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Research Paper

Using Communication as a Project Management Tool for Optimizing Performance of Capital Infrastructure Development

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ABSTRACT: *It is well-researched that a high number of inefficiencies and poor deliveries in project organization are traceable to ineffective communication strategy. Given communication to be the engine of any project group, fundamental problems associated with inadequate effective communication can clearly result in poor project performance in any construction work environment. The contributing factors to these identifiable problems are but notlimited to selective listening, excess information, poor communication channel et cetera. As a precursor to understand the variant effects of communication on construction management at risk (CMAR) projects, this study was conducted to investigate the relationship between effective communication and project performance, organization environment, and quality outcomes. Three hypotheses were created and tested using the Chi-Square test statistics with results showing significant relationships between tested parameters and project performance. Therefore, effective communication strategy is a performance enhancing tool in CM at Risk projects.*

KEYWORDS:*Communication, CMAR projects, performance, project delivery.*

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I. INTRODUCTION

The word "communication" has a rich and complex history. It first appeared in English language in the 14thcentury, taken from the Latin word "communicare" which means to impact, share, or make common defined communication as the transmission of information and meaning from one party to another using shared symbol[1].Effective communication is critical to any organizationssuccess and can help it in many ways. In the construction business,communication plays a role in project development, integrated design, construction management – virtually every facet ofits operations. Ensuring efficient and effectivecommunication across all levels of the construction business is essential in ensuring operational efficiency.

Constant communication between each level of the construction company ensures that all members understand what their role is. This minimizes the chances of misunderstanding and avoidable operational errors. Enforcing a system of a constant flow of communication applies to all levels of an organization structure which includes architects, engineers, contractors, superintendents, safety managers, project managers, and field workers themselves. Amongst these project staff, field workers are a key audience because they often serve as the conduit to other audiences, especially in a projectized environment. If field workers are kept informed and engaged, communicationwith other constituencies are likely to be strong. More than simply keeping field workers informed about the operationalroutines, communication should be a step-by-step process that involves the exchange of information between two or more parts at all organizational levels. Additionally, it should include behavioral patterns, including body language, and facial expressions, rather than the plain exchange of words. There are several other factors that affect project performance including management style, organizational culture, and social relationships, but the creation of effective communication channels is the most cost-effective way of enhancing project performance.

Project performance describes a company's ability to deliver products or services in the most cost-effective way possible, while maintaining quality[2]. Often, this performance is accomplished by operational efficiency which involves maximizing project resources, minimizing waste, including excess materials, defects,

and rework. Reducing idle time on any project can also help to increase its efficiency. Apparently, project teamsare generally quite a diverse group of people that are thrust together to deliver a tailored and unique benefit to an organization. This diversity provides a further communication challenge for the project management team. Successful communication in project management is about being there for everyone, being in touch with the real challenges of the project, understanding the real issues within the team who must deliver the project, as well as understanding the goals of the sponsors who the team delivers the project for. On one hand, it entails emotional intelligence by first considering the needs of the audience you are intending to communicate with, put yourself in their shoes and anticipate what they need to understand, and then provide that understanding only. Since it is a two-way process,the audience needs to be engaged throughout, to ensure that the key messages have been received and understood.

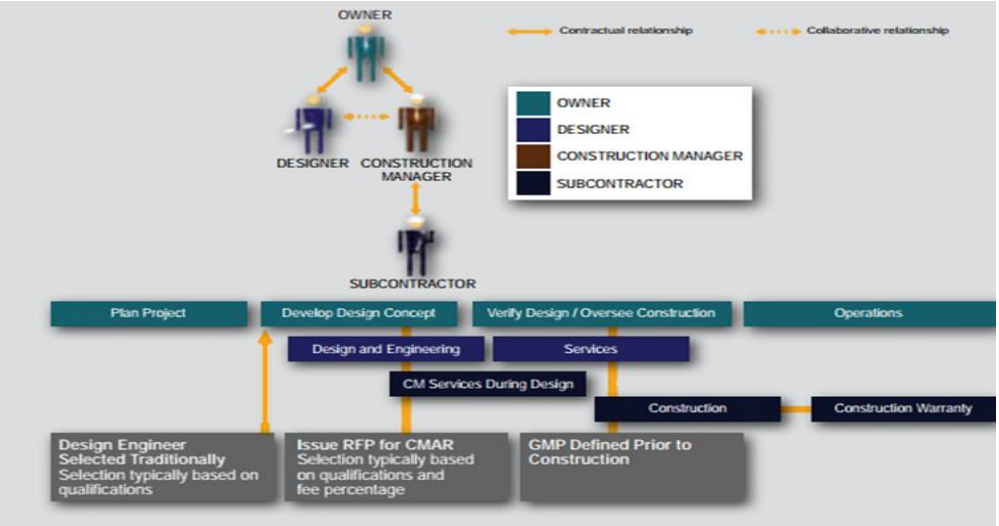

Figure 1:A Typical CMAR Project Model (source; https://www.infinityconstruction.com)

Research on communication and its impact in the construction industry is quite common, and there are numerous papersthat highlight these impacts. However, assessing the impacts of communication on a CMAR based project performance has not been exploredparticularly in this present clime where it is the most adopted project delivery method. Construction management at risk (CMAR) is an innovative approach to construction project delivery methods, useful in the completion of projects of various sizes and values[3]. The construction manager at risk (CMAR) addresses this challenge of overshooting the budget by introducing a ceiling called the guaranteed maximum price (GMP). Overruns beyond this ceiling fall outside the project owner's liability, barring change orders; this approach inevitably makes CMAR a highly risky contract method. In the light of the high risks involved,CRAA CONRAC as a CMAR project presents the perfect opportunity to assess this study because it had a multiplicity of players, all using different means of communication. Therefore, this paper will review how communication can be used as an effective tool for optimizing team performance on a CMAR project using CONRAC as a case study.

1.1 Objectives of the Study

The goal of the study is to determine and evaluate the strategies of enhancing CMAR project performance through effective communication. Specific objectives include:

i. To examine if effective communication affectsproject performance.
ii. To ascertain if the organization environment affects communication.
iii. To verify if communication difficulties affect quality outcomes on a CMAR project.

II. RESEARCH METHOD

The main strategies utilized in the project are case studies and a quantitative survey[4,5]. The case studies will rely on previous papers that focus on the impact of communication in the construction industry. Analysis of these documents will assist in providing a comparative analysis of different projects and how communication contributed to the overall completion.

Quantitative method of research was utilized because it was possible to use a questionnaire in the form of Post Implementation Survey[5]. While choosing a method for measuring the impact of communication might be an arduous task,the research team has determined some useful methods of measurement. Observations were a

tool utilized to inform the trade partner of defects on the project. The team reviewed the total number of observations on the project and noticed improvement in communication per decrease in number of observations.

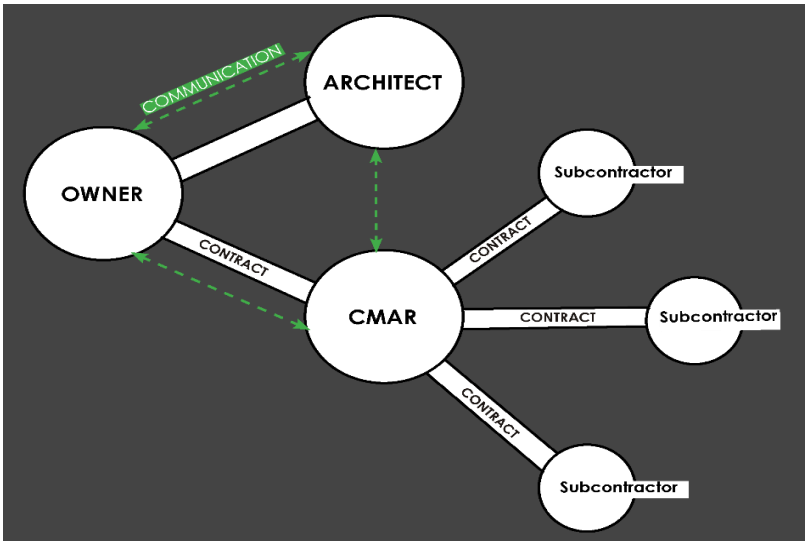

Figure 2: ConRAC Communication Channel (Source; Project Data)

III. DATA COLLECTION AND PRESENTATION

For data collection, use of a paper survey for onsite personnel and a digital survey for offsite personnelwas adopted. There were twenty-six companies onsite and knowing the team leaders are responsible for the communication process within their teams, two supervisors were selected as responders from each company using the stratified random sampling method. Their current supervisory levels are shown in the table 1 below and their response were analyzed using three hypotheses while their inputs were tabulated under five categories namely: strongly agree (SA), agree (A), indifferent (I), disagree (D), and strongly disagree (SD).This totaled a sample size of fifty-two randomly selected for the study. There were seven items in the questionnaire with mixed ratings in words, scales, and figures. Furthermore, performance of each team was duly observed to ascertain the authenticity of each responder. In analyzing the data, simple percentage statistical tool was used to analyze the respondent's characteristics and chi-square statistical tool was used to test the hypotheses based on the study objectives mentioned above.

Supervisory Level	Frequency	Percentage (%)
Management	17	33
Engineering	13	25
Technician	22	42

Table 1: Role Distribution on the ConRAC Project.

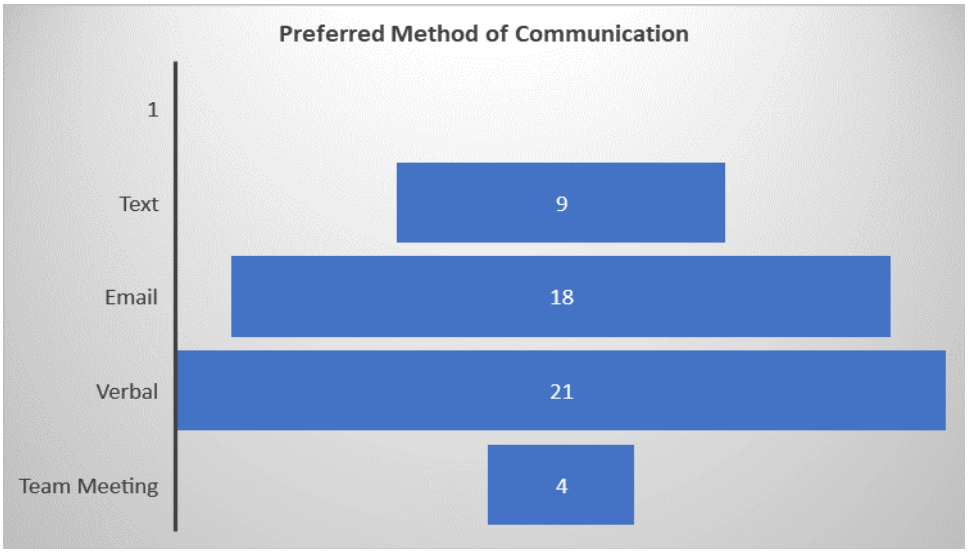

Figure 3: Funnel Chart showing Responders' Preferred Method of Communication (Source; Project Data)

Responder's Age Group	18-24	25-34	35-44	45-54	55-64	65-74
Frequency	0	24	21	7	0	0

Table 2: Responder's Age distribution.

IV. DATA ANALYSIS AND RESULTS

4.1 Test of Hypothesis 1

H_o: There is no significant relationship between effective communication and organization environment
H_i: There is a significant relationship between effective communication and organization environment

Supervisory level	**SA**	**A**	**I**	**D**	**SD**	**Total**
Management	4	10	3	-	-	**17**
Engineering	7	4	2	-	-	**13**
Technician	3	11	6	2	-	**22**
Total	**14**	**25**	**11**	**2**	**-**	**52**

Table 3: Responder Result for Hypothesis 1.

SA = Strongly Agree, A = Agree, I = Indifferent, D = Disagree, SD = Strongly Disagree
E_i = Row Total x Column total
Grand total

$E_{SA} = 14 \times \frac{17}{52} = 4.5 \quad Ei = 14 \times \frac{13}{52} = 3.5 \quad Ei = 14 \times \frac{22}{52} = 5.92$

$E_A = 25 \times \frac{17}{52} = 8.17 \quad Ei = 25 \times \frac{13}{52} = 6.25 \quad Ei = 25 \times \frac{22}{52} = 10.58$

$E_I = 11 \times \frac{17}{52} = 3.60 \quad Ei = 11 \times \frac{13}{52} = 2.75 \quad Ei = 11 \times \frac{22}{52} = 4.65$

$E_D = 2 \times \frac{17}{52} = 0.65 \quad Ei = 2 \times \frac{13}{52} = 0.5 \quad Ei = 2 \times \frac{22}{52} = 0.84$

$E_{SD} = 0 \times \frac{17}{52} = 0 \quad Ei = 0 \times \frac{13}{52} = 0 \quad Ei = 0 \times \frac{22}{52} = 0$

X^2 Formula = $\sum (oi - ei)^2/ei$

$$X^2 = \frac{(4-4.5)^2}{4.5} + \frac{(10-3.5)^2}{3.5} + \frac{(3-5.92)^2}{5.92} + \frac{(0-8.17)^2}{8.17} + \frac{(0-6.25)^2}{6.25}$$

$$+ \frac{(7-10.58)^2}{10.58} + \frac{(4-3.6)^2}{3.6} + \frac{(6-2.75)^2}{2.75} + \frac{(0-4.65)^2}{4.65} + \frac{(0-0.65)^2}{0.65}$$

$$+ \frac{(3-0.5)^2}{0.5} + \frac{(11-0.84)^2}{0.84} + \frac{(6-0)^2}{0} + \frac{(2-0)^2}{0} + \frac{(0-0)^2}{0}$$

Therefore: $X^2 = 173.77$

Calculated $X^2 = 173.77$
Degree of freedom = (R-1) (C-1) = (3-1) (5-1) = 2 x 4 = 8
@ 5% significance from chi square table, tabulated $X^2 = 15.507$
Calculated X^2> tabulated X^2, we reject the null hypothesis H_o.

4.2 Test of Hypothesis 2

H_o: There is no significant relationship between communication difficulties and quality outcomes
H_i: There is a significant relationship between communication difficulties and quality outcomes

Supervisory level	**SA**	**A**	**I**	**D**	**SD**	**Total**
Management	-	1	1	5	11	**17**
Engineering/Superintendent	-	2	1	5	5	**13**
Technician	1	1	11	5	4	**22**
Total	**1**	**4**	**12**	**15**	**20**	**52**

Table 4: Responder Result for Hypothesis 2.

E_i = Row Total x Column total
Grand total
E_{SA} = 1 x 17 = 0.326 E_{SA} = 1 x 13 = 0.25 E_{SA} = 1 x 22 = 0.423
52 52 52
E_A = 4 x 17 = 1.30 E_A = 4 x 13 = 1.00 E_A = 4 x 22 = 3.52
52 52 52
E_I = 12 x 17 = 3.92 E_I = 12 x 13 = 3.60 E_I = 12 x 22 = 5.08
52 52 52
E_D = 15 x 17 = 4.90 E_D = 15 x13 = 3.75 E_D = 15 x 22 = 6.35
52 52 52
E_{SD} = 20 x 17 = 6.53 E_{SD} = 20 x 13 = 5 E_{SD} = 20 x 22 = 8.46
52 52 52
X^2 Formula = $\sum (oi - ei)^2/ei$

$X^2 = (0 - 0.33)^2 + (1-1.30)^2 + (1-3.92)^2 + (5-4.90)^2 + (11-6.53)^2$
0.33 1.30 3.921.30 6.53
$+ (0- 0.25)^2 + (2-1.00)^2 + (1-3.60)^2 + (5-3.75)^2 + (0-5.00)^2$
0.25 1.00 3.603.755.00
$+ (1 -0.423)^2 + (1-3.52)^2 + (11-5.08)^2 + (5-6.35)^2 + (4-8.46)^2$
0.4233.52 5.08 6.35 8.46

Therefore: X^2 = 23.51
Calculated X^2 = 23.51
Degree of freedom = (R-1) (C-1) = (3-1) (5-1) = 2 X 4 = 8
@ 5% significance, tabulated X^2 = 15.507
Calculated X^2> tabulated X^2, we reject the null hypothesis H_o.

4.3 Test of Hypothesis 3

H_o: There is no significant relationship between effective communication and project performance
H_i: There is a significant relationship between effective communication and project performance

Supervisory level	**SA**	**A**	**I**	**D**	**SD**	**Total**
Management	-	-	2	4	11	**17**
Engineering/Superintendent	-	-	4	4	5	**13**
Technician	2	3	10	3	4	**22**
Total	**2**	**3**	**16**	**11**	**20**	**52**

Table 5: Responder Result for Hypothesis 3.

E_i = Row Total x Column total
Grand total
E_{SA} = 0 x 17 = 0 E_{SA} = 0 x 13 = 0 E_{SA} = 0 x 22 = 0
52 52 52
E_A = 3 x 17 = 0.98 E_A = 3 x 13 = 0.75 E_A = 3 x 22 = 1.27
52 52 52
E_I = 14 x 17 = 4.58 E_I = 14 x 13 = 3.50 E_I = 14 x 22 = 5.92
52 52 52
E_D = 18 x 17 = 5.89 E_D = 18 x13 = 4.5 E_D = 18 x 22 = 7.6
52 52 52
E_{SD} = 17 x 17 = 5.56 E_{SD} = 17 x 13 = 4.25 E_{SD} = 17 x 22 = 7.19
52 52 52
X^2 Formula = $\sum (oi - ei)^2/ei$

$X^2 = (0 - 0)^2 + (0-0.98)^2 + (2-4.58)^2 + (7-5.89)^2 + (8-5.56)^2$
0 0 4.58 6.544.90
$+ (0- 0)^2 + (1-0.75)^2 + (2-3.50)^2 + (4-4.50)^2 + (6-4.25)^2$
0 0.75 3.505.003.75
$+ (0-0)^2 + (2-1.27)^2 + (7-5.92)^2 + (7-7.6)^2 + (3-7.19)^2$
01.27 5.92 7.6 7.19
Calculated X^2 = 16.954
Degree of freedom = (R-1) (C-1) = (3-1) (5-1) = 2 X 4 = 8
@ 5% significance, tabulated X^2 = 15.507

Calculated X^2> tabulated X^2, we reject the null hypothesis H_o.

V. DISCUSSION

Referencing the results data above, it is evident that X^2 calculated > X^2 Tabulated for all hypotheses hence, we rejectedall null hypotheses that there is no significant relationship between effective communication and stated parameters-organization, quality, and project performances in CONRAC.

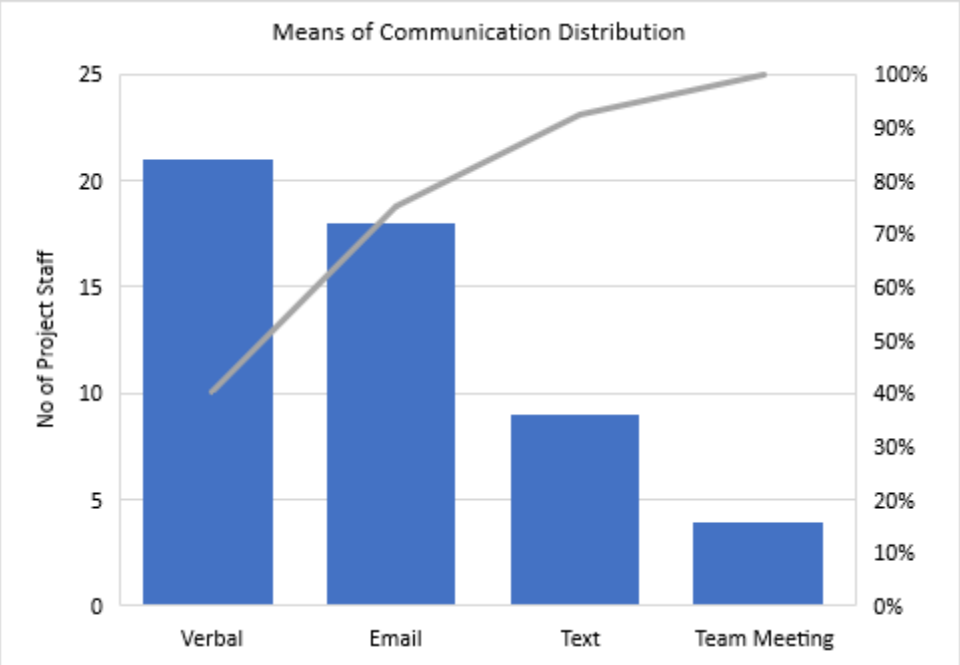

Figure 4: Means of Communication Distribution.

Our finding from figure 4 shows over 40% of project staff preferred verbal communication. This could be attributed to having more technicians in this radar who are basically field staff. Our informed discussion with majority of these technicians hinted their preference for verbal communication to be based on the urgency of what information needs to be communicated as well as access to internet.On the other hand, we observed team meeting to be the least used of highlighted tools which affirmed the communication gap that was noticeable at the start of the project. Having noticed this, communication about issues/errors was discussed at weekly coordination meetings. As the project progressed, a pictograph that was built into the central project management system (Procore) to document information and files to be communicated which was emailed to all trade partners and further discussed at meetings specific to QA/QC meetings instead of merging it with weekly team meetings. Another measure that was put in place to close this gap was to ensure that each trade conduct daily coordination meetings among their teams to enhance a bottom-top collaboration on the project. When companies close the gap between the developers of the strategy and those that must execute it, projects are more successful. Organizations that report more frequent project communication, particularly surrounding the business benefit and contribution to strategy, average significantly more successful projects versus organizations that communicate that same information less frequently [6].

For Engineering and Management, the study shows55% of project staff to be within this group. This helps to balance overdependence of the project young age on verbal communication because every staff within this role spectrum is expected to communicate or share information through Procore. Given their temporary field presence, communication barriers often make it hard for the project office staff to manage field operations properly.Hence, the crucial need for a Construction Management (CM)software[6]. This is essential for communicating technical details by allowing every employee to communicate in real time, automate tasks, and eliminate errors. In addition, the mobile app versions of this software allow for employees to stay connected and informed. They allow messages to be sent to and from the office, and for documents and drawings to be viewed from the jobsite. Unarguably, employees collaborate more efficiently which helps in problem-solving and decision making.

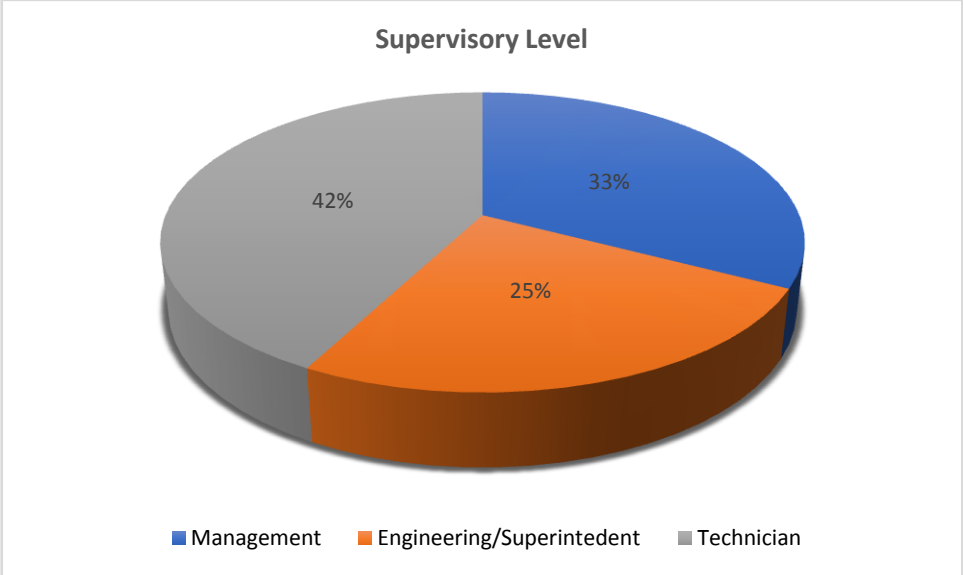

Figure 5: Pie Chart showing Responders' Role on the Project (Source; Project Data)

Also, the organization structure in a typical CM at Risk makes it easier to hold every team lead accountable for the dissemination of information to their teams particularly during coordination meetings where action plans are updated. A major setback to this as experienced during the project was planning key meetings and tasks with regards team lead's vacation. However, with the information stored on CM software, coordinating with field workers was an easy task but more important to this, having an Engineering personnel in a team afforded better collaboration.

Analyzing the age structure of responders and project performance, we found 80% of responders to fall within 25-34 age bracket which posits the relatively young workforce of the project. Empirically, we can draw two inquiries from this: (i) "Are projects with young rather than older employees successful?" and (ii) "Are projects with homogeneous rather than heterogeneous workforces successful?"[7]Taking this outcome into account, we can make a correlation between preferred method of communication and staff age. In doing so, we found interrelation between mean age and verbal communication to be very strong. While this shows a high response rate, the con is that it does not yield effective collaboration because our review on the communication gap during the project had shown a high frequency for one-to-one communication. Since adjusting this gap, every team was mandated to hold a morning interactive session in the presence of construction management team members. The resulting effect was obvious in the data presented in hypothesis 3.

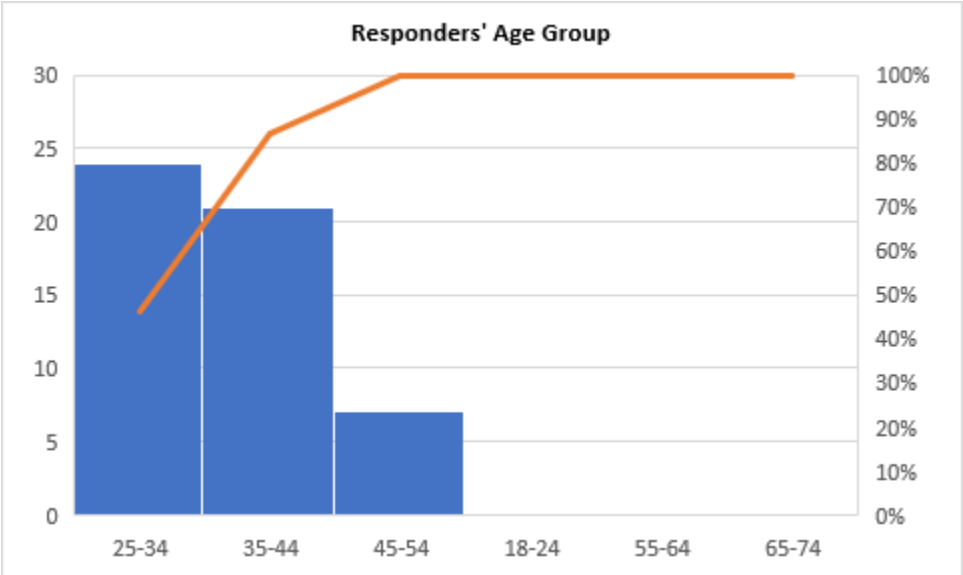

Figure 6: Communication between Responder's age Group.

VI. CONCLUSION

Considering the importance of communication when it comes to project management, it is apparentthat a good mix or network of essential tools must be explored all through project lifespan to achieve strong collaboration among teams. From the results analyzed, it is not surprising that CONRAC project experienced better performance in team's collaboration due to improved communication. Ultimately, decline in rework, increased RFIs, and emails generated were all part of key indicators deployed to verify this improvement.And, therefore, infer that effective communication is significantly related to overall team performance and quality delivery on a CM at Risk project.

For future research,it would be desirable to create data sets with higher observation numbers, which would make it possible to analyze changes due to workforce availability. In addition, it is important to mention that pattern of communication in the project organization should serve to indicate areas where communication is most deficient and the channels through which information can be made to flow most effectively.

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