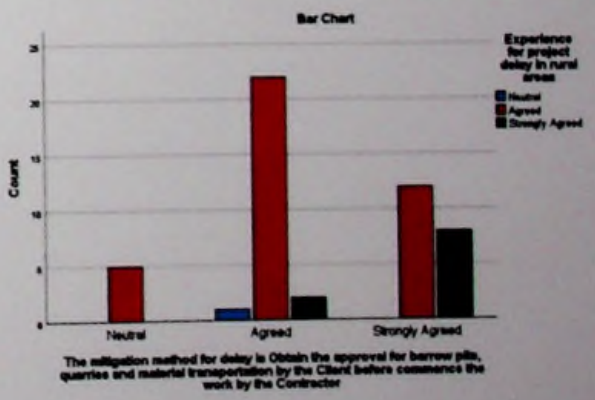
Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.054[a]	6	.983
Likelihood Ratio	1.603	6	.952
Linear-by-Linear Association	.281	1	.596
N of Valid Cases	50		

Factor 19. Obtain the approval for barrow pits, quarries and material transportation by the Client before commence the work by the Contractor

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	9.262[a]	4	.055
Likelihood Ratio	10.307	4	.036
Linear-by-Linear Association	7.158	1	.007
N of Valid Cases	50		



Factor 20. Take immediate precaution for avoid/spreading of deceases among working staff in remote site. (eg. Dengue)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	8.625[a]	6	.196
Likelihood Ratio	9.876	6	.130
Linear-by-Linear Association	6.044	1	.014
N of Valid Cases	50		

Factor 21. Provide and distribute meals and beverages for workers in the site during the working hours.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.605[a]	6	.595
Likelihood Ratio	4.868	6	.561
Linear-by-Linear Association	.001	1	.975
N of Valid Cases	50		

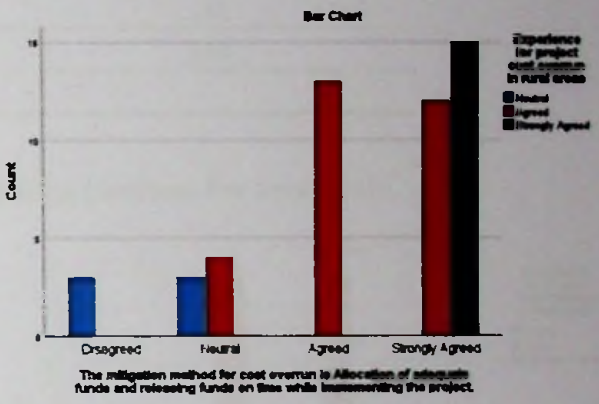
ANNEXURE 05

Chi-Square Test Results: Mitigation Measures for Cost Overrun in Construction Project in Rural Area

Measure 01. Allocation of adequate funds and releasing funds on time while implementing the project

Chi-Square Tests

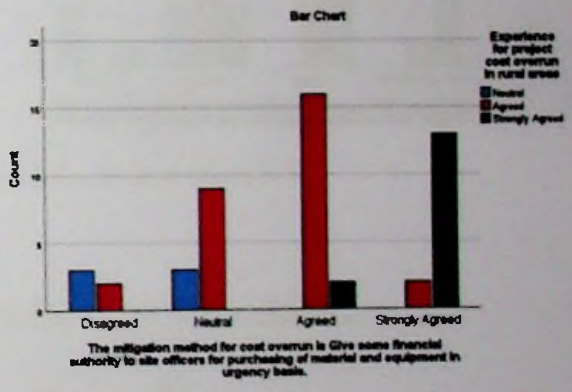
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	49.042[a]	6	.000
Likelihood Ratio	46.500	6	.000
Linear-by-Linear Association	27.723	1	.000
N of Valid Cases	50		



Measure 02. Give some financial authority to site officers for purchasing of material and equipment in urgency basis.

Chi-Square Tests

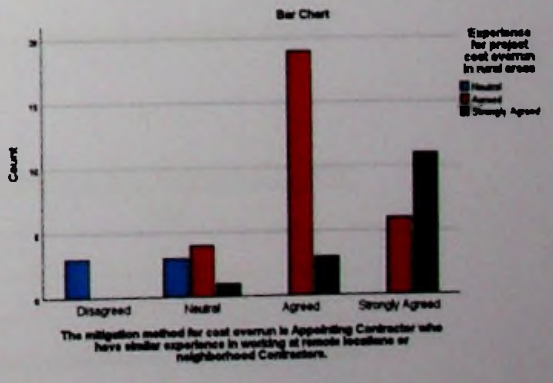
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	47.544[a]	6	.000
Likelihood Ratio	48.592	6	.000
Linear-by-Linear Association	29.725	1	.000
N of Valid Cases	50		



Measure 03. Contractor who have similar experience in working at remote locations or neighborhood Contractors.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	45.272[a]	6	.157
Likelihood Ratio	37.968	6	.000
Linear-by-Linear Association	23.400	1	.000
N of Valid Cases	50		



Measure 04. Use advance technology to forecast the adverse weather condition (eg. Flood forecasting system

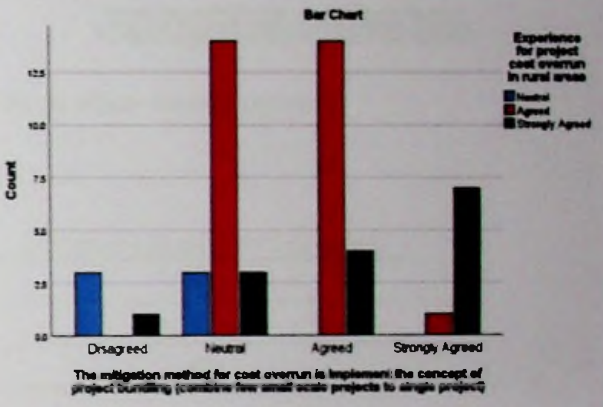
Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	8.150[a]	6	.227
Likelihood Ratio	9.131	6	.166
Linear-by-Linear Association	2.080	1	.149
N of Valid Cases	50		

Measure 05. Implement the concept of project bundling (combine few small scale projects to single project)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	34.099[a]	6	.000
Likelihood Ratio	30.808	6	.000
Linear-by-Linear Association	14.971	1	.000
N of Valid Cases	50		



Measure 06. Social/cultural events and harvesting periods shall be taken in to account when preparing the Project Scheduling.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	33.442[a]	6	.312
Likelihood Ratio	30.502	6	.000
Linear-by-Linear Association	20.104	1	.000
N of Valid Cases	50		

Measure 07. Obtain the Contractors all risk insurance with high premium due to remoteness

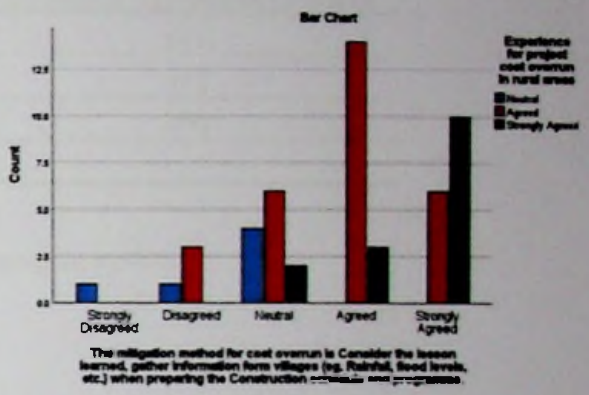
Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	9.442[a]	8	.306
Likelihood Ratio	11.109	8	.196
Linear-by-Linear Association	.132	1	.717
N of Valid Cases	50		

Measure 08. Consider the lesson learned, gather information form villages (eg. Rainfall, flood levels, etc.) when preparing the Construction schedule and programme.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	28.046[a]	8	.000
Likelihood Ratio	27.370	8	.001
Linear-by-Linear Association	16.206	1	.000
N of Valid Cases	50		



Measure 09. Consider the rates of the previous projects when prepare the cost estimate in rural projects.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	9.586[a]	6	.003
Likelihood Ratio	6.959	6	.325
Linear-by-Linear Association	2.447	1	.118
N of Valid Cases	50		

Measure 10. Use advance technology for communication between project stakeholders (eg. video conference, instant messaging, etc.)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	23.255[a]	6	.895
Likelihood Ratio	24.604	6	.000
Linear-by-Linear Association	10.551	1	.001
N of Valid Cases	50		

Measure 11. Consider the uncertainties when pricing the bids

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	13.972[a]	8	.001
Likelihood Ratio	12.307	8	.138
Linear-by-Linear Association	5.673	1	.017
N of Valid Cases	50		

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Measure 12. Allocate adequate contingency allowance

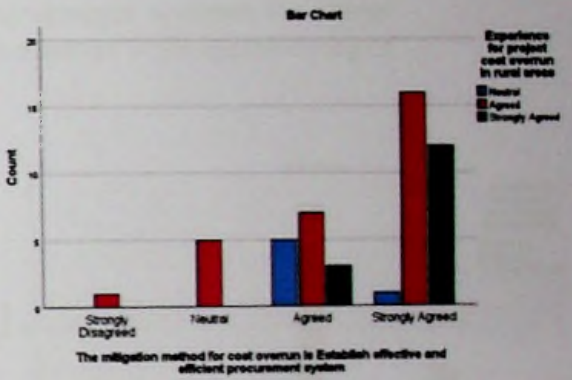
Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.293[a]	6	.011
Likelihood Ratio	8.854	6	.182
Linear-by-Linear Association	3.088	1	.079
N of Valid Cases	50		

Measure 13. Establish effective and efficient procurement system

Chi-Square Tests

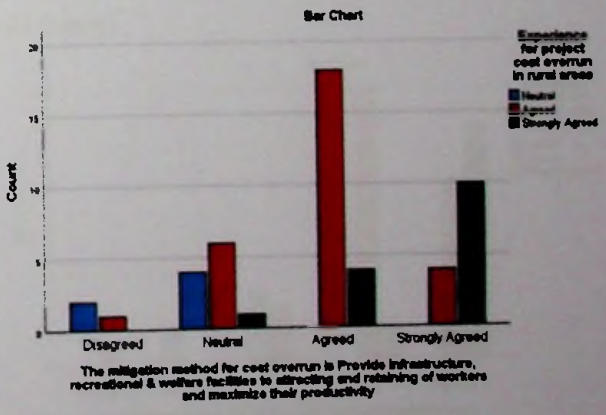
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	13.925[a]	6	.030
Likelihood Ratio	14.901	6	.021
Linear-by-Linear Association	3.856	1	.050
N of Valid Cases	50		



Measure 14. Provide infrastructure, recreational & welfare facilities to attracting and retaining of workers and maximize their productivity

Chi-Square Tests

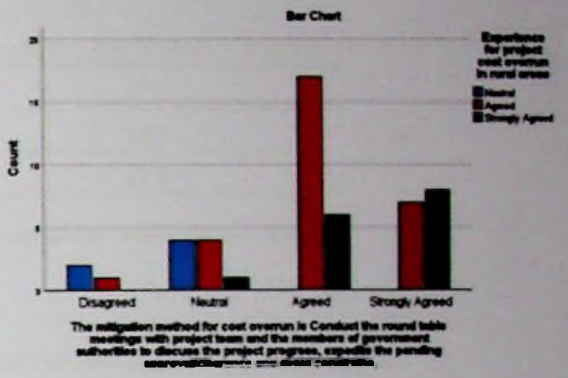
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	33.349[a]	6	.000
Likelihood Ratio	31.562	6	.000
Linear-by-Linear Association	21.126	1	.000
N of Valid Cases	50		



Measure 15. Conduct the round table meetings with project team and the members of government authorities to discuss the project progress.

Chi-Square Tests

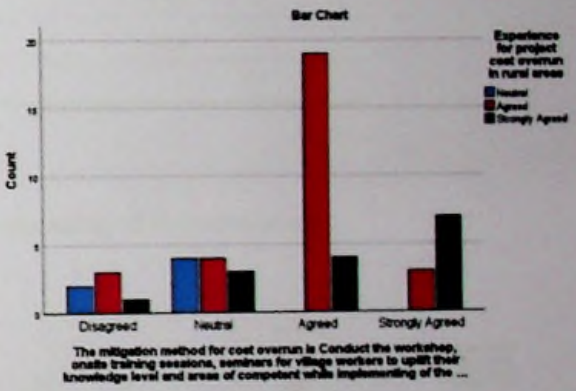
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	26.672[a]	6	.000
Likelihood Ratio	24.838	6	.000
Linear-by-Linear Association	15.802	1	.000
N of Valid Cases	50		



Measure 16. Conduct the workshop, onsite training sessions, seminars for village workers to uplift their knowledge level and areas of competent while implementing of the rural project.

Chi-Square Tests

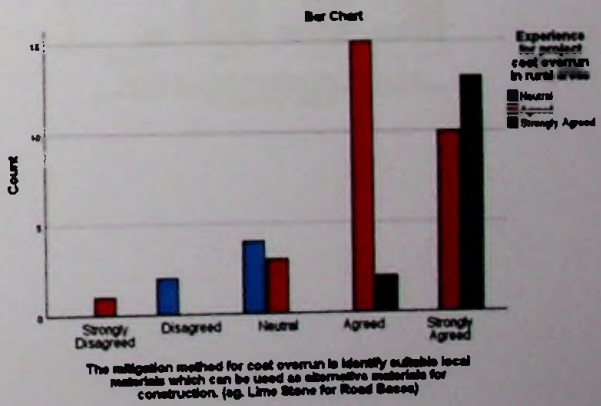
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	23.319[a]	6	.001
Likelihood Ratio	23.567	6	.001
Linear-by-Linear Association	9.251	1	.002
N of Valid Cases	50		



Measure 17. Identify suitable local materials which can be used as alternative materials for construction (eg. Lime Stone for Road Bases)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	45.248[a]	8	.000
Likelihood Ratio	39.788	8	.000
Linear-by-Linear Association	20.926	1	.000
N of Valid Cases	50		



Measure 18. Appointing highly experience on site design engineers, decision makers for remote project.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.034[a]	6	.672
Likelihood Ratio	4.965	6	.548
Linear-by-Linear Association	2.446	1	.118
N of Valid Cases	50		

Measure 19. Obtain the approval for barrow pits, quarries and material transportation by the Client before commence the work by the Contractor

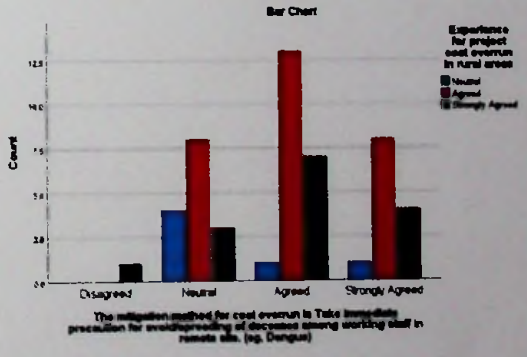
Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	7.378[a]	6	.287
Likelihood Ratio	9.383	6	.153
Linear-by-Linear Association	2.134	1	.144
N of Valid Cases	50		

Measure 20. Take immediate precaution for avoid/spreading of deceases among working staff in remote site. (eg. Dengue)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.860[a]	6	.004
Likelihood Ratio	6.602	6	.359
Linear-by-Linear Association	.590	1	.442
N of Valid Cases	50		



Measure 21. Provide and distribute meals and beverages for workers in the site during the working hours.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.856	6	.334
Likelihood Ratio	8.485	6	.205
Linear-by-Linear Association	3.592	1	.058
N of Valid Cases	50		

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