American Journal of Engineering, Science and Technology (AJEST) Volume 19, 2023

Influence of Rework on Road Projects in Ghana: A Case of the Sawla – Fulfulso Road

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Abstract

The incidence of rework in project delivery has been of great concern to project managers as it affects profitability, productivity, and project performance. The study aims to identify the effect of rework on project cost and project duration and the factors responsible for reworks in the road construction sector in Ghana. The authors choose two major road projects linking the Northern and Upper West Regions of Ghana as case studies for this research. Scheduled interviews were conducted involving key stakeholders involved in the road construction. The authors instituted a weekly site visit to the project sites to validate the research findings. The study revealed an average increase of about twenty-one percent (21%) and twenty-three-point eight percent (23.8%) in cost and duration, respectively, due to rework. The causes of rework, as revealed by this study, are deviation from quality specifications, poor site managerial related problems, inadequate coordination, and communication among stakeholders of the project and changes in construction methods. The rework had negative impacts on the returns on investment, frequent armed robbery attacks along the road stretch, and avoidable road accidents. These impacts resulting from the rework have consequential effects on other sectors of the economy sectors whose activities depend on road transport. The existence of construction firms hinges on reducing waste at construction site, so effectively managing rework is imperative for project managers.

Keywords: Cost Overruns, Fufulso-Sawla, Ghana, Project Delay, Rework.

1. Introduction

Construction is one of the most significant sectors, contributing to about 10% of the Gross National Product (GNP) in developed countries. The fact that the construction industry is vital to the socio-economic development of every nation cannot be overemphasized (Navon, 2005). The Construction industry remains a vital sector as far as every nation's development is concerned (Agyakwa-Baah and Fugar, 2010). The sector ranks as one of the most critical determinants of the Gross Domestic Product (GPD) in Ghana, which has contributed an average of 8.9% to its GPD (Ghana Statistical Service, 2010). The construction industry plays a significant role in the

development of rural and urban communities and also provides enormous employment to a more substantial population of the country (Amoah et al, 2011).

The construction industry, despite its numerous contributions, is one of the dicey and complicated industries characterized by very fluctuating and unforeseen variables (Oyewobi et al. 2011), making rework inevitable in road construction projects. The term rework has been described and interpreted widely in the literature on construction management (2002b). Expressions like non-conformances, quality deviation, defects, and quality failures have been used synonymously for rework (Buratti et al.1992, Abdul-Rahman 1993, Barber et al.2000, Josephson and Larsson 2001, Josephson et al.2002). Ashford (1992) defined rework as the process by which any effort or corrective work is made to the already completed work section to fulfill its fundamental requirements. Or the process of putting extra effort on a piece of work due to nonconformance to standards'' (Construction Industry Development Agency, 1995). Similarly, Love et al., (2000) described rework as the avoidable effort of re-doing an activity or process which has already been done incorrectly. Though the menace of rework cannot be eliminated, its occurrence can be reduced if the necessary procedures and specifications are followed (Hwang et al., 2009).

The occurrence of reworks in the construction industry is very rampant in most projects globally, affecting profitability, productivity, and project delivery time (Jason et al.2012).Love (2002a) also bolsters this point by saying that rework contributes to cost and time overruns in construction projects. The fact that construction involving civil works has a high rate of rework and waste cannot be ruthlessly eliminated resulting in deadline delays and low-quality work (Grohmann, 1998).A study on rework by Ibrahim (2016) on residential building projects West Bank in Palestine, revealed a range of ten percent (10%) and fifteen percent (15%) increase in the original contract sums because of rework. However, another study by Jason et al. (2012) revealed a lower median cost of 4.03%. The main objectives of this study are limited to identifying the factors responsible for reworks in the road construction industry in Ghana, to determine the various effects of reworks in terms of cost to the contractor and usage to the client and end-user and to make recommendations on how to reduce re-work on road construction projects in Ghana.

2. Research Methodology

The methodology employed for this research is the empirical method, which is based on observed and measured phenomena and derives knowledge from real-time experience rather than from theory or belief. Direct and indirect observations and experiences serve as back-bone for this study. The authors chose two major road projects in the Northern Region of Ghana as a case study on the premise that they do as the main approved roads linking the Northern and the Upper West Regions. The roads also serve as the access route to most tourist centers in the regions, such as Mole National Park, the Larabanga Old Mosque, and the Mystic Stone, all significant

national landmarks in Ghana. In line with this methodology, the study outlined specific interviews with the Deputy Chief Executive, Northern Regional Highway Director (Ghana Highway Authority), Northern Regional Maintenance Manager, Northern Regional Materials Engineer, and Sawla Area Manager all under Ghana Highway Authority (GHA). Weekly site visits to both projects site, also carried out to make the necessary field observations needed for this study.

3. Findings and Discussion

3.1 *Background to Case Study Projects*

The proposed project was the re-construction/construction of the 147.5km Fufulso-Sawla road, which traverses three (3) districts namely, Central Gonja District, West Gonja District, and Sawla-Tuna-Kalba District all in the Northern Region of Ghana. The road, earmarked for development into a trunk road providing the main gateway to the Upper West Region from Tamale (Environmental and Social Impact Assessment, ESIA, June 2010).

The project involved engineering feasibility study, social and economic viability studies for the re-construction of the trunk road. It was classified as a category 1, given the type of works to be undertaken and the potential direct and indirect impacts it could generate, especially on sensitive ecosystems.

Re-construction/Construction of the corridor comprised:

- Construction of 147.5km paved carriageway with bitumen surface;
- Construction of drainage system including culverts
- Construction camps;
- Water supply in the communities along the road corridor;
- Support to Women's agro-processing activities along the road corridor;
- Rehabilitation of existing schools;
- Rehabilitation of existing health facilities;
- Remodeling of markets and lorry parks, for communities along the stretch such as Larabanga, Busunu, Fufulso, and Sawla.

The construction phase involved bituminous surfacing of 147.50km with a carriageway of 7.3m and 2m wide shoulders on both sides of the carriageway. Some of the detailed works were construction/rehabilitation of eighty (80) culverts, placement of road signs along the road, haulage of materials, construction of work camps, and earthworks (ESIA, June 2010).

3.2 Project Justification

Road infrastructure constitutes a major component of the transport system in Ghana. Road transport makes up about 98% and 95% of freight and passenger traffic (Ministry of Transportation, 2007).

The main objectives for the construction of Fufulso-Sawla Road Project were to:

i) provide the only link between Tamale and Wa, the regional capitals of the Northern and Upper West Regions respectively;

ii) increase agricultural production, socio-economic advancement of the people and reduce poverty; and

iii) provides the only access to the Mole National Park, the Larabanga Old Mosque, and the Mystic Stone, which are critical national landmarks of great tourism importance in Ghana.

The low-lying nature of some sections of the current road made it flood-prone and unmemorable after heavy rains. This affected traffic flows. Gullies created by severe erosion at sections of the road also led to the narrowing of the existing highway, which detrimentally leads to down movement of goods and people. However, the implementation of the project was aimed at opening up the area, especially the rural agricultural sections, and providing a boost to socio-economic activities with its resultant benefits to the local communities and the nation as a whole (ESIA, June 2010).

3.3 Economic Benefit of the Project

About 41km stretch of the road separates the Mole National Park and Kenikeni Forest Reserve. Over 93 species of mammals, about 400 species of birds, nine amphibians, 33 reptilians, and several insectivorous species and five endemic butterfly species, were recorded in the Mole National Park. The park is also home to two endemic plant species confined to northern Ghana. The communities along the existing road depended initially on wells and boreholes for water supply. In communities where boreholes are inadequate, water from the dams serves for domestic purposes.

The Fufulso - Sawla corridor is home to some key sites of historical and cultural importance. The Mole National Park, Jintrepe Mass Grave, Larabanga Mystic Stone, and the ancient mosque are of interest to the local people and foreigners, with an estimated 10,000 people visiting these places every year. Hence, this road's need to be upgraded was a step in the right direction (ESIA, June 2010).

3.4 Project Information

The project's employer was the Ghana Highway Authority (GHA), funded by the African Development Bank (AfDB). The Engineer’s representative was also M/S Intercontinental Consultants and Technocrats Pvt Ltd., India, and M/S Twum Boafo & Partners, Ghana (JV). Considering the work volume and the minimum value of works executed within the last five

years which was a pre-requisite of awarding the contract, the project was divided and awarded into two lots. The first lot started from Fulfulso to Larabanga (80km + 3km to Damango Hospital) was awarded to M/S China International Water & Electric Corp. (CWE) with a contract sum of GH¢74,202,461.28 comprising GH¢34,633,330.10 local component and US$26,676,418.24 component. On the other hand, the second lot on the other hand, started from Larabanga to Sawla (67.5km + 6km to Mole Park) was awarded to M/S China Harbour Engineering Company Ltd. (CHEC) with a contract sum ofGH¢51,457,730.62comprising GH¢34,633,330.10 local component and US$6,798,992.52 component. Table 1 shows the summarized project information.

Table 1: Summarized project information

Lot No	Lot 1:	Lot 2
Road Name	Fufulso – Larabanga (80km + 3km to Damango Hospital)	Larabanga – Sawla (67.5km + 6km to Mole Park)
Name of Contractor	M/S China International Water & Electric Corp. (CWE)	M/S China Harbour Engineering Company Ltd. (CHEC)
Original Contract Amount	Ghana Cedi Component -34,633,330.10 US$ Component - 26,676,418.24 Total Ghana Cedis Equiv. GH¢74,202,461.28	Ghana Cedi Component- 38,406,165.02 US$ Component - 6,798,992.52 Total Ghana Cedis Equiv. GH¢51,457,730.62
Revised Contract Amount including variations	GH¢47,243,728.30 US$38,953,130.22 Total Ghana Cedis Equiv- GH¢105,022,906.35 Total US Dollars Equiv- US$ 26,255,726.58	GH¢47,842,337.45 US$9,204,838.92 Total Ghana Cedis Equiv.- GH¢61,457,730.62 Total US Dollars Equiv- US$ 15,364,432.66
Contract Period	36 months (original) 43 months (Revised)	36 months (original) 42 months (Revised)
Commencement Date	3rd January 2012	3rd January 2012

Scheduled Completion Date	2nd January 2015 (original) 31st July 2015 (Revised)	2nd January 2015 (original) 2nd July 2015 (Revised)

3.5 Quality Control

As per clause 7.1b of FIDIC 2006, the Contractor was to execute the works carefully and adequately, per recognized acceptable practices.. However, direct personal structured interviews with the former Regional Highway Director and the Sawla Road Area Manager (G.H.A) revealed that in the quest for the contractors to complete the works ahead of schedule. The Contractor working on the second Lot resulted in working both day and night with no direct supervision during the night shifts. Per the design works, the Contractor raised most of the road sections, and as a quality control measure, all fillings ought to have layers of 150mm. The interview also revealed that most of the gravel material used during the night shifts was not approved. Observations pointed one occasion, the Regional Highway Director visited the site and offered an advised both to the Engineer's Representative and the Contractors on the need to work according to the specifications given as an early warning sign, as per clause 32.1 of the Conditions of Contract. The response from both the Engineer's Representative and the Contractors indicated no cause for alarm. Should there be any defects whatsoever, the defects liability period will cater to all those issues on the defects.

These incidences are in line with the findings on a study done on reworks by Burati et al. (1992), who discussed the causes of "quality deviations" in design and construction. He defined "Quality as 'conformance to established requirements.' The term deviation indicates that a product or result that does not fully conform to all specification requirements. The study proved that when management's attention was drawn to the fact that they were deviating from the prescribed quality standards, they turned a deaf ear to it. Other previous studies can also buttress this by many researchers (Ye et al., 2014; Palaneeswaran et al., 2008; Love et al., 1999, 2002a, 2010; Love and Edwards, 2004; Josephson et al., 2002) who identified managerial aspects as critical factors contributing to rework.

3.6 Defects Liability Period

The hand of lots 1 and 2 handed over on 25th August 2015, which means that the Defect Liability period contractually was on 24th August 2016. However, a joint inspection conducted Client’s, site, the Engineer’s Representative, and representatives of the two contractors revealed a lot of significantdefects thatought to be corrected especially on Lot 2. The situation on the ancillaries for Lot 2 per the interview conducted for this research was very alarming. The GHA team suggested taking over the Roads without the ancillary works to enable the Contractor to rectify the ancillary works' defects. However, by GHA’s suggestion was contested by the Contractor who insisted on correcting all defects both on the road and on the ancillary works within two calendar months and duly accepted by the Client (GHA). The Contractor made efforts as per the above arrangement. Photographs of some of the defective as well as their

correspondent reworks are shown in the photographs attached.

Again, a joint handing over inspection was made in November 2016 after three months' expiration of the Defects Liability Period date and it was resolved that one of the projects (Lot 2) cannot be taken over since the defective sections were many. The situation created an alarm to the Client, who decided to extend the Defects Liability Period (DLP) by another six months. The cause of deterioration from the part of the affected Contractor was attributed to the continuous haulage of chippings by heavy-duty trucks which were hauling chippings from two quarries at Tuna to the Projects site. The Contractors initially contested this extension of the DLP, but after an arbitration act, it was agreed that the DLP must be extended by additional six months to May 2017.

Figure 1. Illustrates some of the defective works executed by the contractor due to poor supervision and the lack of adequate understanding of the contract documents.

3.7 Period and cost for reworks done (Lot 2)

From the above discussion, the remedial works for Lot 2 started in October 2015 and have been on-going to the date of gathering information for this study in April 2017. Approximately about 105 sections received reworks with each section's length ranging from 30m to 200m. For a particular area (CH.120+000 to CH.120+800), the stretch rectified length was about 800m. Some of the sections affected have received reworks for almost three consecutive times. The total road that received reworks sums up to approximately 12.40, which represents 18.3% of the full road length for Lot 2.

However, physical observation of lot 1 revealed three significant sections for remedial works. The Contractor reported to the site in December 2016, and since been working on the three

identified sections. From the Client's point of view, the level of defects on Lot 1 was within an acceptable range, which they think the Contractor can efficiently work on them to enable them completely to take over the Project. For this research's purpose and objective, Lot 1 will not be analyzed further since the Client is generally satisfied with the quality performance of the road in this Lot. The reason given by the GHA team on the success of the Contractor on Lot 1 is the Contractor's ability to work according to the given specification as well their ability to officially raise early warning signs on almost all issues that had the potential of affecting the quality of works executed.The correction on the reworks for Lot 2 was tackled with two significant gangs, with each crew possessing the following equipment as shown in the table below:

Figure 2. Shows the Contractor’s Reworks and defects corrections

Table 2: Approximate Days of Equipment usage (2015)

ITEM	DESCRIPTION	QUANTITY	PERIOD USED (DAYS)			
			Oct -16	Nov -16	Dec -16	Total
1.	Excavator	1Nr	15	26	23	64
2.	Tipper Trucks	4Nr	15	26	23	64
3.	Vibratory Roller	2Nr	15	26	23	64
4.	Payloader	1Nr	15	26	23	64
5.	Grader	1Nr	15	26	23	64
6.	Water Bowser	1Nr	15	26	23	64
7.	Pick up	1Nr	15	26	23	64

Table 3: Approximate Days of Equipment usage (2016)

ITEM	DESCRIPTION	QTY	PERIOD USED (DAYS)												
			Jan-16	Feb -16	Marc -16	Apr -16	May -16	Jun -16	July-16	Aug-16		Oct-16	Nov-16	Dec-16	Total
1.	Excavator	1Nr	26	26	25	25	25	24	25	26	2	26	25	2	301
2.	Tipper Trucks	4Nr	26	26	25	25	25	24	25	26	25	26	25	23	301
3.	Vibratory Roller	2Nr	26	26	25	25	25	24	25	26	25	26	25	23	301
4.	Payloader	1Nr	26	26	25	25	25	24	25	26	2	26	25	2	301
5.	Grader	1Nr	26	26	25	25	25	24	25	26	2	26	25	2	301
6.	Water Bowser	1Nr	26	26	25	25	25	24	25	26	25	26	25	23	301
7.	Pick up	1Nr	26	26	25	25	25	24	25	26	2	26	25	2	301

Table 4: Approximate Days of Equipment usage (2017)

ITEM	DESCRIPTION	QTY	PERIOD USED (DAYS)				
			Jan-16	Feb -16	Mar -16	Apr -16	Total
	Excavator	1Nr	26	26	25	25	102
	Tipper Trucks	4Nr	26	26	25	25	102
	Vibratory Roller	2Nr	26	26	25	25	102
	Payloader	1Nr	26	26	25	25	102
	Grader	1Nr	26	26	25	25	102
	Water Bowser	1Nr	26	26	25	25	102
	Pick up	1Nr	26	26	25	25	102

Table 2, 3 and 4 details the average hiring rate of the equipment and the cost of the machinery usage cost from October 2016 to April 2017. Table 5 summarizes the equipment cos for works.

Table 5: Summary of Equipment Cost for reworks (2015 – 2017)

ITEM	DESCRIPTION	QTY PER GANGS	QTY FOR 2 GANGS	PERIOD USED (DAYS)					COST ANALYSIS	
				2015	2016	2017	SUB-TOTAL	TOTAL FOR 2 GANGS	DAIHLY HIRINGRATE INCLUDING FUEL (US$)	AMOUNT (US$)
	Excavator	1Nr	2	64	301	10	467	934	700	653,800
	Tipper	4Nr	8	64	301	10	467	934	325	303,550
	Vibratory	2Nr	4	64	301	10	467	934	500	467,000
	Payloader	1Nr	2	64	301	10	467	934	375	350,250
	Grader	1Nr	2	64	301	10	467	934	650	607,100
	Water	1Nr	2	64	301	10	467	934	275	256,850
	Pick up	1Nr	2	64	301	10	467	934	100	93,400
	TOTAL									**2,731,950**

3.7.1 Labor Cost

The average labor force on each gang is about fifteen, making the number of field workers about thirty. Considering about five office staff, the approximate number of employees amounts to thirty-five (35). The details are highlighted in Table 6.

Table 6: Summary of Labor Cost for re-works (2015 – 2017)

ITEM	DESCRIPTION	QTY PER GANGS	QTY FOR 2 GANGS	PERIOD USED (DAYS)					COST ANALYSIS	
				2015	2016	2017	SUB-TOTAL	TOTAL FOR 2 GANGS	DAILY LABOUR WAGE (US$)	AMOUNT (US$)
	Operators	5	10	64	301	102	467	934	12.50	11,675.00
	Drivers	6	12	64	301	102	467	934	8.75	8,172.50
	Laborers	4	8	64	301	102	467	934	5.00	4,670.00
	Supervisors	5	10	64	301	102	467	934	16.00	14,944.00
	TOTAL									**39,461.50**

3.7.2 Material Cost

The estimated cost of materials used for the primer seal and seal of the reworks are shown in Table 7:

Table 7: Summary of Material Cost for re-works (2015 – 2017)

ITEM	DESCRIPTION	UNIT	QUANTITY	RATE (GH¢)	AMOUNT (GH¢)
	AC-10 Bitumen	Lit	369,025	0.75	**276,768.75**
	Kerosene	Lit	27,776	0.75	**20,832.00**
	Precoating Material	Lit	38,745	0.78	**30,221.10**
	10mm Chippings	m^3	1,033	25.00	**25,825.00**
	14mm Chippings	m^3	1,550	25.00	**38,750.00**
	TOTAL				**395,396.85**

Table 8 gives a summary of all equipment, labor and material cost estimated to be incurred by the contractor for the re-works have been summarized below:

Table 8: Summary of equipment, labor, and material cost for re-works (2015 – 2017)

ITEM	DESCRIPTION	AMOUNT (US$)	AMOUNT (GH¢)
1.	Equipment Cost	**2,731,950.00**	10,927,800.00
2.	Labor Cost	**39,461.50**	157,846.00
3.	Material Cost	**395,396.85**	1,581,587.40
	TOTAL	**3,166,808.35**	**12,667,233.40**

Figures 7 and 8 can be analyzed using a formula developed by the Construction Industry Institute – CII. (1997) used for quantifying the impact of rework on construction cost. The formula is indicated in the chart below:

Total Field Rework Factor	=	Total direct cost of field rework
("TFRF")		Total construction cost
TFRF	=	US$3,166,808.35
(“TFRF”)	=	US$ 15,364,432.66
TFRF		0.21

The Field Rework Factor of 0.21 (21%) is considered total profit, which the contractor could have realized. Also, the time used for the reworks alone is 23.8% of the revised contract period. Findings from other studies support the above results on the cost of reworks done. Barber et al. (2000) suggested that rework costs could be as high as 23% of the contract value. In a sample of private building projects in Hong Kong, the direct cost of rework was 16.1% of the original contract value. The corresponding value for indirect expenses was 4.8% (Palaneeswaran et al., 2005). Rhodes et al. (2002) researched South Africa's construction projects and found rework costs to be 13% of the completed project's value.

3.8 Effects of re-works

Based on the client's anticipated expectation for embarking on this project, the identified effects resulted:

- The client had the initial plan of laying asphalt on the road, but per the study's findings, that arrangement cannot be possible. The high cost of introducing a stabilized base on the road did not yield its intended results.
- Road users regularly face armed robbery attacks, especially at night, at the road's defective sections, which compelled vehicles to slow down considerably.
- Accidents still occur due to the development of potholes and protruded sections of the road.
- Reduce the revenue ought to have been generated by the Government of Ghana since the menace will prevent some tourists from visiting some prominent tourist centers around the road corridor.
- Frequent and high maintenance charges to vehicle owners who use the road
- The future chance of the contractor who executed the works on Lot 2 is likely not to be awarded any future project in Ghana.

The studies support the outlined effects conducted by Palaneeswaran (2006). They argued that the direct impact of rework on the project consists of additional time, the cost to rectify the occurrence, materials, and an increase in labor cost to fix the defect, plus related extensions of workforce supervision.

As listed above, the last effect is an example of indirect consequences of rework that are a lot harder to express in terms of money or costs. These effects can be directly linked to Love's (2002a) findings, who, among other factors, stated End-user dissatisfaction and Damage to a professional image.

5. Conclusion and Recommendations

This study aimed to identify the effects of rework on project cost, schedule, scope, and other related factors on the road construction project in Ghana. The authors studied extensively two major road projects linking Northern and Upper Regional parts of Ghana with interviews between stakeholders and eighteen (18) frequent site visits. The average percentage of rework compared to the revised contract sum is 21%, while the time used for the rework is 23.8% of the revised contract period.

The study results revealed the most significant rework causes that significantly impact project performance: deviation from quality specifications, poor site safety/management, the total absence of coordination/communication between stakeholders, and frequent changes to scope without due regard to change order process. The other related effects result from lack of risk identification before the start of the project leading to rampant insecurity along the project's stretch. The temporary nature and lack of skilled workers engaged with the project led to errors and rework. The findings may help the road sector construction stakeholders appreciate rework causes that affect construction performance and cost-related matters. The results will develop defined strategies for better coordination, preplanning, and risk identification from project initiation to closeout to reduce rework, enabling project performance improvements to Ghana's road sector projects. The findings and recommendations of this study may also apply to other African and developing countries.

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