

DEVELOPING A FRAMEWORK FOR ENHANCING DELIVERY OF SUBCONTRACTORS' WORK IN COMPLEX CONSTRUCTION PROJECT

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1 ABSTRACT

The study aims to develop a model for the effective management for the subcontractors on construction site in Kenya. All subcontractors, both domestic, named and nominated were in consideration under this study. The target population identified was projects carried out by NCA 1 and NC2 contractors in Kenya and therefore respondent included consultants, contractors' site manager and subcontractors involved on the projects under study. 110 participants were identified. Factors affecting performance of subcontractors included proficiency of the construction site manager, the number of subcontractors on a given site, the effectiveness of the subcontractors for a given subcontracted work. The effectiveness or project performance of these underlying determinants on subcontracting performance is studied a binary logistic regression. Based on the Contractors are suggested to have an effective construction site manager who will improve the general coordination on site. The subcontractors are suggested to improve the cashflows for the project, communication for the office and the construction site office, procurement methods, quality of staff on site and safety standards while undertaking the construction project. Subcontracting is dominated by labour only subcontracting but needs to widen to improve the performance. The consultants are encouraged to be involved in selecting the construction site manager and the subcontractors on every level to improve performance. There is need to determine the threshold of work to be subcontracted to have affective teams on give construction site

2 INTRODUCTION

Subcontracting over the years has played a vital role in the construction sector and has become an essential characteristic of building. A building project always revolves around the project alliances that involve active interactions of both the project owners and non-owners (Design Team, suppliers as well as Contractor and Subcontractors team) to deliver a project in an atmosphere of shared responsibilities as well as liabilities (Brahm, 2014). According to Ednan (2008), Subcontractors carry out most of the construction works and their impacts on the industry are apparent in some construction activities. Hinze and Tracey (1994) says that subcontractors supply labor and materials, and they change order-related drawings and specifications into real components of the facility and thus, they cater for up to 90% of the construction projects value. Subcontractor's work largely determines the success of the construction industry. For example, in building construction projects, 80-90% of total work is done by subcontractors. Although subcontracted portions of highway projects and other infrastructural projects are less, an important part is carried out under subcontracted agreements (Hinze, 1994). In essence, construction mismanagement that starts from a single contractor may influence the workforce,

and this might affect scheduling thus, causing damages that affect multiple parties (Shimizu and Cardoso, 2002).

With the many players on a construction project, this study focuses mainly on the extent to which Main Contractors subcontract their work, the Subcontractor's performance and impact on the general construction project delivery with the aim of reducing the challenges that might be experienced when one wants to achieve project plan.

3 STATEMENT OF THE PROBLEM

Sohail (1999) says that the construction industry relies heavily on the specialist sub-contractors to bring the expertise needed for specific jobs, quality on specialist sub-contractors, is more imperative since it has a direct bearing on the performance of the major contractors on a key element of the work. Dykstra (2011) noted that subcontracting is useful in shifting financial risk and cost, adding quality and efficiency, creating a more vibrant and competitive industry. With different players involved on a single project, it should be noted that

Due to increased number of players in terms of sub-contracting, there have been continued delays of the project delivery with strained budgets and quality not reaching to the clients or consultants' expectations in most of the construction projects. Whitten (1999) argued that general contractors design firms and construction management companies are the focus of most studies in the construction industry. Although there might be many reasons for this, specialty contractors are the ones that carry out most construction on site as subcontractors (Hinze and Gambatese, 2003). Albino and Garavelli (2007), points out that the key contractor performances are strongly dependent on sub-contractors. Mbachu (2008) adds that the performance of subcontractors determines the general contractor's or consultant's ability to deliver the project within the specified time, quality and cost. The main contractors and owners do not understand the scope of work and the dependencies between subcontractors' work. Conflicts between the general contractors, subcontractors and other participants in the project create a critical problem to the success of the complex and fast-paced projects because the conflicts will lead to cost litigation and dissatisfied customers (Dossick and Schunk, 2007).

With many subcontractors on site, the mismanagement of subcontractors can be the main source project failures. The problem of subcontractors should not be ignored because it can cause a great impact on a construction project and may even extend to the Main Contractor organization's operations.

With the recent growth of the subcontractors in the industry which has resulted in the competition for the available construction subcontractor's work and the undoubted role played by subcontractors in the performance of the project. The research seeks to evaluate sub-contractors on their effectiveness and influence on the project delivery with the aim of time, budget and quality preciseness as a strategy of construction project management.

4 Objectives of the study

The main objective of this study is to develop a model for management and evaluating sub-contractors on project performance.

- a) To investigate the extent to which main contractor subcontract various trades.
- b) To evaluate various factors that influence the choice of a sub-contractor on a given project by the MC or the Client.
- c) To obtain feedback on the challenges faced by subcontracting various trades in relation to general project performance

4.1 Hypothesis

NULL: Mismanagement of subcontractors is the cause of project failures

ALTERNATE: Mismanagement of subcontractors is not the cause of project failures

4.2 Research significance

The findings of this study will be utilized on all big projects undertaken in Kenya. This will include the government policy makers, private developers, consultants, contractors, subcontractors, construction site manager and academicians. Contractors can improve more in subcontractor management and therefore improve the relationship between the entities. The project owners can also improve the effectiveness in utilizing the subcontracting on construction project.

5 LITERATURE REVIEW

5.1 Introduction

In recent past years, the construction industry has shown tremendous progressive improvement and growth in terms of size, project complexion, and new sophisticated methods of project delivery. The construction industry is vital in the economic output of our country as it contributes to about 6.5% of the total output of the country. In Fagbenle et al 2014 findings, it is shown that in complex projects subcontracting up to 90% of work is subcontracted, which means the main contractor remains with only 10% of the works to undertake. Subcontracting is common and well-practiced according to Rafiq M. Choudhry, 2012.

Main contractors have realized that the Sub-contractors have the greatest cost-saving potential and ability to deal with unfair contract conditions (Matthew, et al. 1996). Main Contractors and clients employ sub-contractors to shift risk, thus resulting in a dependency on complete contracts instead of cooperative relationships (Erik Eriksson, 2007). The subcontractors should not be treated as isolated entities since their relationship with MCs is crucial in project success. This is due to increased project fragmentations to achieve the desired project requirements.

Sub-contracting refers to a business entity where the Main Contractor employs additional people or companies usually referred to as sub-contractors to help in completing a project. Even though the subcontractors are introduced into the project, the main contractor still plays the main role of work delivery. Usually, the subcontractors are introduced into the project to ensure timely and cost-effective project delivery. Man et al. (2013) argues that subcontracting means bargaining down labor cost, facilitates quick task completion, spreads the risk of less rewarding and toxic activities.

The relationship between the main contractors and subcontractors has been weighted to be of great concern in many complex projects. Loh and Ofori, 2000 argue that the quality of subcontractors is

as important as it bears the direct performance of the main contractor works. Any problem arising might cause a great loss on the project. These problems might emerge either from the main contractor's team or subcontractors.

5.2 EMPIRICAL REVIEW

Each project has a unique combination of job-specific subcontractors that are typically assembled under a general contractor acting as the head and the general contractor may also have his own labor force working alongside the various subcontractors throughout the project. (Ashteror, 2014). He further documented that there is a team approach to completing the work on most projects with the general contractor taking the lead to manage the jobsite and direct the personnel.

Ashteror, 2014 identified the following as the key castors to be considered in subcontract site management.

5.2.1 Technical and managerial skills of the subcontractor

A good subcontractor must have good management skills to be part of the company's policy. Most of the Sub-contractors are hired on a specialized basis and should have an excellent inter-management since a company may have more than one project at the same time. Skills that the subcontractor possesses forms a valuable resource base for the for the organization (Ashteror, 2014). Martin, 2007, points out that technical skills are usually obtained through training programs that the organization may offer its managers or employees.

5.2.2 Financial capabilities of the subcontractor

The organization's ability to finance projects has a direct influence on the performance and operations of its activities, as a consequence, poor financial base may bring subcontracted projects into a situation of fund shortage and progress delays (Yu Tao,2009). According to Liu Jing, 2008, the ability to manage financial resources not only relates to cashflow stability and even success or failure of the project, but also affects subcontractors operating profits. This element is very key unit of analysis in management of subcontractor, since most subcontractors perform a specific task that they have been assigned before seeking payments (Hendrick et Al, 1991).

5.2.3 Subcontractors qualification and experience for the works

A subcontractor is hired because of the specialization of the subcontracted works. Chengye Kang, 2011 says that the quality of Subcontractor's construction team directly affects the project quality and duration and plays a major role in determining project economic performance. This forms a basis for keenly considering this variable in management of subcontractors.

5.2.4 Subcontractor relationship with the main contractor

This relationship in in line with the construction site project relationship management which is defined as the process in which project managers build and maintain relationships between the project stakeholders in the phases which they are mostly involved in the project (Bourne & Walker, 2008). Since subcontractors forms an integral team player, their relationship within the site with other construction players is paramount. Contractual relationship management has paid particular attention to the players and their importance in the project management process and has resulted in the adoption of new management practices that are relationship based. These approaches control

the problems resulting from traditional practices in construction through fostering collaborative working within and between project organizations (Xu & Smyth, 2015). The construction industry being an old traditional industry, the use of old-day methods in carrying out the construction activities has more than often led to various problems like poor performance in projects (Meng, 2012).

5.2.5 Construction Site managers capabilities

According to Gould et al, (2009), the general superintendent oversees all jobsite operations throughout the project duration of a particular project which includes scheduling of the subcontractors, dimension control, quality control, safety control measures, work hours, jobsite access, security, inspection, etc.

Knutson et al, 2003 identified that subcontractor's success depends heavily on the capabilities of the site manager selected for the project. Construction Site manager is typically responsible for the scheduling of subcontract crews and directing the sequence of work throughout the project duration. This will determine the general output of the subcontractor and in turn the contractor's production. Productivity issues are one of the main variables that can most affect the profitability of the subcontractor on the jobsite (Garrett, 1979). Coordination is very key where we have more than one parties involved on a construction site. A good and coordinated site reduces conflicts and ensure that each component is installed in the proper location.

The involvement of subcontractors sometimes is a competition between risk and profits, hence in determining the best criteria in the process of management of the subcontractors there must be trade in between the two factors.

Most MCs subcontract most of their construction work therefore they work as agents. (Shash 1998). The main contractor and subcontractor interface variables are key in determination of the project successful completion during the construction phase. Conceptual framework has been identified from the literature review that has an element on site coordination,

5.2.6 PERFORMANCE INDICATORS

Project performance has been a competitive point that allows the project team to make informed choices of Contractors and Sub-contractors. According to Luu et al. (2008), "performance measurement is the heart of ceaseless improvement. As a general rule, benchmarking is the next step to improve contractors' efficiency and effectiveness of products and processes". About the performance, key performance indicators must be established to set a benchmark that can be used to identify the company's set targets and to identify its weaknesses and opportunities with growth. Key Performance Indicators (KPI) are compilations of data measures that are used to evaluate the performance of a construction project (Cox et al., 2003). KPIs play a vital role in providing information on the performance of tasks, projects, and companies in a construction operation.

Many types of research have been done to evaluate the Key Performance Indicators, and most of them is a task or specific driven in each nation. Elshakour et al. (2013) explore the basis of performance as benchmarking. Through his research, he seeks to identify the parameters that will form a basis to measure performance. Benchmarking can be defined as "A systematic process

of measuring one's performance against results from recognized leaders to determine best practices that lead to superior performance when adapted and implemented'' (Hudson, 1997 cited in El-Mashaleh et al., 2007).

Elshakour et al. (2013) point out the different classification of benchmarking. The classifications of benchmarking are internal, functional, and competitive based on its environment. Similar business units within the same organization perform internal benchmarking, for example, it can be done between different branches or by geographically scattered subsidiaries, and divisions. Competitive benchmarking entails comparing the products, services, and performance of an organization with that of its direct competitors in the same industry. Functional benchmarking this type identifies the best practices in any type of organization, and then it compares it to the best practices carried by companies operating in the same field (Camp, 1989; Watson, 2007; CCIC, 2006; Swan and Kyng, 2004).

5.3 CONCEPTUAL FRAMEWORK

Figure 1 represents the relationship between the different variables in the study.

With the assumption that the main Contractor is a subcontracting entity, the project performance is the dependent variable. It is affected by Sub-contractors' performance, Site coordination, which is determined by the effectiveness of the site manager and the numbers of subcontractors on a particular project, which indicates the complexity of coordination of activities on site. The Subcontractors performance is influenced by the following independent variables which includes financial resources available, communication within the main office and site office for the subcontracted company, technical expertise to carry out the subcontracted works, payment of the workers, training of workers on subcontracted works, procurement practice by the subcontractor.

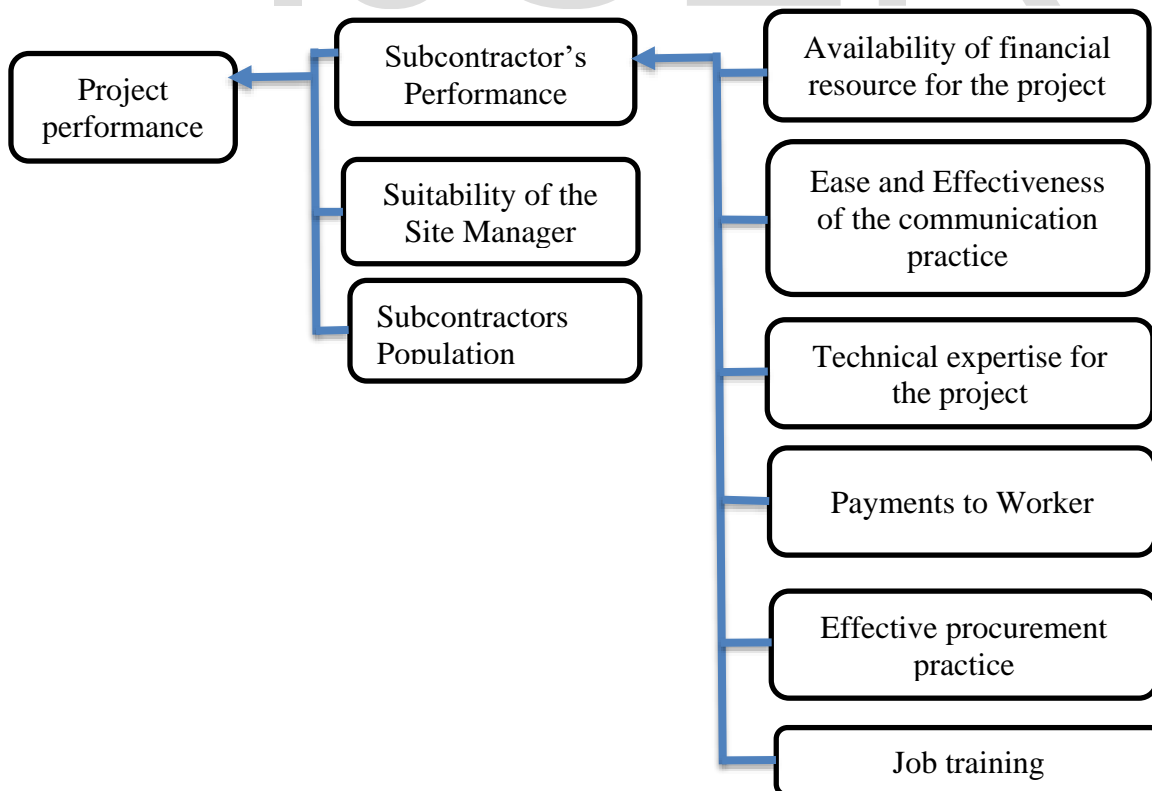


Figure 1: Conceptual Framework

6 RESEARCH DESIGN

The researcher utilized quantitative approach to accomplish the purpose of this study. Primary data from the field was used in the analysis. The target population in this research was projects undertaken by NCA 1 and NCA 2 according to National Construction Authority portal in Kenya. The researcher utilized the following formula for sampling unit:

$$N = n' / [1 + (n'/N)]$$

Where:

N= Total number of populations

N'= Sample size from finite population

$n' = \text{sample size from infinite population} = S^2/V^2$; where S^2 is the variance of the population elements and V is a standard error of sampling population. (Usually $S = 0.5$ and $V = 0.05$)

All the project under study, the consultants, construction site manager and the subcontractor's questionnaires were prepared and collected. Seventy questionnaires were distributed, and 50 complete sets collected back dully filled to be utilized in the analysis.

7 RESULTS

7.1

CORRELATION TABLE

TABLE 1: TABLE 1: TEST FOR CORRELATION OF THE VARIABLES

		Project performance	Site Manager's Suitability	Subcontractors' Evaluation	Subcontractors Population
Pearson Correlation	Project performance	1.000	.336	.469	.012
	Site Manager's Suitability	.336	1.000	.081	-.241
	Subcontractors' Evaluation	.469	.081	1.000	.204
	Subcontractors Population	.012	-.241	.204	1.000
Sig. (1-tailed)	Project performance	.000	.000	.000	.451
	Site Manager's Suitability	.000	.000	.201	.006
	Subcontractors' Evaluation	.000	.201	.000	.016
	Subcontractors Population	.451	.006	.016	.000
N	Project performance	110	110	110	110
	Site Manager's Suitability	110	110	110	110
	Subcontractors' Evaluation	110	110	110	110
	Subcontractors Population	110	110	110	110

Source: Survey Results (2020)

This checks for the multicollinearity between the predictor variables which assumes that we should not have multicollinearity between predictor variables

If the correlation were greater than .7 then for the purposes of regression, we would say the variables are multicollinear, so we look for the values that are less than .7

In our case Site Manager's suitability = .081

Subcontractor Evaluation = .204

Subcontractor Population = .241

Predictor variables to correlate with outcome variable at a value greater than 3 so looking at our project performance, our outcome variable are:-

Site Manager's suitability = .336

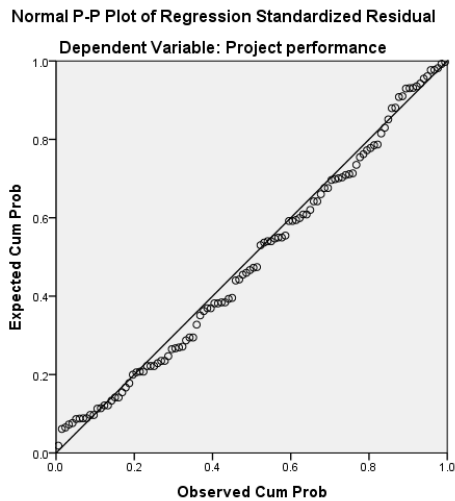
Subcontractor Evaluation = .469

Subcontractor Population = .02 which is less than 3

This means that: -

There is a positive correlation between project performance, Subcontractors evaluation and Site manager suitability and a negative correlation between subcontractors' population and Site manager suitability with a significance level of 1. This positive correlation has formed part of further analysis for regression by the researcher.

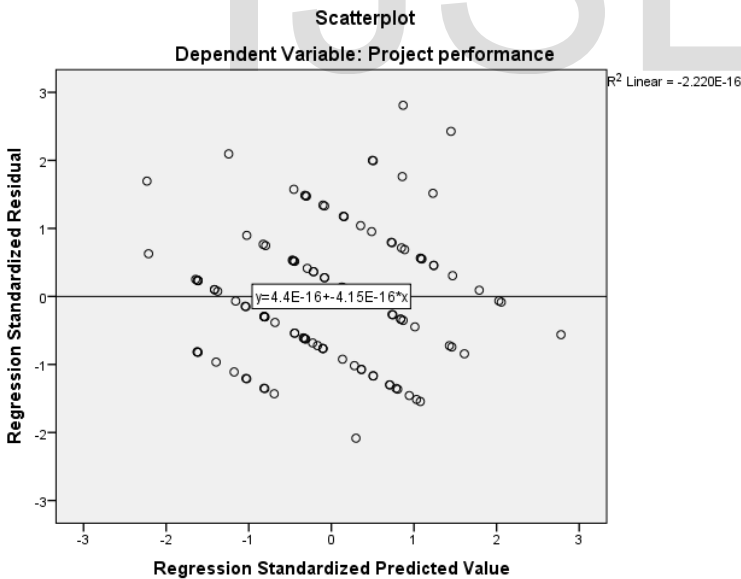
7.2 NORMAL PP PLOT TABLE



Source: Survey Results (2020)

The output graph showed that the points were less far from the line, thus a linear relationship between in depended variable and depended variable.

SCATTER PLOT



Source: Survey Results (2020)

The output of scatter plot was maintained between -3 and +3 either on Y axis and X axis, that shows a positive linear relationship of the plots.

7.3 RESIDUALE STATISTICS

Residuals Statistics^a

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	2.39	5.53	3.79	.627	110
Std. Predicted Value	-2.233	2.780	.000	1.000	110
Standard Error of Predicted Value	.096	.328	.174	.049	110
Adjusted Predicted Value	2.24	5.59	3.80	.637	110
Residual	-1.978	2.665	.000	.936	110
Std. Residual	-2.084	2.809	.000	.986	110
Stud. Residual	-2.126	2.835	-.003	1.004	110
Deleted Residual	-2.056	2.713	-.005	.971	110
Stud. Deleted Residual	-2.162	2.935	-.001	1.013	110
Mahal. Distance	.127	12.018	2.973	2.291	110
Cook's Distance	.000	.075	.009	.015	110
Centered Leverage Value	.001	.110	.027	.021	110

a. Dependent Variable: Project performance

Source: Survey Results (2020)

From the tables, the Standard Residual has a minimum of -2.084 and max of 2.665 this is a good range for Standard Residual

And for cooks' distance was maintained between the range is 0.000 to 0.075 which is within range, which was not beyond 1.

7.4 MODEL SUMMARY

Model Summary^b

Model	R	R Square	Adjusted Square	Std. Error of the Estimate	Change Statistics				
					R Change	Square Change	F Change	df1	df2
1	.556 ^a	.310	.290	.949	.310	15.850	3	106	.000

a. Predictors: (Constant), Subcontractors Population, Subcontractors' Evaluation, Site Manager's Suitability

b. Dependent Variable: Project performance

Source: Survey Results (2020)

The model has a linear assumption of effect of population of subcontractors, the suitability of the site manager and subcontractor’s evaluation for efficiency on Project performance which is dependent variable.

R square = .310

Adjusted R square is .290

The research established that there was 31% variance in depended variable which is statistically significant to 0.00

7.5 ANOVA TABLE

ANOVA^a

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	42.793	3	14.264	15.850	.000 ^b
Residual	95.398	106	.900		
Total	138.191	109			

a. Dependent Variable: Project performance

b. Predictors: (Constant), Subcontractors Population, Subcontractors' Evaluation, Site manager's Suitability

Source: Survey Results (2020)

The ANOVA tests the null hypothesis of the standardized linear regression model if the slope of the line is 0 zero

Checking on our statistics the p-value was less than 0.05, this means that we accept the null hypothesis.

NULL: Mismanagement of subcontractors is the cause of project failures

ALTERNATE: Mismanagement of subcontractors is not the cause of project failures

7.6 COEFFICIENT TABLE

Coefficients^a

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
	B	Std. Error	Beta			Zero-order	Partial	Part
1 (Constant)	.426	.655		.650	.517			

Site Manger's Suitability	.227	.064	.298	3.548	.001	.336	.326	.286
Subcontractors' Evaluation	.369	.069	.447	5.371	.000	.469	.463	.433
Subcontractors Population	-.006	.068	-.008	-.088	.930	.012	-.009	-.007

a. Dependent Variable: Project performance

Source: Survey Results (2020)

The research established that: -

Site manager's suitability at 22% and Subcontractor evaluation at 36% made significant contribution to change in the project performance (dependent variable) but the Subcontractor population did not

For the researcher to choose the scores that predict the movement in the project performance the following model was deduced: -

$$Y = .22X_1 - .006X_2 + .37X_3 + 0.426$$

8 CONCLUSION

Currently, subcontracting has been done as an afterthought for many of the main contractors' firms, who on large scale utilizes the domestic form of subcontracting form. From the survey the results established that subcontracting should be an integral determinant of any project development. The contractors should develop a work relationship with subcontractors for any upcoming project to reduce the negative force on a construction project.

In the current state, there is always less involvement of consultant's in the selection of the domestic subcontractors for the works which was deemed to be executed by the main contractors. In the most cases, the consultants are only involved in hiring the nominated subcontractors with works dominantly limited mostly to electrical works, mechanical works, air conditioning works, lifts, ICT, audio visual and sound control. From our survey, it was established that it is paramount for the consultants to be involved in hiring of the suitable subcontractors for the works. The evaluation should be multi-established for both domestic, named and nominated subcontractors. The determinant attributes ranges from availability of resources to execute the subcontracted works, relevant staff with technical expertise to execute the job, past experience in the same area, available training programs to the staff in the job area.

Keeness in having both academically proficient and a person with adequate site experience and a manager has been a challenge on most of construction sites. The hiring criteria differs from one main contractor to another. The survey results beam towards having a qualified site manager for the site to be executed. The research established that it will be more benefit to involve the consultants on hiring of the construction site manager. The attributes to look out for will range from good communication skills, technical knowledge on site management, vast knowledge in coordination and delivery of multi-paced projects, good sense of material and resource management on site.

There is never threshold for the number of sub-contractors that a main contractor can employ on site. This is a function of the site manager ability to manage teams. For a proper and ease site deliveries, firms should establish a threshold work to subcontract. The research found out that if the main contractor has more control on the project by having work the more likely the ease in coordination and quality control, time control and possibly budget control is easily established.

The research established that subcontractors most often are hired for subcontracted works without having available resources ready to undertake the subcontracted works. The research findings points out that the subcontractors should prepare for the subcontracted works by establishing the right materials through good procurement systems, have financial resources for the works, and also have good labour management that can be enhanced through trainings, timely payment of labour works and having adequate labour for the works to be executed.

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References

- Brahm, J. T. 2014. Subcontracting in project-based firms: Do you follow the same pattern across your different projects? *International Journal of Project Management*, 32 (6): 995–1006.
- C. S. Dossick, M. P. 2007. Subcontractor schedule control method. *Journal of Construction Engineering and Management*, vol. 133, p. 262.
- Cardoso, J. Y. 2002. Subcontracting and cooperation network in building construction: a literature review. *Proceedings IGLC-10, Gramado-RS*.
- Ednan Enshassi, R. M. 2008. Safety performance of Subcontractors in the Palestinian Construction Industry. *Journal of Construction in Developing Countries*, 13 (1):.
- Eriksson, P. A. 2007. Procurement effects on trust and control in client-contractor relationships. *Engineering, Construction and Architectural Management*, Vol. 14 No. 4, pp. 387-399.
- Relationship Type. *Journal of Construction Engineering and Management*, vol. 1, 2009, p. 48.
- Hinze, J. 1997. *Construction Safety*. New jersey Prentice Hall.
- Lehtinen, U. 2001. Changing Subcontracting: A study on the evolution of supply chains and subcontractors (Academic Dissertation). University of Oulu.
- Mbachu, J. 2008. Conceptual framework for the assessment of subcontractors' eligibility and performance in the construction industry. *Construction Management and Economics*, 26;;471–484.
- Mohammed Dahane, C. C. 2010. Computers & Industrial Engineering. *Effects of extension of subcontracting on a production system in a joint maintenance and production context*, 58 (1): 88–96.
- Sohail, M. 1999. Review of safety in construction and operation for the WS & S Sector- A literature review: Part II. Task No. 166. . UK: Loughborough University.
- V. Albino and A. C. Gravelli, “A neutral network application to subcontractor rating in Construction firms,” *International Journal of Project Management*, Vol. 16, pp. 9-14,1998
- Tracey, J. H. 1994. The contractor-subcontractor relationship: the subcontractor's view. *Journal of Construction Engineering and Management*, vol. 120, pp. 274–287.
- Whitten, B. 1999. *How to Hire and Supervise Subcontractors*. Washington DC.: Home Builders Press
- Yu Tao, “How do EPC project contractors select and manage construction subcontractors?” *Journal of Petroleum and Chemical Construction*, 2009(3): 42-44

Liu Jing, "Application of AHP in contractor selection" *Journal of Science and Technology Innovation Herald*, 2008(3): 165-166.

Hendrick, D., Schemm N., (1991). *Safeguarding Your Subcontract Rights*. Alexandria, VA: Foundation of the American Subcontractors Association.

Knutson, K., Schexnayder, C. J., Fiori, C., Mayo, R. E., (2003). *Construction Management Fundamentals*. Boston, MA: McGraw-Hill, Inc.

Gould, F. E., Joyce, N. E., (2009). *Construction Project Management* 3rd ed. Upper Seattle River, NJ: Pearson Education, Inc.

Fang, D., Choudhry, R. M., & Hinze, J. (2012). *Proceedings of CIB W99 International Conference on global unity for safety & health in construction. 28-30 June 2006, Beijing China*. Beijing: CIB, Tsinghua University Press.

Mathew, J., Anderson, D., Kennedy, J., Ma, L., & Tan, A. (1996). *Engineering Asset Management Proceedings of the 1st World Congress on Engineering Asset Management (WCEAM) 11 - 14 July 2006*. London: Springer.

Loh., & Ofori. (2002). *Construction sub-contractor management*. Washington, D.C.: Transportation Research Board.

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