Cause and Effect of Quality Evaluation of Constructed School Buildings – By Susmita Khatri and Sewak Bhatta

Email: susmita.khatri7@gmail.com

Abstract

"Education is one thing no one can take away from you." —Elin Nordegren. Such a wonderful precious assets are produced inside the school building. Thus the quality of school building is a causal infrastructure for future dimension of country. Thus the study is about the quality of school building. This study on quality evaluation of constructed school buildings, a case study of public schools of Siyari rural municipality of Rupandehi district, was be conducted during the period from July 2022 to June 2023. From the methodological perspective: Field observation, in-depth interview, focus group discussion and questionnaire survey were the tools for the field investigation. The proposed study was focused on finding out the quality of construction works within the territory of Siyari Rural Municipality of Nepal. The study finds out the level of the quality of the works. Furthermore, the study suggests the appropriate techniques for maintaining the quality of construction works.

Keywords: Quality of construction works, School building, Sustainability,

Introduction

Infrastructure is a public asset. Government policy has an important role to influence the effects of the project on economic development and social needs of communities. The term infrastructure covers a range of services from utilities such as power, telecommunications, water supply, sanitation and sewerage, solid waste collection and disposal, and piped gas: to public works such as road, dam and canal works, railways, building, irrigation system, urban transport, port and waterways and airports (World-Bank, 1994). However, it is about the school building as a crucial infrastructure.

"Education's purpose is to replace an empty mind with an open one." —Malcolm Forbes. Thus education is the backbone of development. This definition of development not only includes economic development but also social and cultural betterment of society. This is explained by the aims of education. By educating a society, the people gain knowledge and learn methods by which

they can help build infrastructures and set up economically self-reliant communities. School is an important place to help students grow in their various capabilities. They spend approximately 30% of their daily lives in schools for their educational activities. Since most of their activities are performed indoors, indoor environmental attributes, such as light, heat, air, and sound should be maintained as required (Shrestha, Rijal, Kayo, & Shukuya, 2021). In recent years there has been an increasing interest from governmental authorities and Non-Governmental Organizations (NGOs) in the seismic safety enhancement of school buildings in developing countries. Schools represent a reference point for local communities and can be used as primary facilities for emergency and recovery activities after an earthquake. Focusing on the Nepal case, the last 2015 seismic events have shown that Nepalese school buildings are characterized by a high level of vulnerability. According to post-disaster surveys, more than the 20 percent of the country's classrooms experienced damage or collapse during the earthquake. Nepal's building stock is mainly constituted by non-engineered constructions realized without seismic detailing and material quality controls (Giordano, De Luca, Sextos, & Maskey, 2019). Education System of Nepal consists of Primary level to University education. There are 35,222 Public and Private Schools and more than 1,400 Colleges all over Nepal as of 2016. According to the recent study conducted by the Ministry of Education, the composition of school going population is about 22%.

The Ministry of Education (MOE) and the Department of Education (DOE) is overall responsible for planning and development of implementation strategies of school infrastructure. DOE is expending billions of rupees per year for a large numbers of educational infrastructure constructions and maintenance of classrooms, toilets, water supply etc. under assistance of several donor agencies like ADB, World Bank, FINIDA, NORAD, DANIDA, JICA, EU, DFID etc. Similarly, a few INGO/NGOs like UNICEF, Save the children etc. have been working in the field of child friendly school construction and other physical facilities development (Shrestha, Rijal, Kayo, & Shukuya, 2021).

Objectives

The study aims to identify the existing problems and issues related to the quality of construction works in school buildings and to provide recommendations to improve the quality of construction works in the future.

The problem faced by the quality of construction works on school buildings in Siyari Rural Municipality of Rupandehi District in Nepal is likely to be the substandard quality of the construction work, which could lead to safety hazards for the students and teachers using these buildings. The study focuses on quality issues in public building projects and current practices in the school building project.

Literature review

School-level education now falls under the jurisdiction of municipal government, and the involvement of local government and local communities can be expected to deliver better results, as the beneficiaries of education play a central role in school management. In a diverse society like Nepal, local government autonomy in managing local activities such as school education can promote more effective governance according to local needs and preferences (Neupane, 2020)

Education in Nepal has taken a considerable leap on its own. There are now 35,222 elementary and secondary schools and 10 universities with more than 1,400 colleges and campuses throughout Nepal (2016). Expanding educational opportunities is a priority of the government: its current 2016 School Sector Development Plan seeks to graduate Nepal "from the status of least developed country by 2022 through strengthening access and quality of education"**.**

Educational building means a building exclusively used for a school or college, recognized by the appropriate Board or University, or any other competent authority involving assembly for instruction, education or recreation incidental to educational use, and including a building for such other users' incidental thereto such as a library or a research institution. A school is actually a home away from home for any student. During student life most of the waking hours of any student are spent at school, learning anything and everything in various dimensions from books, teachers, peers and even school environs (Simkhada, 2023).

A well-designed, spacious, and functional building is what every school should be. Classrooms should be large and well-ventilated, with plenty of natural light and breeze. A school should be built with various amenities in mind, such as well-equipped labs, halls, open fields, games equipment, dormitories, and sanitation. Apart from all of this, the school's architectural design is also very important. Buildings and classrooms should be designed to allow students to freely enter and exit the classroom. Personal vehicles such as scooters and bicycles should be transported and parked in designated areas (Rodrigues, Furtado, Vila-Pouca, Varum, & Barbosa, 2018)**.**

The construction project is affected with many participants and the stockholders which are engaged in the projects. There is interaction among such stakeholders (client, consultant and contractor) because of different causes. The key factors which affect are team members and participants in the construction of public project. All the project members are also guided thorough other factors, they are as background training, skills, and the willpower/desire of the members but still the threaten of construction remains challenging, especially in the construction of industry, such cases are found abundantly (World-Bank, 1994)**.**

Concept of quality of materials

Quality control is essential part of all kinds of construction as well as manufactures of any product throughout the world. Quality control assures the quality of any product or construction works anticipated by designer and is ultimately capable to give satisfactory economic return directly or indirectly. The cost incurred by exercising quality control would just be 1.5 to 2 percent of the total construction cost whereas the direct and indirect economic return could be 5 to 10 percentage of total construction cost (Neupane, 2020)**.**

Factors affecting the construction quality

The construction industry like any other production industry is faced with challenges that affect the performance and output of the endeavor. Identifying potential critical factors that affect the quality performance of small scale contractors before the commencement of projects will ensure client satisfaction at the completion of project. Identifying the potential critical factors will however not eliminate the problem of quality but to a large extent help project team to avoid such negative factors and strictly adhere to project specifications to reduce errors which will call for re-work by both consultants and contractor**s**. Every contractor and construction firm has intention to offer the best quality services, but there may arise different obstacles that can pop up along the way to interrupt these plans (Simkhada, 2023).

Nature of Construction Project

Construction professionals play the vital role in quality control. They are as project managers, engineers, architects, and quantity surveyors and they are the core participants of each construction project. They are concentrated as a project team from different projects. And each project team creates a societal environment. They co-operate, collaborate and commence the work to close out.

They are intermingled each other as the tapestry of clothes. They are garlanded. They have some vested interested keeping their various goals and needs (Shrestha, Rijal, Kayo, & Shukuya, 2021).

Quality Control Tools

There are many approaches to quality control. The type we use depends on your specific product and should be determined before any quality control inspection begins (World-Bank, 1994). There are seven primary quality control tools which include:

Quality control: - "Quality control is the part of quality management that ensures products and service comply with requirements. It is a work method that facilitates the measurement of the quality characteristics of a unit, compares them with the established standards, and analyses the differences between the results obtained and the desired results to make decisions which will correct any differences."

Quality Assurance: "The planned and systematic activities implemented in a quality system so that quality requirements for a product or service will be fulfilled." Quality assurance isn't about the end product itself, but it is process oriented but QC looks into the final product and determines whether it has been built or implemented correctly.

Construction Supervision Guideline for school reconstruction

In any civil construction works, close monitoring and supervision thereof are important tasks for all engineers and sub-engineers assigned to the project for assuming such duties and responsibilities in order to assure required quality and to complete the project within the time period specified in the contract, among many other objectives to be accomplished. In addition, those engineers and sub-engineers are often having to take other duties and responsibilities not only physical supervision of the construction works but also other aspects and/or issues relevant to health and safety control, environment control, document control including reporting, and cost control including reviewing and recommending contractor's progress payment, and so on as well as coordination with and among all stakeholders of the project (Badal 2020). The guidelines described the quality control mechanism under the following different headings Engineer's Supervisory Responsibilities (Review of Contract Documents, Supervision of the Construction Works, Supervising Post Construction Works)

Quality Control Plan (QCP)

The Engineer shall review and comment on the Quality Control Plan (QCP) to be submitted by the Contractor to the Engineer for his approval which shall provide detailed description of procedures, instructions, and reports used to ensure compliance with the Contract Documents. The QCP must be prepared by paying attention to the following concerns, but not limited to, and submitted together with the quality control organization chart to the Engineer for his approval: Quality control for materials, Quality control for workmanship, and Tests and inspections (World-Bank, 1994)

Quality Control for Materials

Materials used for the permanent works of the Works shall be strictly conform to the quality and kind specified and/or required in the technical specifications and contract drawings of the Contract Documents. In addition, items and tolerances, and methods, frequencies, etc., for required inspections of each work item covered by the technical specification of the Contract Documents

Quality Control for Workmanship

Workmanship expected for the permanent works of the Works shall be strictly conform to the quality with allowable tolerances specified and/or required in the technical specifications and contract drawings of the Contract Documents, as well as relevant codes and standards commonly accepted in Nepal (Neupane, 2020).

Methodology

It is a Case Study of Public Schools of Siyari Rural Munucipality of Rupandehi District.

Study Area

Siyari Rural Municipality is located in Rupandehi District, ProvinceNo. 5 in western Nepal. The total current population of the municipality is 38466, in which the male is 48.22 %(18549) and the female is 51.77 %(19917) of its total populations. There are total 7 no of ward. The office is located at Siyari, Rupandehi else all the ward offices are established at its own ward. This Municipality lies nearly in the center of province no. 5 connected to West Highway. The area that Siyari Rural Municipality belongs is 66.17Sq km. There are total of 53 educational infrastructures

(School) in Siyari Rural Municipality where there is 39 public school and 14 private schools. The area of the research here is about the quality of public educational infrastructure.

Data Analysis

Data analysis was carried out using the Relative Importance Index (RII). The RII is used to evaluate the ratings of the respondents. In this research, Likert 5-point scale has been used to determine the relative importance index (RII) for the factors indicating the status of road, causes and effects of problematic road, solutions for better construction and preparedness for better construction of rural roads. The value of RII is in the range of 0 to 1 (0 not inclusive). The higher the value of RII, the more important the ttributes/variables of the respected topic and ranked at top. Ranking of the attributes/variables are arranged in ascending order.

Items	Strongly Disagree	Disagree	Neutral	Agree	Strongly Ageree
SCALE	1	2	3	4	5

(Source: Desk Study, 2022)

The following formula is used to derive RII (Relative importance index) for each factor: -

$$\text{RII} = \frac{\sum W}{AN} = \frac{5n5 + 4n4 + 3n3 + 2n2 + 1n1}{5N}$$

Equation 1: Shows the calculation of RII value using Likert scale.

Where,

W is the weighting given to each factor by the respondent, ranging from 1 to 5;

n5 number of respondents selecting a total strongly agree or always;

n4 number of respondents selecting agree or often;

n3 number of respondents selecting neutral or sometimes;

n2 number of respondents selecting disagree or rarely;

n1 number of respondents selecting total strongly disagree or never;

And N the total number of respondents.

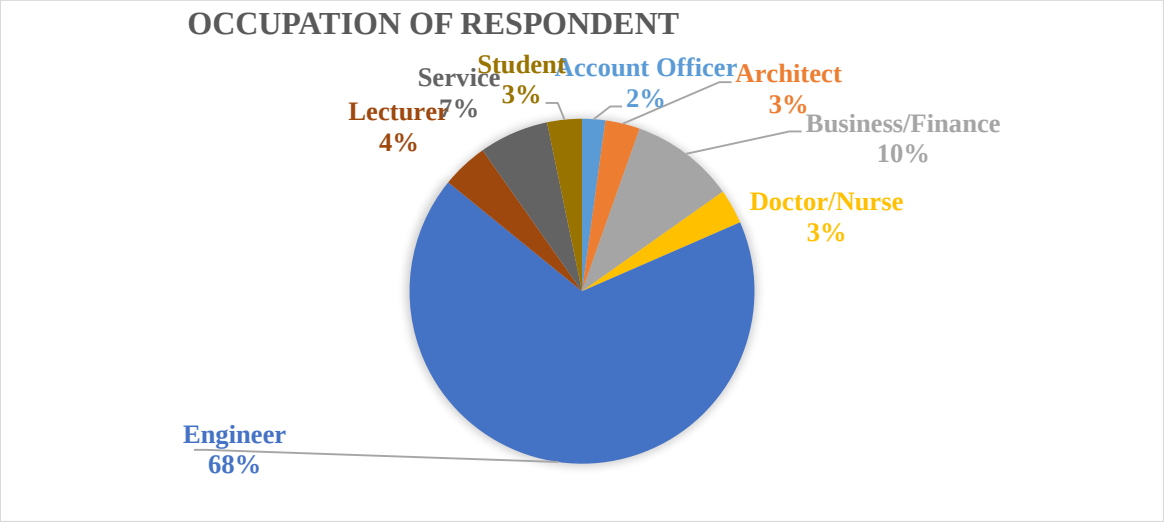
Method of Data Collection

Field observation, in-depth interview, focus group discussion, and questionnaire are the major tools used during field investigation of this study. The study was carried out during the period from August 2022 to June 2023.

Results and discussion

A. Classification of respondents based on profession

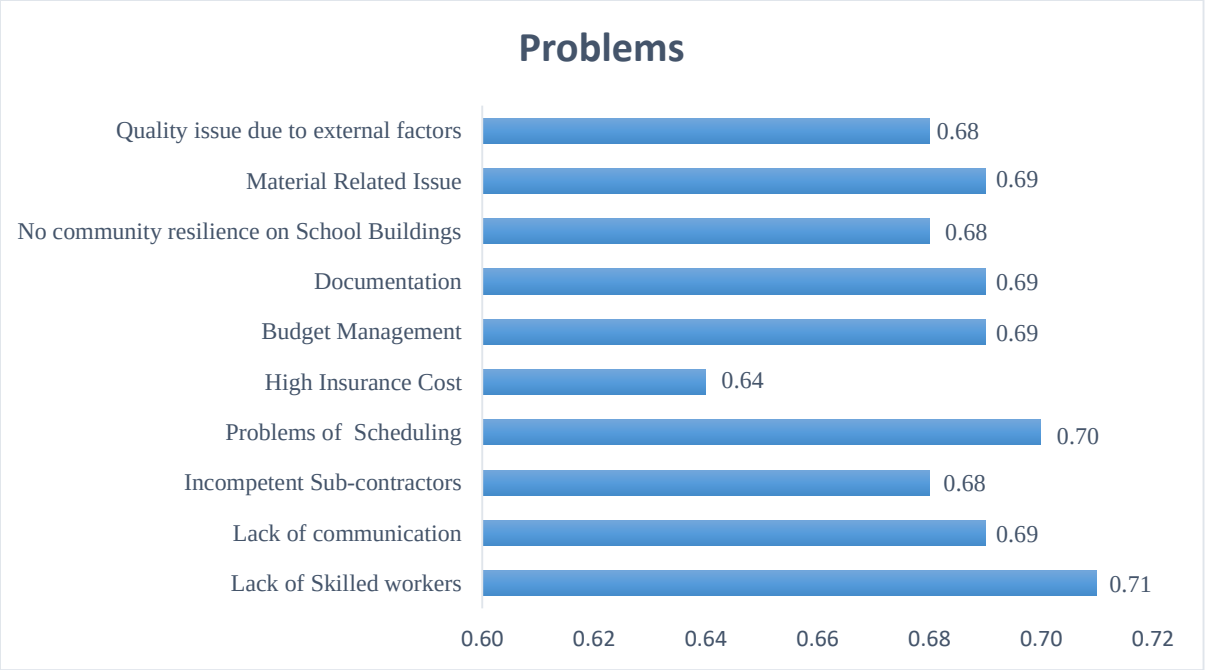
The survey was done with the respondent of different occupation. The survey indicates that 59.62% of the respondents are Engineer whereas 8.65% of the respondents are from Business/Finance sector. Similarly, 5.77% of Service, 3.85% of Lecturer, 2.88% of Doctor/Nurse and Architect and 1.92% of Accountant. The pie chart of Occupation status of the respondent is shown in Figure.



(Field survey, 2022)

B. Major problems of building construction

The weightage distribution of the problems faced during construction of School Buildings is shown. Respondents agreed with the 'Lack of Skilled Workers' is at top position. Similarly, data shows that 'Problems of Scheduling 'is at second most problem, and 'Material Related Issue', 'Documentation', Budget Management', 'Lack of Communication' is the third most problem whereas 'No Community Resilience on School Buildings', 'Quality issue due to external factors' and 'Unreliable subcontractor' are the fourth problems and 'High Insurance Cost' is at least which is shown



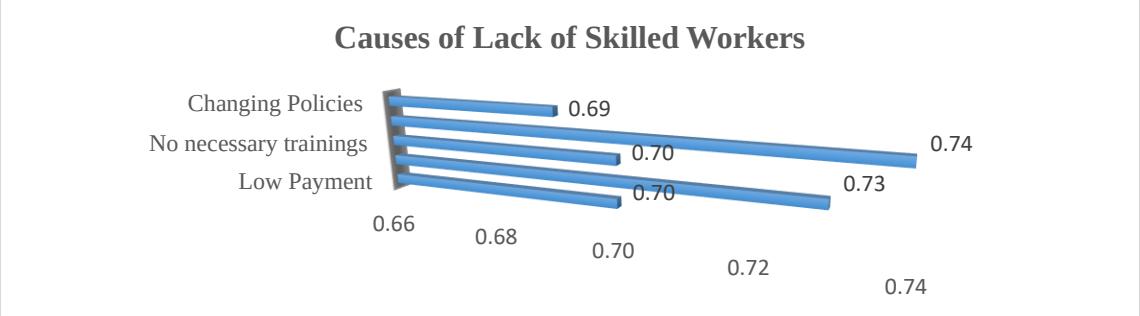
(Field survey, 2022)

C. Causes and Effects

1. Lack of skilled workers

Causes

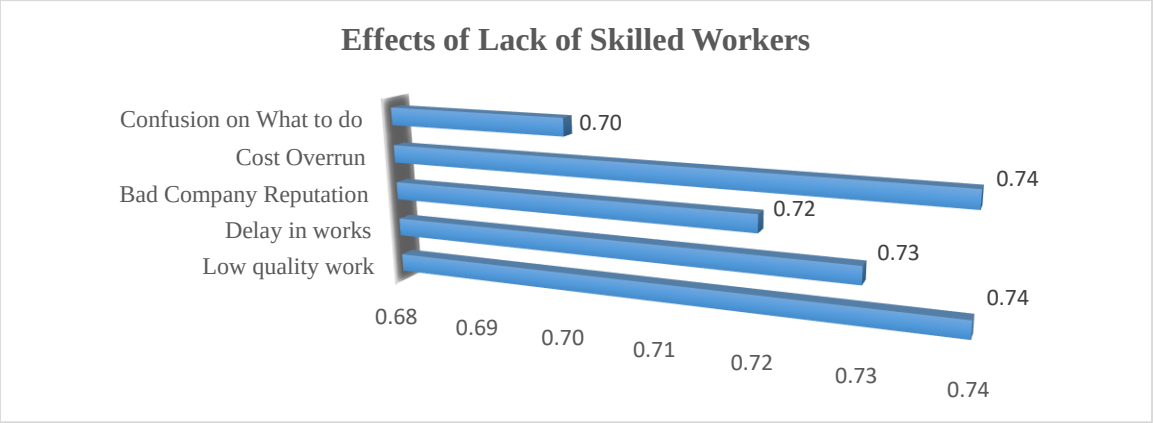
Respondents agreed with the 'No job Security' is the main cause. Similarly, data shows that 'Attraction to Foreign employment' is the second most cause and 'No necessary training' and 'Low payment' are the third causes whereas 'Changing policies' has least weightage. Figure describes about the weightage for the causes of Lack of Skilled Workers.



(Field survey, 2022)

Effects

Respondents agreed with the 'Cost Overrun' and 'Low Quality Work' are the main effect. Similarly, data shows that 'Delay in work, is the second most effect are the second most effect. 'Bad Company Reputation' is the third most effect and 'Confusion on what to do' has least RII value. Figure describes about the weightage for the effects of Lack of Skilled Workers.

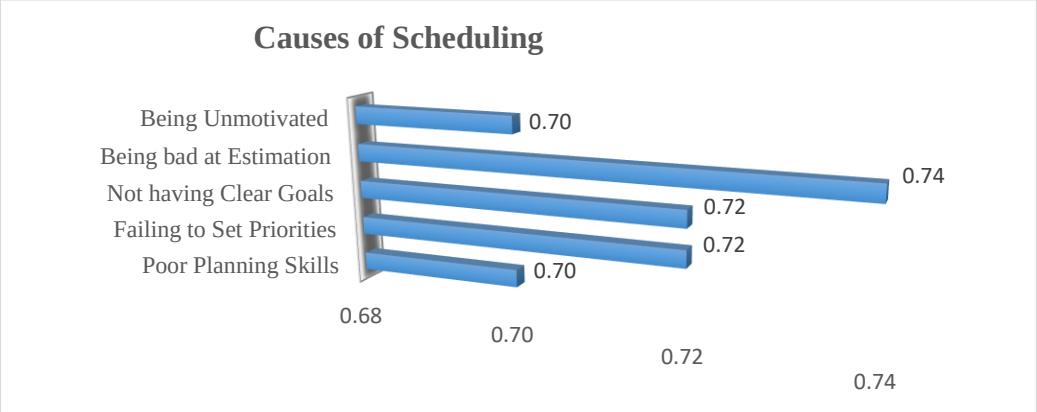


(Field survey, 2022)

2. Scheduling

Causes

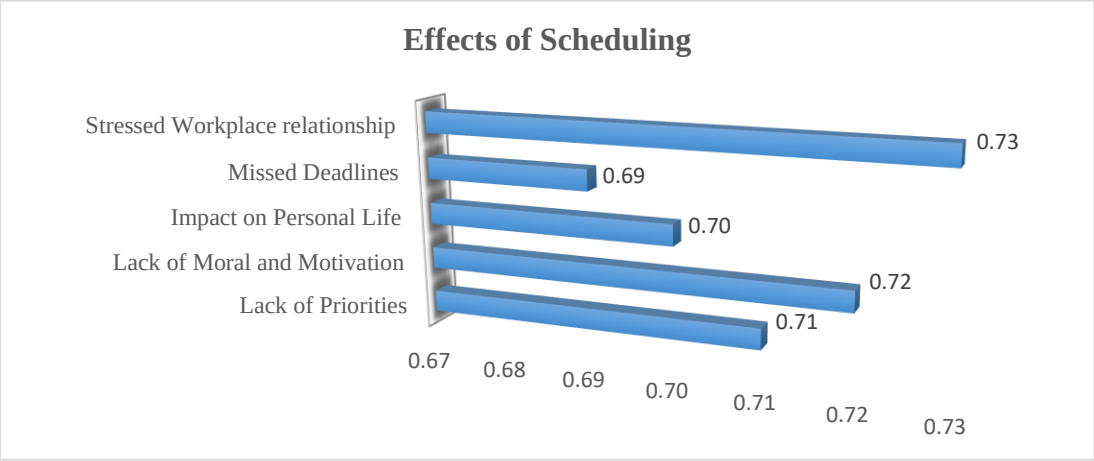
Respondents agreed with the 'Stressed workplace' is the main effect. Similarly, data shows that 'Not having clear goals" and "Failling to set priority", are the second most effect are the second most effect. 'Being unmotivated' and "Poor planning skills"are the third most effect. Figure describes about the weightage for the effects of Lack of Skilled Workers.



(Field survey, 2022)

Effects

Respondents agreed with the 'Stressed workplace' is the main effect. Similarly, data shows that 'Not having clear goals" and "Failing to set priority", are the second most effect are the second most effect. 'Being unmotivated' and "Poor planning skills "are the third most effect. Figure describes about the weightage for the effects of scheduling.

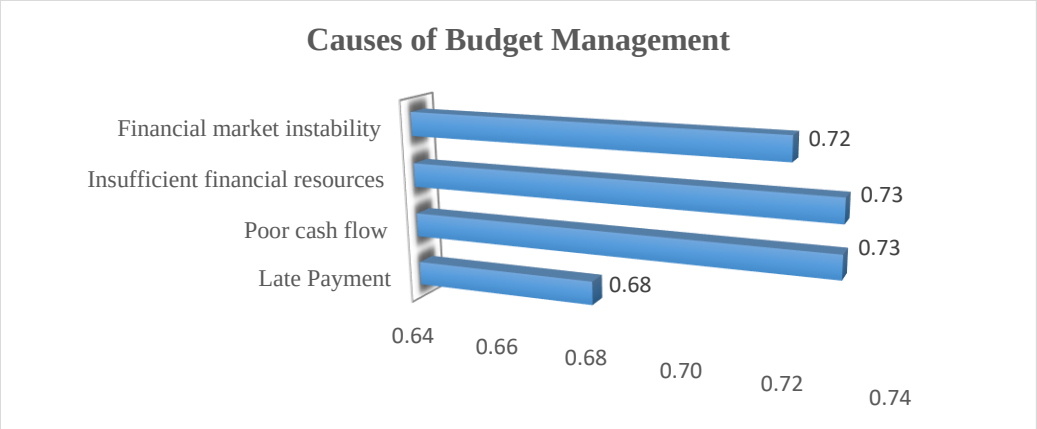


(Field survey, 2022)

3. Budget Management

Causes

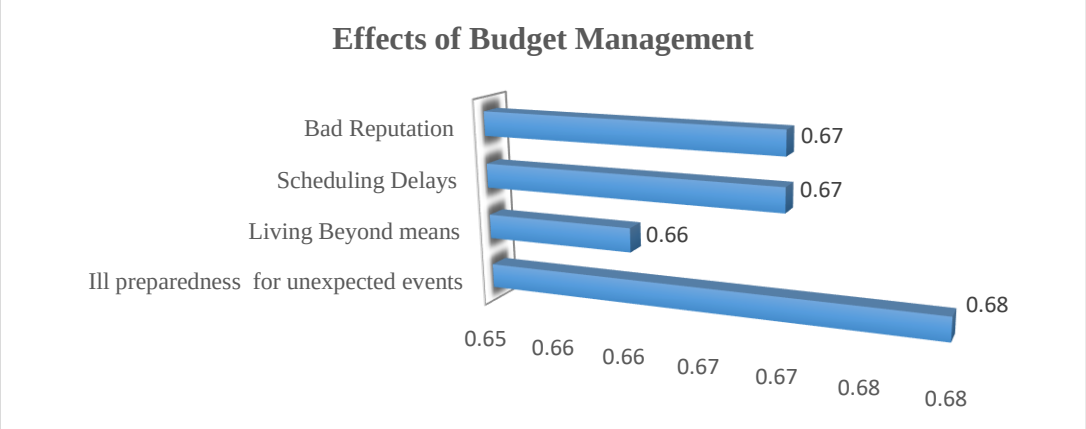
Respondents agreed with the 'Insufficient Financial resources', 'Poor Cash flow' as the main cause. Similarly, data shows that 'Financial market instability', is the second most cause and 'Late Payment' has least significance.



(Field survey, 2022)

Effects

Respondents agreed with the 'Rll Events for Unexpected events' is the main effect with Relative Importance Index (RII) 0.68. Similarly, data shows that 'Bad reputation', 'Scheduling delays' is the second most effect and 'Living Beyond means' has least RII value. Figure describes about the weightage for the effects of Budget Management.



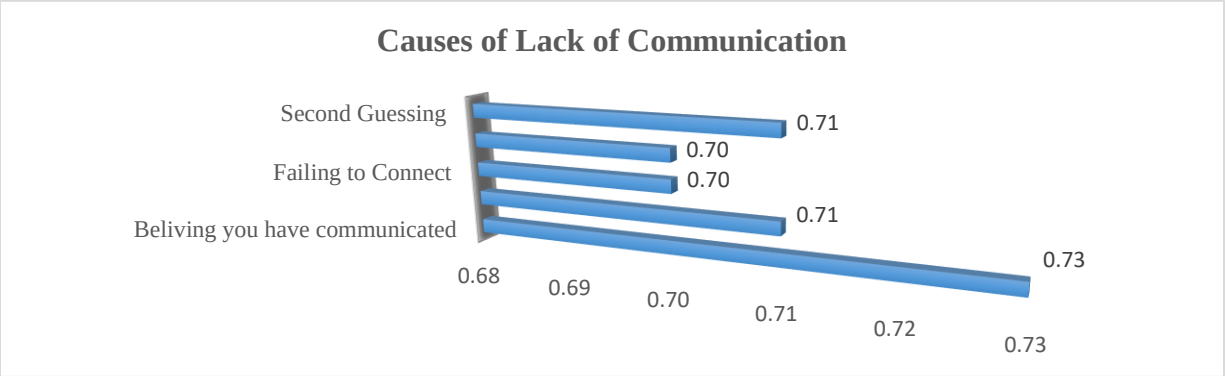
(Field survey, 2022)

4. Lack of Communication

Causes

Respondents agreed with the 'Believing you have communicated' is the main cause. Similarly, data shows that 'Second Guessing' and 'Talking without listening' is the second most and 'Trying

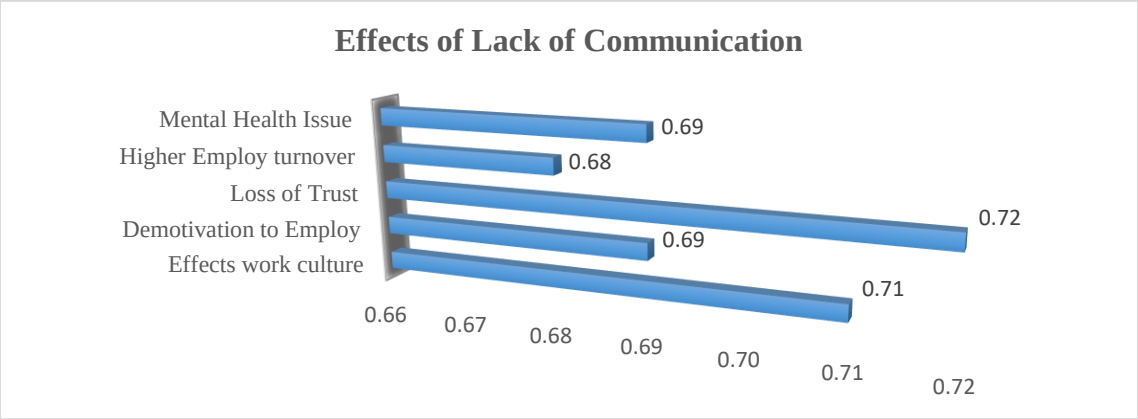
to Convince' and 'Failing to Connect' has least RII value. Figure describes about the weightage for the causes of Lack of Communication.



(Field survey, 2022)

Effects

Respondents agreed with the 'Loss of Trust' is the main effect. Similarly, data shows that 'Mental Health Issue' 'Demotivation to Employ', is the second most effect and 'Higher Employ Turn over' has least RII value. Figure describes about the weightage for the effects of Lack of Communication.



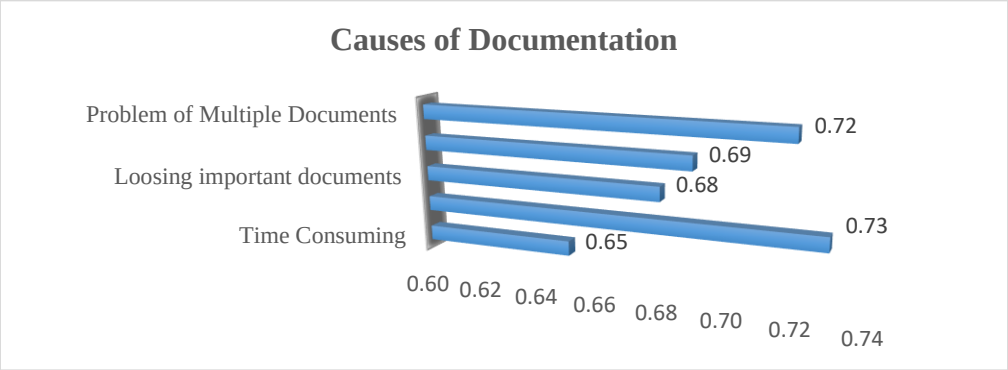
(Field survey, 2022)

5. Documentation

Causes

Respondents agreed with the 'Lack of Understanding of specific information' is the main cause. Similarly, data shows that 'Problems of multiple documents', is the second most cause, 'Editing Challenges' is the third most causes, 'Loosing Important Documents' is the fourth most causes

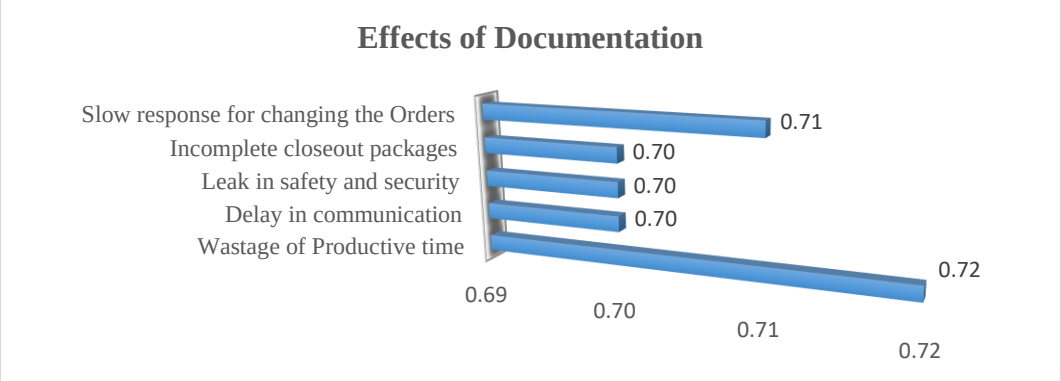
and 'Time consuming' has least RII value. Figure describes about the weightage for the cause of Documentation.



(Field survey, 2022)

Effects

Respondents agreed with the 'Wastage of Productive time' is the main effect. Similarly, data shows that 'Slow response for changing the orders' is the second most effect and 'Incomplete closeout packages', 'leak in safety and security', and 'Delay in Communication' has least RII value. Figure 4.8 describes about the weightage for the effects of Documentation.

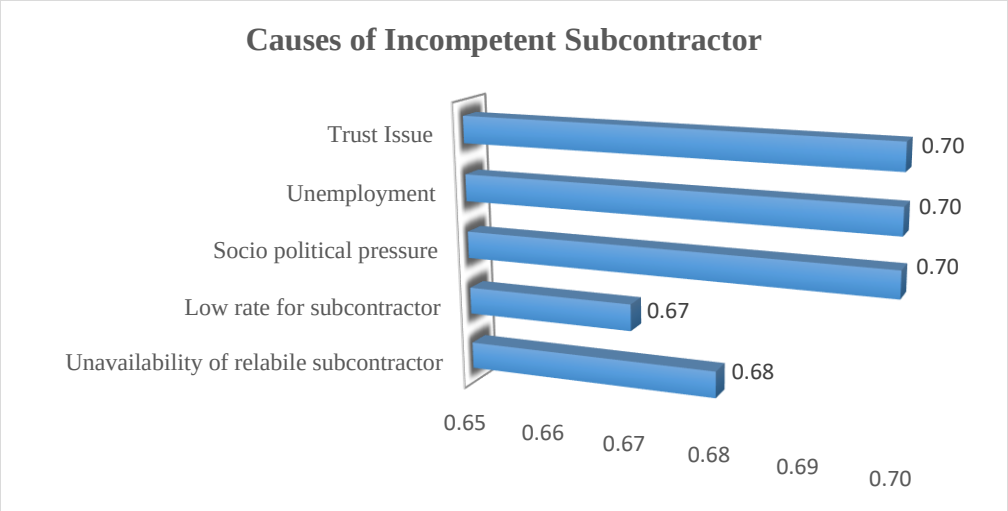


(Field survey, 2022)

6. Incompetent Subcontractor

Causes

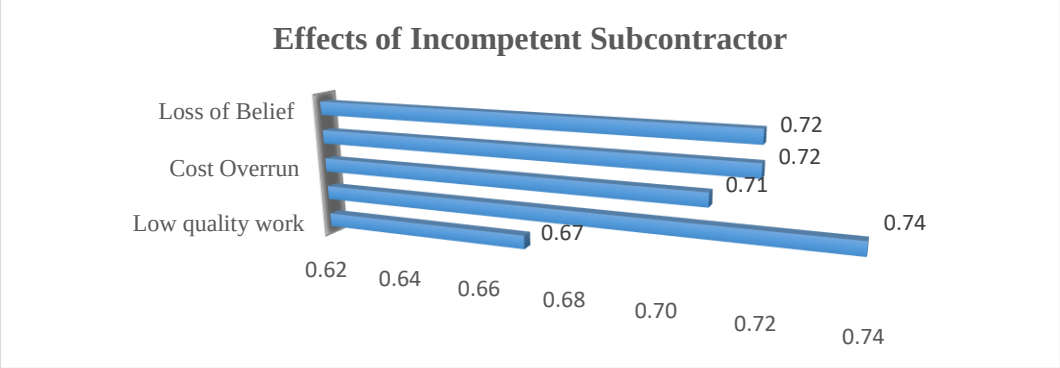
Respondents agreed with the 'Trust Issue', 'Unemployment', 'Socio Political Pressure' are the main cause. Similarly, data shows that 'Unavailability of reliable subcontractor' is the second most cause and 'Low rate for Subcontractor' has least RII value. Figure describes about the weightage for the causes of Incompetent Subcontractor.



(Field survey, 2022)

Effects

Respondents agreed with the 'Project Delay' is the main effect. Similarly, data shows that 'Loss of Belief' 'Dispute between client and contractor', is the second most effect and 'Cost Overrun' is the third most effect and "Low Quality work' has least RII value. Figure describes about the weightage for the effects of Incompetent subcontractor.

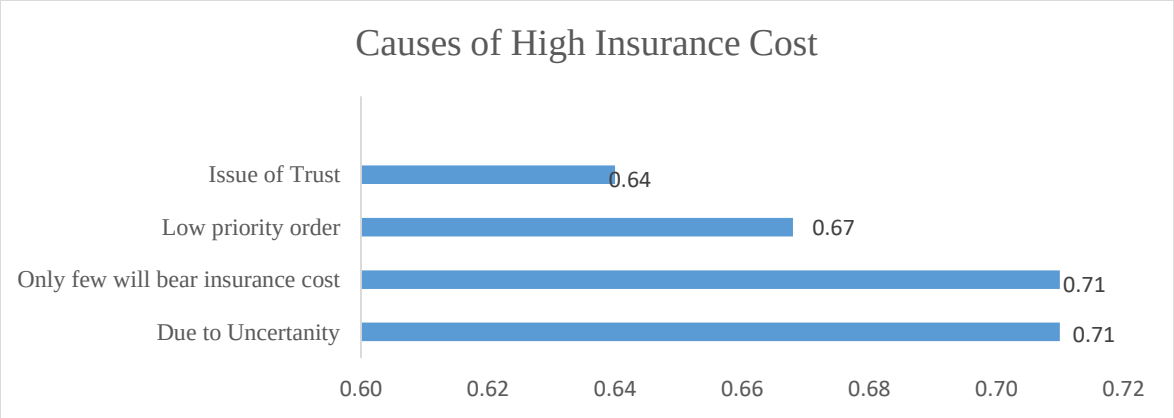


(Field survey, 2022)

7. High Insurance Cost

Causes

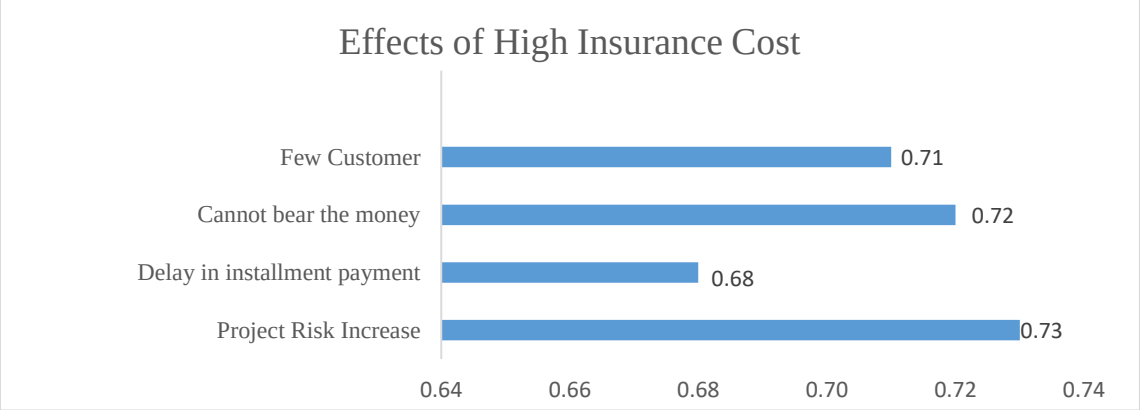
Respondents agreed with the 'Due to uncertainty', 'Only few will bear insurance cost' is the main cause. Similarly, data shows that 'Insurance is not compulsory', is the second most cause and 'Issue of Trust' has least RII value. Figure describes about the weightage for the cause of High Insurance Cost.



(Field survey, 2022)

Effects

Respondents agreed with the 'Risk Increase' is the main effect. Similarly, data shows that 'Fear' is the second most effect and 'invites Accidents' is the third most effect, 'cost should be bearded by owner' has least RII value. Figure describes about the weightage for the effects of High Insurance Cost.



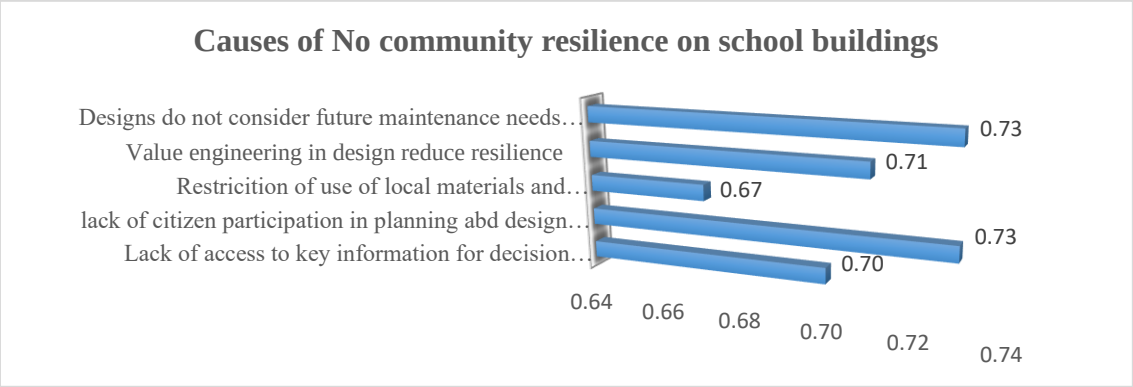
(Field survey, 2022)

8. No Community Resilience on School Buildings

Causes

Respondents agreed with the 'Design do not consider future maintenance needs and associated cost', 'Lack of Citizen participation in planning and designing process' is the main cause. Similarly, data shows that 'value engineering in design reduce resilience', is the second most cause, 'Lack of access to key information for decision making (i.e risk map)' is the third most causes and 'Restriction of use of local materials and vernacular construction methods in rural

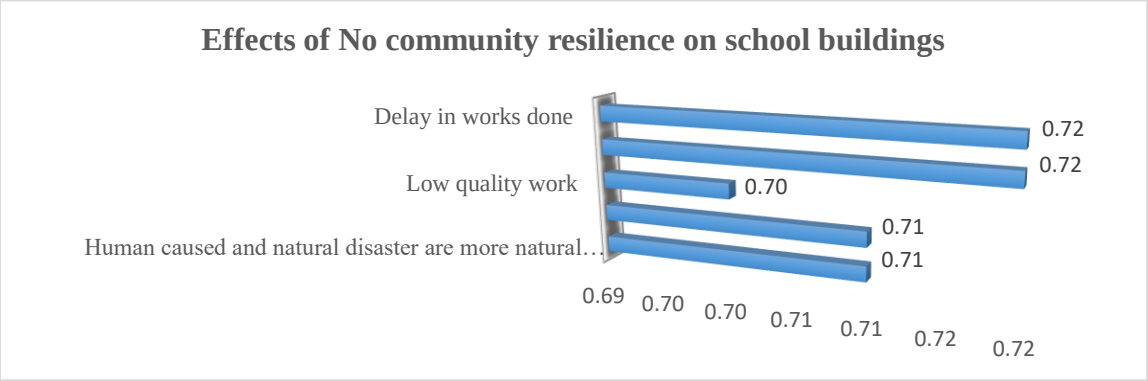
construction' has least RII value. Figure describes about the causes of no community resilience on school building.



(Field survey, 2022)

Effects

Respondents agreed with the 'delay in work done', 'Cost overrun' is the main effect. Similarly, data shows that 'Dispute are more natural and costly', 'Human caused and natural disaster are more natural and costly' is the second most effect and 'Low Quality work' has least RII value. Figure describes about the weightage for the effects of no community resilience on school buildings.



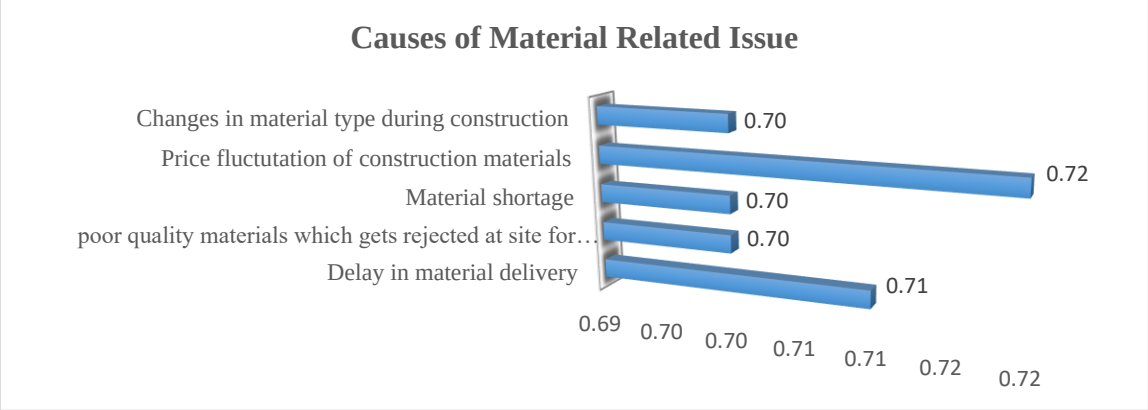
(Field survey, 2022)

9. Material Related Issue

Causes

Respondents agreed with the 'Price fluctuation of construction materials' is the main cause. Similarly, data shows that 'Delay in material delivery', is the second most cause, 'Changes is

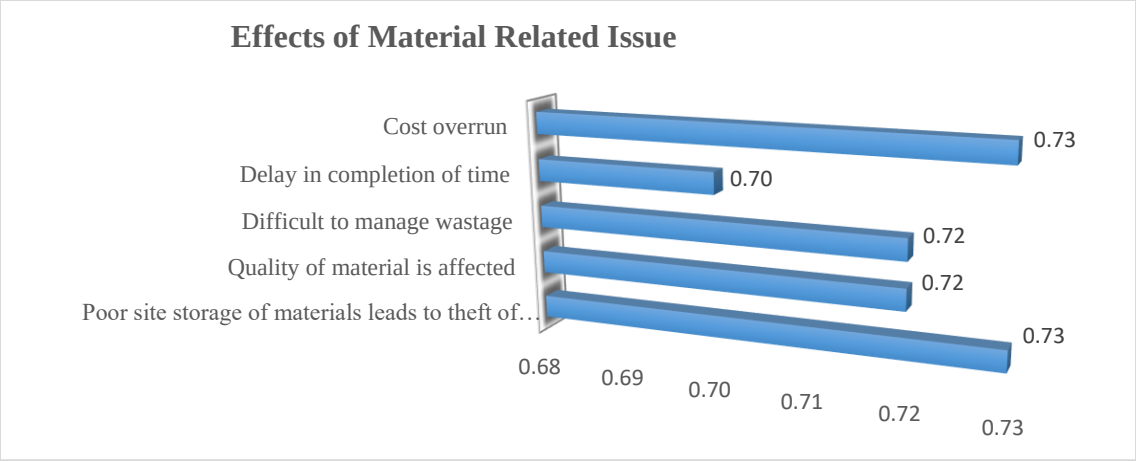
material type during construction', 'Material Shortage', and 'Poor quality materials which gets rejected at site for construction' has least RII value. Figure describes about the causes of Material related issue.



(Field survey, 2022)

Effects

Respondents agreed with the 'Poor site storage of materials leads to theft of materials, resulting in low profitability', 'Cost overrun' is the main effect. Similarly, data shows that 'Difficult to manage wastage', 'Quality of material is affected' is the second most effect and 'Delay in completion time' has least RII value. Figure describes about the weightage for the effects of material related issue.



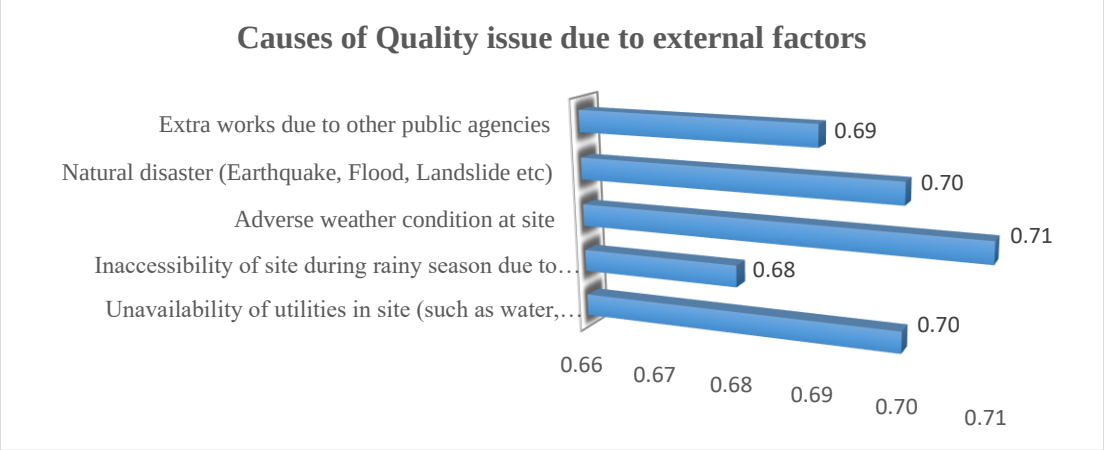
(Field survey, 2022)

10. Quality Issue due to external Factors

Causes

Respondents agreed with the 'Adverse weather condition at site' is the main cause. Similarly, data shows that 'Natural disaster (Earthquake, Flood, Landslide)', 'Unavailability of utilities in site

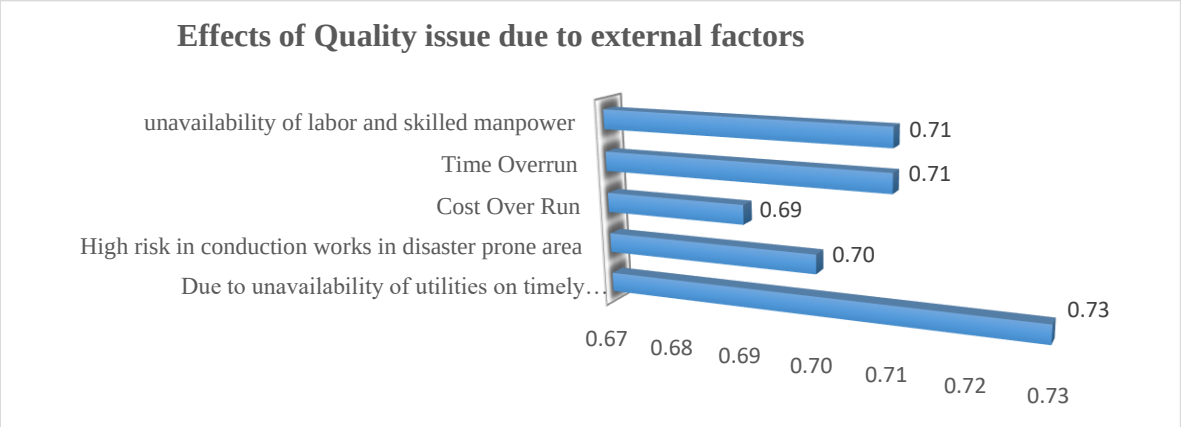
such as water, electricity, telephone etc.' is the second most cause, 'Extra work due to other public agencies' is the third most cause, 'Inaccessibility of site during rainy season due to flood landslide' has least RII value. Figure describes about the causes of Quality issue due to external factors.



(Field survey, 2022)

Effects

Respondents agreed with the 'Unavailability of utilities on timely completion of work' is the main effect. Similarly, data shows that 'Unavailability of labor and skilled manpower', 'Time Overrun' is the second most effect, 'High risk in conduction works in disaster prone area' is the third most effect' and 'Cost Overrun' has least RII value. Figure describes about the weightage for the effects of Quality issue due to external factors.

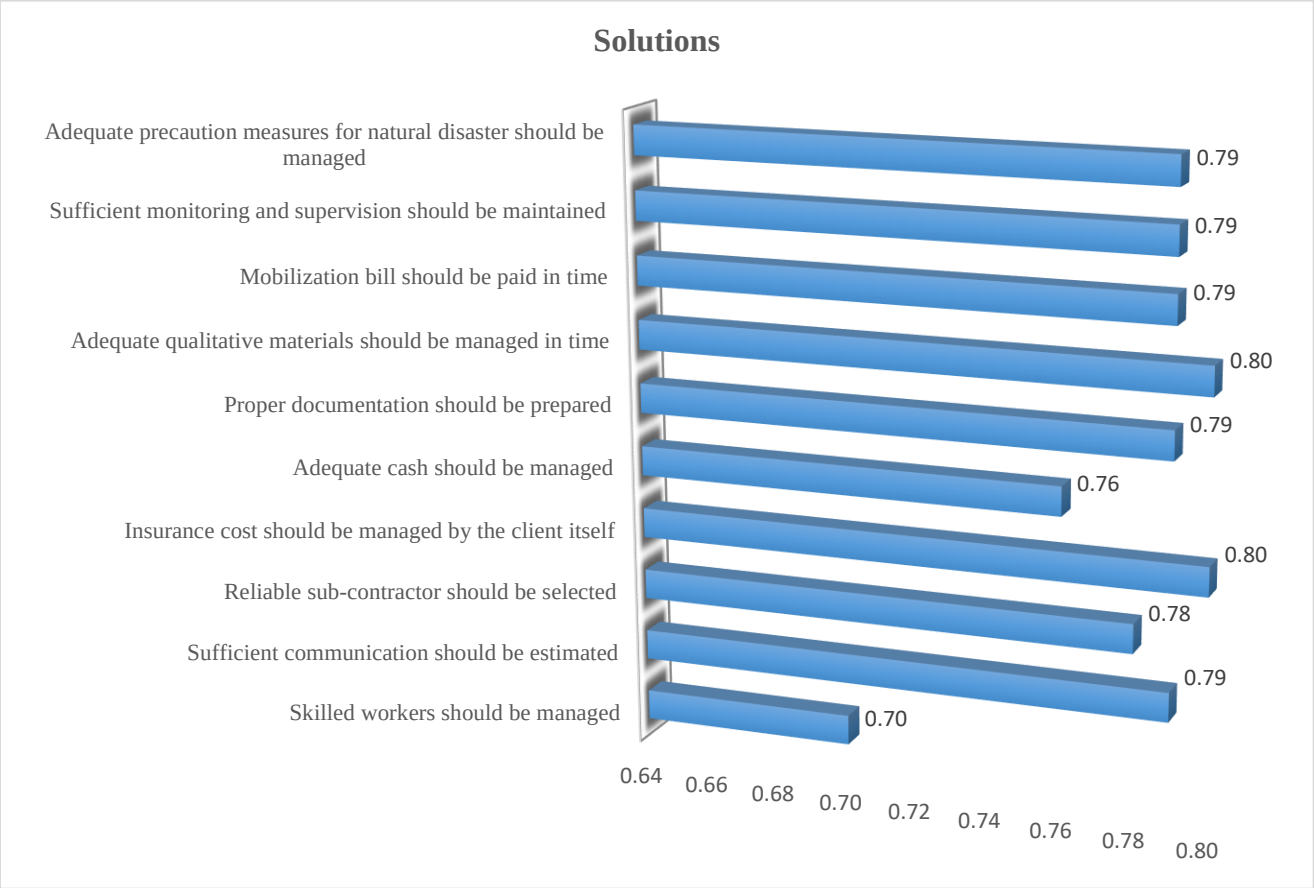


(Field survey, 2022)

D. Solutions

The given figure below describes for the ranking of 'Solutions' to reduce the effect of those problems occurred during the construction of School Buildings. Majority of the respondents agreed

with the 'Adequate qualitative materials should be managed in time' and 'insurance cost should be managed by client itself' is most important solution. Similarly, it shows that 'Sufficient communication should be estimated' and 'Proper documentation should be prepared', 'Mobilization bill should be paid in time', 'Sufficient monitoring and supervision should be maintained', 'Adequate precaution measures for natural disaster should be managed' are the second most important solution. Likewise, 'Reliable sub-contractor should be selected' is another third important solution. Respondents agreed to the solutions of problems during construction of school buildings as 'Adequate cash should be managed' has fourth most solution. 'Skilled workers should be managed' has least ranking with Least Agree.



(Field survey, 2022)

Conclusion

Compromising on the school building is compromising the quality of education. Compromising the quality of education is the compromise with the future of country. The adequate qualitative materials should be managed in time' and 'insurance cost should be managed by client itself' is

most important solution. Similarly, ‘Sufficient communication management should be maintained and Proper documentation should be prepared. Similarly, the Mobilization bill should be paid in time. Sufficient monitoring and supervision should be maintained. Adequate precaution measures for natural disaster should be managed. Likewise, Reliable sub-contractor should be selected for the best solution.

References

Badal, Bharat Prasad. "Buddhists Herminutics: An Analysis of Dhammapada in Sustainable Development." *Research Nepal Journal of Development Studies (RNJDS)* 4.1 (2020): 27-43.

Giordano, N., De Luca, F., Sextos, A., & Maskey, P. N. (2019). Derivation of fragility curves for URM school buildings in Nepal. . *In 13th International Conference on Applications of Statistics and Probability in Civil Engineering (p. 301). Library of Seoul National University.*

Negev, Y., & Lavy, S. (2017). The Impact of Documentation on Project Success: A Study on Construction Projects. *Procedia Engineering*.

Neupane, P. (2020). Policy Framework for Education Development in Nepal. *International Education Studies, 13(1)*, 89-97.

Perumal, V., & Bakar, A. (2011). The needs for standardization of document towards an efficient communication in the construction industry. *Acta technica corviniensis-Bulletin of engineering, 4*(1), 23.

Rodrigues, H., Furtado, A., Vila-Pouca, N., Varum, H., & Barbosa, A. R. (2018). Seismic assessment of a school building in Nepal and analysis of retrofitting solutions. *International Journal of Civil Engineering, 16, ,* 1573-1589.

Shrestha, M., Rijal, H. B., Kayo, G., & Shukuya, M. (2021). A field investigation on adaptive thermal comfort in school buildings in the temperate climatic region of Nepal. *Building and Environment, 190*, 107523.

Simkhada, R. K. (2023). The education system in Nepal faces various challenges and issues. . *International journal of economic perspectives, 17(1)*, 183-188.

World-Bank. (1994). *Infrastructure Facilities.* New York: World Bank