

Determinants of Subcontracting Performance in Road Construction Projects: Case of Addis Ababa Road Projects

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Abstract: *The study aims to examine the current subcontracting performance and its determinants in Addis Ababa city road authority road projects. It is descriptive and explanatory type. A sample of 51 representatives, 9 contractors, 32 subcontractors and 10 consultants, involved in AACRA projects during 2012-2017 have participated on the study. Major determinants (22) of subcontracting performance have been identified from literature reviews. The stakeholders' score on these determinants have been ranked by the use of relative Importance Index (RII). Then the underlying four determinants of subcontracting performance have been extracted using a factor analysis from the top ten determinants. The effect of these underlying determinants on subcontracting performance is studied by a binary logistic regression. Initial subcontractor selection and document preparation problem, Poor performance of the subcontractor, cooperation problems and delay of progress payments are the significant determinants of subcontracting performance on time dimension. Initial subcontractor selection and document preparation problem, poor performance of the subcontractor and cooperation problems are the significant determinants of subcontracting performance on cost and quality dimensions. Contractors are suggested to select their subcontractors properly with preset criteria and prepare subcontract document with precaution. Subcontractors need to improve the quality of their works and meet schedules. AACRA and the consultants need to be involved on selection and evaluation of subcontractors. Subcontracting is dominated by labor-only subcontracting but needs to widen up to other subcontracting types. AACRA need to prepare a subcontracting policy, guidelines and a modality for minimum percentage for subcontract works.*

Keywords: Determinants, subcontracting, performance, projects

1. Introduction

The construction industry plays a key role for governments in both growing and mature economies. The total annual revenue of almost \$10 trillion and added value of \$3.6 trillion, the construction industry accounts for about 6% of global GDP. Ayalew, et al. (2016) mentioned that the GDP contribution of the Ethiopian construction industry has been raised to 5.6% and approaches to the sub Saharan average (6%). Road construction is one of the sectors in the construction industry with invaluable contribution for development of nations. Ethiopia has placed increased emphasis on improvement of the quality and extent of road infrastructure in the country. To give adequate infrastructure service to the occupants, Addis Ababa City Road Authority (AACRA) allocates massive amount of budget and resource to expand and rehabilitate the existing road network. AACRA has spent more than 20 billion birr starting from 2006 to 2016 in construction of road projects as per AACRA Communication Affairs Directorate (2017). AACRA is currently engaged in increasing the Addis Ababa city road coverage to reach 25% before 2020 from the current 22% coverage.

Subcontracting is a project delivery business strategy used by main contractors to deal with uncertainties in the construction market and to transfer risks such as financial risks, completion risks and quality risks. Subcontracting reduces direct costs and overheads and allows main contractors to use more competitive smaller firms with lower overhead costs and better knowledge of the local market conditions, practices and procedures. The identification of poor subcontracting as one of the causes for poor project performances in previous studies has made it more vital to study subcontracting performance at AACRA to improve the

performance of its road projects. The purpose of this study is to identify the determinants of subcontracting performance and their effects at AACRA.

2. Statement of the Problem

Different authors and researchers have emphasized the benefits of subcontracting on construction works. Dykstra (2011) noted that subcontracting is useful in shifting financial risks and costs, adding quality and efficiency, creating a more vibrant and competitive industry. However, instead of improving project success, subcontracting can act as a catalyst for poor project outcomes if not well performed (Mudzvokorwa, 2017). Subcontracting can be a risk to construction projects (Yoke-Lian et al., 2012). The failure in subcontracting has been identified as one of the causes for project delays in different countries. In Malaysia, poor subcontracting is found to be among the top five reasons contributing to project delays as per Yoke-Lian et al. (2012). Kaliba (2010) identified subcontracting as a cause for project schedule overruns in Zambia. The different determinants that affect subcontracting performance have been studied in different countries like Zambia, Nigeria, Pakistan, China and other countries.

Subcontracting is a common practice at Addis Ababa city road projects but the performance of subcontracting is being questioned on its current contribution for timely project completion, cost minimization and achievement of quality works. According to Koshe and Jha (2016), poor subcontracting performance is one of the causes of construction projects delay in Ethiopia. Though subcontracting is being practiced at AACRA projects for a while, the issues regarding subcontracting were not well

addressed independently and sufficiently from other factors that affect the performance of road projects.

Objectives of the Study

The main objective of the study is to examine the current subcontracting performance and identify the determinants of subcontracting performance at Addis Ababa city road projects. More specifically the study is expected to achieve the following objectives.

- To study the existing subcontracting performance of Addis Ababa city Road projects.
- To sort out the determinants of subcontracting performance in Addis Ababa city Road Projects.
- To study the effect of the identified underlying determinants on the subcontracting performance of Addis Ababa city Road Projects.

Significance of the Study

The finding of the study is invaluable for all involved on AACRA Road Projects. This includes government policy makers, subcontractors, contractors, project Owners and Consultants and Academicians/Researchers. Contractors and subcontractors can reformulate their policies and strategies on subcontracting. Also the project owner, AACRA, can get an insight on how best to utilize subcontracting.

3. Literature Review

Subcontracting is becoming more prevalent on construction projects. Rajput and Agarwal (2015) stated that up to 90 % of the work on a construction project is performed by subcontractors in Zambia. In Singapore, about 60% to 70% of construction work is subcontracted as per Lin (2011). According to Okunlola (2015), a study conducted in Nigeria; at least 70% of construction work is subcontracted by the main contractor. It is then logical for a main contractor to give due attention to subcontracting works since it has become a major portion of construction project works.

Subcontracting performance can be measured in terms of Time, Cost, Quality, Predictability and customer satisfaction according to Lin (2011) but many researchers like Chamara et al. (2015) and Yoke-Lian et al. (2012) underlined that performance of subcontracting can be measured mainly by time, cost, and quality dimensions.

Expecting to harvest the benefits of subcontracting on their construction projects, different countries are also incorporating contractually binding subcontracting clauses on their general conditions of contracts. Countries have started to develop their subcontracting modality for a minimum percentage of subcontracting works that should be subcontracted on their road projects. For instance, Zambia has legislation for a minimum of 20% subcontracting modality as per Zambian Road Development Agency (2011). Instead of improving project performance, subcontracting can act as a catalyst for poor project outcomes (Mudzvokorwa, 2017). Subcontracting performance is faced with different kinds of problems.

These problems might emerge both from the main contractor or the subcontractor.

I. Contractor related

Absence of Proper Initial documentation

According to Lebas (2014) proper Initial documentation of subcontracting works is identified as one of the factors that affect the performance of subcontracting. The different requirements and responsibilities from both parties should be placed in the conditions of the contract. If a subcontract document is not well prepared, a problem on the implementation subcontracting is expected to happen.

Poor Subcontractor Selection

There should be a better combination of subcontractor selection criteria, apart from price. According to Lavelle et al. (2007) the common criteria for subcontractor selection should be Price, past performance, Health and safety record, Financial capability, Current workload, Reputation, past relationships, Resources (both physical and human), Technical/ managerial capability, Number of years the firm has been working in the market, References, Location of firm, Appropriate insurance cover.

Failure in Subcontractor Management

According to Yong (2015), a research made on highway subcontracting in china, poor subcontract management is one of the major factors that affect road construction subcontracting. Okunlola (2015) listed the major problems caused by the contractor in managing subcontractors as: main contractors' financial problem; delay in contract progress payment; interruption and termination of work by contractor and Lack of coordination of the different subcontractors. The contractor therefore needs to coordinate and share resources properly effectively and efficiently among the subcontractors through the project time period.

II. Subcontractor related

A company that performs particular tasks on a construction project can be defined as a subcontractor as per Polat and Damci (2014). Problems can be caused by a subcontractor and can affect the whole subcontracting process. The ability of the main contractor to deliver the project within time, quality and cost depends largely on performance of subcontractors as per Yoke-Lian et al. (2012). According to Okunlola (2015) the major problems in subcontracting caused by subcontractors are poor performance of subcontractors (delay of works and substandard works) and non-adherence to the contract.

Poor performance of works

A subcontractor with poor performance of works at project level could not meet schedules and meet the quality standard. Subcontractors need to deploy the required resources for the project according to their subcontract agreements. Sufficient skilled labor need to be available on the subcontractor's team. Substandard work of subcontractors is the main problem area as per the study conducted in Pakistan by Choudhry et al. (2012).

Non-Adherence to the contract

The subcontractor is expected to properly use the resources of the main contractor. Sub-subcontracting without getting the approval of the main contractor is a common reason for contractual disputes on subcontracted works. As per Yong (2015), sub subcontracting is one of the major factors that affect subcontracting on road construction projects.

III. Cooperation

Cooperation is recommended by different researchers besides solving the different problems faced in the subcontracting process. According to Citi (2013) six important factors were found that lead to willingness to collaborate among contractors are; collaboration encourages teamwork; develops cooperation between team members; stimulate information sharing; improves quality and timely project completion; enhance service quality; and better communication among project members. Absence of long term Partnership; Poor communication and Lack of Team Work are the major causes of cooperation problems.

Poor communication

Subcontractor-contractor relationship needs mechanisms for getting solutions at early stages. Meetings are helpful to address subcontracting issues at early stage. Weekly, monthly, quarterly and other performance reports can also be used to understand the existing subcontracting problems in detail. Verbal and written communications facilitate the subcontracting process as per Mudzvokorwa (2017).

Lack of Team Work

Stakeholders should work towards their common goal of executing project works as a team. According to the study conducted by Mudzvokorwa (2017) in Zambia: lack of cooperation, limited trust, and ineffective communication between the contractor and the subcontractor are studied as the main causes of subcontracting problems.

Absence of Partnership

Partnership is a long term commitment between two or more organizations to implement a structured collaborative approach that facilitates team work across contractual boundaries for the purposes of achieving specific business objectives (California Department of Transportation Division of Construction, 2013). Through this the development of trust and shared goal there is an increase in the likelihood of project success. According to Mirawati et al. (2015) partnering has a positive impact on project performance, not only with regard to time, cost and quality, but also improvement in profit margins and reducing litigations.

4. Methodology**Conceptual framework**

The following conceptual framework was developed from the prevailing literature (Figure 1).

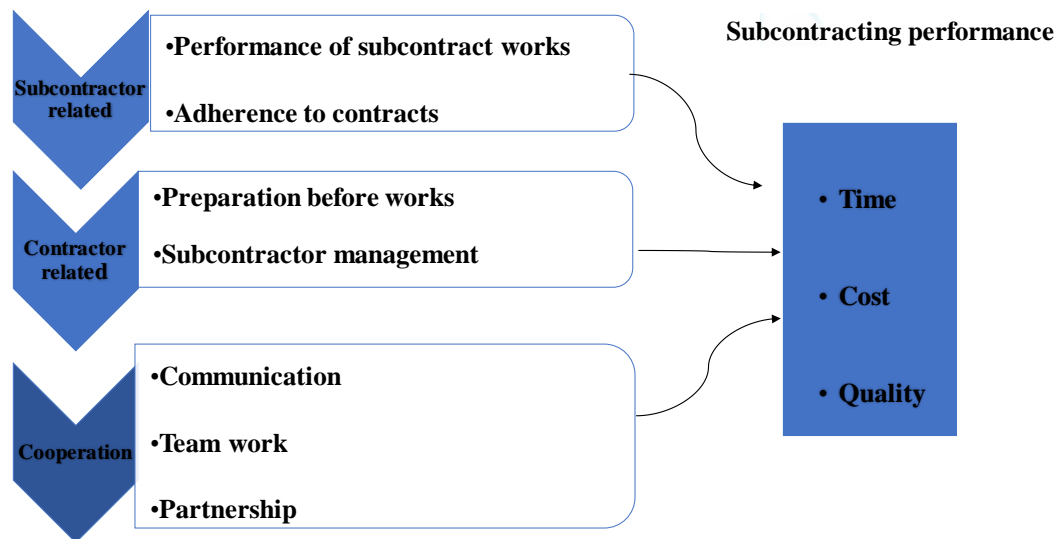


Figure 1: Conceptual Framework (Determinants of subcontracting performance)

Research Design

Explanatory design with quantitative approach was used to accomplish the purpose of the study. The researcher used both primary and secondary data as a source of data. The population of the study has comprised road construction projects, which were completed during 2012-2017 under AACRA. As per AACRA project completion report, there were 38 road projects completed during 2012-2017 under AACRA. To determine the optimum sample size, the researcher employed the simplified formulae of Yamane & Taro (1967) and then 60 questionnaires were distributed to 9

Contractors, 11 Consultants and 40 subcontractors proportionately.

Study Variables

- **Dependent Variables:** Subcontracting performance for time, cost, quality dimensions were the dependent variables to measure the success of the subcontracting at AACRA road projects.
- **Independent Variables:** Subcontractor related factors; contractor related factors and cooperation factors were the three independent variables affecting subcontracting

performance at AACRA road projects on different dimensions.

relationship between them. Hence RII (Table 1) was used for the study which can be calculated using the following equation:

$$RII = \frac{\sum W}{A \times N}, 0 \leq RII \leq 1$$

Where: W is the weight assigned to each determinant by the respondents (ranging from 1 to 5). A is the highest weight (i.e. 5 in this case), N is the total number of respondents (51 in this case).

5. Results

Descriptive statistics

There has been an extensive utilization of subcontracting at AACRA projects (Figure 2). Among the respondents 49% rated “Labor domestic works” as the dominant subcontracting category (Figure 3). The approval of Subcontractors is seldom done by consultants on AACRA projects (Figure 4). Subcontracting performance in AACRA is considered poor in time, cost and quality dimensions by the majority (72%, 82% and 84% respectively) of the respondents.

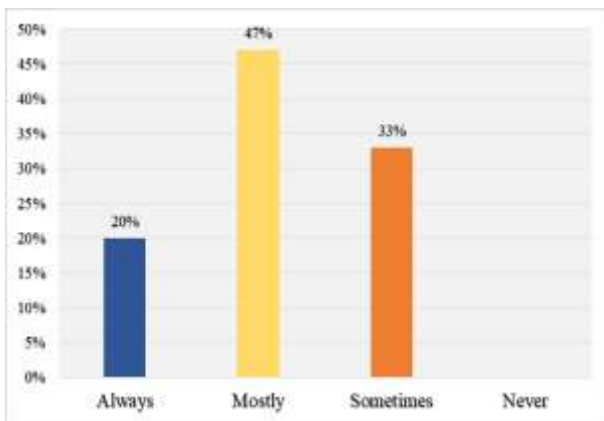


Figure 2: Utilization of Subcontracting
Source: Survey Result (2017)

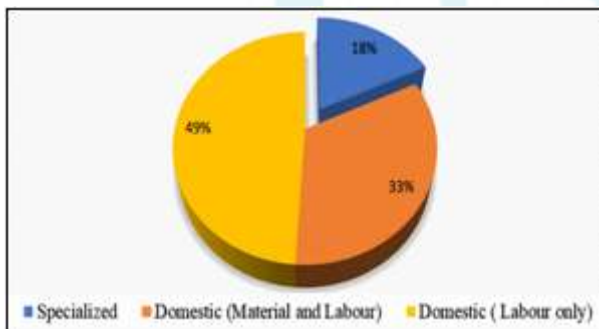


Figure 3: Subcontracting Category
Source: Survey Result (2017)

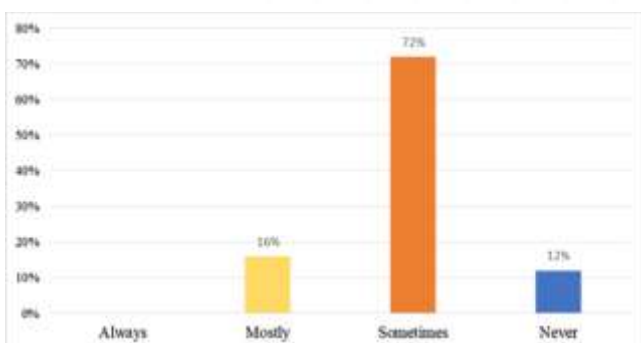


Figure 4: The trend of subcontractor approval

RII (Relative importance index)

According to Koshe and Jha (2016), mean and standard deviation of each individual determinant is not a suitable measure to assess overall rankings as they do not reflect any

Table 1: Determinants of subcontracting performance in AACRA Projects as rated by Contractors, Subcontractors and Consultants (combined)

Category	Determinants	RII	Rank
Subcontractor related	Substandard works	0.875	1
Subcontractor related	Poor method of works	0.847	2
Contractor related	Delay in progress payment	0.847	3
Subcontractor related	Not deploying the required resource	0.839	4
Cooperation	Absence of Team work	0.804	5
Contractor related	Absence of properly prepared Initial document for subcontracts.	0.776	6
Subcontractor related	Shortage of skilled labor on the subcontractor’s team	0.769	7
Cooperation	Absence of long term partnership	0.757	8
Contractor related	Poor Subcontractor selection	0.745	9
Cooperation	Absence of proper communication	0.741	10

Source: Survey Result (2017)

Correlation analysis

The relationship between the contractors, subcontractors, consultants’ views on the determinants of subcontracting performance was shown by Pearson Correlation analysis using the RII scores by contractors, consultants, subcontractors. Among the top ten determinants rated by the three groups of stakeholders, six determinants namely substandard works, poor method of works, not deploying the required resource, absence of team work, absence of properly prepared initial document for subcontracts, shortage of skilled labor in the subcontractors’ team were included on the top ten determinants of all groups. A Pearson correlation was calculated to confirm the difference and alignment in rating the determinants of subcontracting performance by the different stakeholders. (Refer Annex III). Thus the correlation between the views of contractors and subcontractors, contractors and consultants, subcontractors and consultants were summarized on Table 2.

Table 2: Correlation test for stakeholder’s views

Stakeholders	Pearson Correlation coefficient	Significance level
Contractors and Subcontractors	0.711	1%
Contractors and Consultants	0.717	1%
Subcontractors and consultants	0.625	1%

Source: Survey (2017)

There is a positive correlation between contractors and subcontractors, contractors and consultants, subcontractors and consultants with a significance level of 1%. The presence of a positive correlation between the three different stakeholders and the presence of the six common top ten

determinants has enabled the researcher to consider the combined top ten factors as representative determinants of all the stakeholders for further analysis.

Factor Analysis

A factor analysis was performed to select the underlying factors out of the 10 factors already selected by RII by a

Principal Component Analysis (PCA) or Factor Analysis to extract the underlying factors based on the total variance of factors. The suitability of the data for factor analysis was assessed using KMO and Bartlett’s test. A VARIMAX orthogonal rotation was used as it provided clearer separation of factors (Refer Table 3).

Table 3: Rotated Component Matrix

	Component			
	1	2	3	4
Poor method of works	.745			
Not deploying the required manpower and other resources	.751			
Substandard works by the subcontractor	.788			
Shortage of skilled labor on the subcontractor’s team	.710			
Absence of properly prepared Initial document for subcontracts.			.796	
Poor Subcontractor selection			.771	
Delay of progress payment				.889
Absence of regular communication		.716		
Absence of Team work on the project		.788		
Absence of long term Partnership		.700		

Source: Survey Result (2017)

Poor performance of the subcontractor, Cooperation problem, Poor preparation of the contractor and Delays of progress payment are the underlying determinants that affect performance of subcontracting at AACRA as depicted on the 1st to 4th column of the Rotated Component Matrix. (Refer Table 3).

Regression Analysis

The next question is how significantly the underlying determinates affect performance of subcontracting. Binary logistic regression is selected as it is a specialized form of regression formulated to predict and explain a binary (two-

group) categorical variable rather than a metric dependent measure.

Model 1: Effect of the determinants on subcontracting performance on time dimension

The Wald criterion (Refer Table 4) demonstrated that poor performance of the subcontractor, initial preparation problem, cooperation problems and Delay of progress payment made significant contributions to prediction (p = .014, .020, .023, .020) at 95% level of confidence.

Table 4: Subcontracting Performance on time dimension

		B	S.E.	Wald	Df	Sig.	Exp(B)
Subcontracting Performance on Time dimension	Poor performance	-3.677	1.495	6.045	1	.014	.025
	Initial preparation problem	-3.674	1.579	5.415	1	.020	.025
	Cooperation problem	-2.873	1.262	5.181	1	.023	.057
	Delay of payments	-2.641	1.139	5.381	1	.020	.071
	Constant	-4.033	1.686	5.723	1	.017	.018

Source: Survey Result (2017)

Model 2: Effect of the determinants on subcontracting performance on cost dimension.

Likewise, the Wald criterion for cost dimension demonstrated that poor performance of the subcontractor made significant contributions to prediction (p = .008) for 99% level of confidence. Initial preparation problem and cooperation problem made significant contributions to prediction (p = .034 and .022) for 95% level of confidence. “Delay of payments” from the model were rejected since its effect was not significant by the Wald statistic (p=.133).

Model 3: Effect of the determinants on subcontracting performance on quality dimension. The Wald criterion for quality dimension demonstrated that poor performance of

the subcontractor, initial preparation and cooperation problem made significant contributions to prediction (p = .037, .038 and 0.041) for 95% level of confidence. “Delay of payments” from the model were rejected since its effect was not significant by the Wald statistic (p=.913).

6. Conclusion

Currently, the practice of subcontracting at AACRA is extensive but mainly dominated by labor-only works which are usually much lower in amounts than material plus labor and specialized works. Road project contracts at AACRA have a maximum limit of 40% for subcontracting works but the minimum percentage of works that should be subcontracted is not placed on the contracts. AACRA and

consultants have had low involvement on the selection of subcontractors. Evaluation of road projects had seldom incorporated evaluation of the different subcontractors involved on the projects. Both quantitative and qualitative studies have confirmed the significant effect of Poor preparation of the contractor on subcontracting performance of AACRA. The selection criteria of subcontractors had been based on a personal relationship with a subcontractor and too low price offer by the subcontractor. Also Subcontract documents had not been properly prepared by the contractor. The absence of clear terms and conditions on subcontract documents has been a reason of disputes between contractors and subcontractors.

Poor performance of subcontractors (quality and execution problems) had a significant effect on time, cost and quality dimensions of subcontracting performance. Subcontractors with poor method and substandard works were among the reasons that resulted delays and cost overruns due to reworks and contractual disputes. Subcontractors with substandard works have made a negative impact on subcontracting performance of AACRA projects on quality dimension. Lack of Cooperation (absence of team work between the contractor and subcontractor, failure of communication between the contractor and subcontractor in resolving progress issues and absence of long term partnership) was the other identified determinant which has affected subcontracting performance on time, cost and quality dimensions. Delay of progress payments by the contractor was the other significant determinant that has affected subcontracting performance on time dimension by affecting the financial capacity of subcontractors.

7. Recommendations

Client/AACRA/

- Subcontracting practice at AACRA should extend to full domestic (material and labor) and specialist types of subcontracting. To widen subcontracting in magnitude and type, the inclusion of a modality for minimum percentage of subcontracting works on road contracts is highly recommended.
- AACRA needs to develop a system for its involvement on the approval of subcontractors and evaluation of subcontracted works. A preparation of subcontracting policy and guidelines is essential for all stages of the project, from contract document preparation to evaluation of projects.

Contractors

- Contractors better select subcontractors with properly designed selection criteria.
- Subcontract documents should clearly define the responsibilities of contractors and subcontractors.
- Progress payments need be paid to subcontractors in time by the contractor.
- The contractor needs to work with subcontractors as a team, communicate properly and develop a long term partnership.

Subcontractors

- Subcontractors better improve the quality of their works by enrolling the necessary resources and methods including skilled manpower.

Consultants

- Consultants should be involved on subcontractors' approvals and Project evaluations need to incorporate evaluation of the subcontractors.

References

- [1] AACRA Communication Affairs Directorate. (2017). Finot AddisMagazine, February, Volume 1~ Issue 3pp.:18-23
- [2] PMBOK Guide(A Guide to the Project Management Body of Knowledge). (2013). 5th ed. Project Management Institute.
- [3] Ayalew, T., Dakhli, Z. and Lafhaj, Z. (2016). Assessment on Performance and Challenges of Ethiopian Construction industry. Journal of Architecture and Civil Engineering Volume 2 ~ Issue 11 pp.: 01-11
- [4] Boston consulting Group (2016). Shaping the Future of Construction, a Breakthrough in Mindset and Technology, presented at World Economic Forum, Geneva.
- [5] California Department of Transportation Division of Construction, (2013). Field Guide to Partnering on Caltrans Construction Projects, California Department of Transportation Division of Construction, California
- [6] Chamara, KGA, S. and Harshini, M. (2015). Evaluating Subcontractor Performance in Construction Industry. Paper presented at the 6th International Conference on Structural Engineering and Construction Management, Kandy, Srilanka.
- [7] Choudhry, R., Hinze, J., ASCE, M., Arshad, M. and Gabriel, H. (2012). Subcontracting Practices in the Construction Industry of Pakistan. Journal of Construction Engineering and Management. Volume 132~ Issue 12
- [8] Dykstra, A. (2011). Construction Project Management: A Complete Introduction. San Francisco: Kirshner publishing company.
- [9] ERA. (2016). Annual road projects performance report .Available at:<http://www.era.gov.et/>
- [10] Hair, J. F., Black, W.C, Babin, B. J and Anderson, R. E (2010). Multivariate Data Analysis: A Global Perspective, 7th edition. Published by Pearson Education
- [11] Kaliba, C. (2010). Cost Escalation, Schedule Overruns and Quality Shortfalls On Construction Projects. Unpublished dissertation, University of Zambia
- [12] Lavelle, D., Hendry and Steel, G. (2007). The selection of subcontractors: Is price the major factor? Paper presented at the 23rd Annual ARCOM Conference, 3-5 September 2007, Belfast.
- [13] Lebas, D.L. (2014). Entering into Construction Contracts and Subcontracts, Construction Law Seminar, Austin, Texas.
- [14] Lin, L. (2011). Supply chain quality management for subcontracting systems in the construction industry. MEng thesis. Wollongong, New South Wales: University of Wollongong.

- [15] Mirawati, N. A., Othman, S. N. & Risyawati, M. I. (2015). Supplier-Contractor Partnering Impact on Construction Performance: A Study on Malaysian Construction Industry, *Journal of Economics, Business and Management*, 3(1), pp. 29-33
- [16] Mudzvorwa, T. (2017). Improving the main contractor-subcontractor relationship through partnering on construction projects, *PM World Journal*, Vol. VI, Issue II
- [17] Okunlola, O.S, (2015). The Effect of Contractor Subcontractor Relationship on Construction Duration in Nigeria, *International Journal of Civil Engineering and Construction Science*. Vol. 2, No. 3, 2015, pp. 16-23.
- [18] Polat, G. and Damci, A. (2014). Subcontracting Practices in International Construction Projects: Evidence from Turkish Contractors, Paper presented at the Creative Construction Conference Istanbul, Turkey.
- [19] Rajput, B.L. and Agarwal, A. L (2015). Study of Pros and Cons of Subcontracting System Adopted in Executing Indian Construction Projects, *International Journal of Modern Trends in Engineering*, No:2349-9745
- [20] Werku Koshe and K. N. Jha. (2016). Investigating Causes of Construction Delay in Ethiopian construction Industries. *Journal of Civil, Construction and Environmental Engineering*. Vol.1, pp. 18-29
- [21] Yamane, Taro. (1967). *Statistics: An Introductory Analysis*, 2nd Edition. New York: Harper and Row.
- [22] Yoke-Lian, L., Hassim, S., Muniandy, R., and Teik-Hua, L. (2012). Review of Subcontracting Practice in Construction Industry', *IACSIT International Journal of Engineering and Technology*, Vol. 4, No. 4.
- [23] Zambian Road Development Agency. (2011). Modality of subcontracting on Zambian road projects. Available at <http://www.rda.org.zm/index.php/publications>