UNIVERSITY OF LUSAKA

SCHOOL OF POSTGRADUATE STUDIES

STRATEGIC LEAN THINKING AND VALUE MANAGEMENT FOR GRAVEL ROADS IN ZAMBIA: A CASE STUDY OF OUTPUT PERFORMANCE BASED ROAD CONTRACTS

BY

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Strategic Lean Thinking and Value Management philosophies in the Construction and Maintenance of Gravel Roads in Zambia

DECLARATION

I hereby declare that this PhD Research and Thesis were conducted and written solely by myself, guided and assisted by Professor Chibelushi M. Musongole (PhD) and Dr. Christine P. Mushibwe (PhD) in accordance with the University of Lusaka Senate rules. Further that all information in this Document [PhD Research Thesis] has been obtained and presented in accordance with academic regulations and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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DEDICATION

It is with great honour that I dedicate this piece of work to my Wife, Children and Parents. But most of all it is worthwhile to note that this work was provoked and conducted in memory of my late mother and my late daughter so as to keep their dreams alive and bring their desires and aspirations somehow to fruition.

UNILUS, Lusaka, April, 2015.

Kasongo Richard Mwale

"…what should have been done in haste yesterday is better done in calm tomorrow[1]…and tomorrow of yesterday is today, which is now[2]"

(Bjornfot Anders[1], 2006 and Author[2], 2015)

"I do not know what I appear to the World; but to myself I seem to have been only like a boy playing on the Seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me".

(Hopp & Spearman, Isaac Newton)

"This Journey is far from over, but suffice to say that in my view I could safely say that my perceived destination for now is here, where my steam appear to have vanished"

(Kasongo, R.M. Author, 2015).

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I am most grateful to my research supervisor, Professor C. M. Musongole, for his critical but infallible guidance, patience and support coupled with the rich knowledge and experience in the areas of Research methodology and Statistics to which I have greatly benefited and will always remain deeply indebted. His unreservedly calmness whenever I called upon him for advice, is one which I will always cherish for the impetus it gave to this research work.

Further, I wish to extend my sincere gratitude to Dr. C.P. Mushibwe (ZAOU), Management and members of Staff of University of Lusaka (UNILUS), especially the Department of Business Administration and Management for their unfailing and awesome guidance and support rendered to me during the entire course of my studies. Without their contribution, this piece of work could not have been realised. I also will forever remain indebted to Management and Staff of Ng'andu Consulting Limited, for their goodwill to have allowed me to take up PhD studies, amidst the busy and demanding work schedules. I specifically wish to extend my indelible gratitude to the following; Eng. A. Ng'andu (Managing Director), Eng. D. Mwale (Director), Eng. M. Liyungu (Director) and all those that contributed in several and various ways to this study. Great appreciation is also extended to Engineers and other Staff of the RDA, NRFA, NCC, Consulting and Contracting firms for their valuable support.

I am most grateful to my wife Janet and children, Kasongo, Kutasha and Bupalo for their patience and support, especially that I have been away from them emotionally and sometimes physically for the entire period of the PhD studies programme. I wish to thank all my relatives such as Dad, Uncles, Siblings, Cousins, Nieces, Nephews and several close friends etc. that have sacrificed greatly during the course of this very long and daunting but worthwhile PhD voyage. I wish to remember through this piece of work, my dear late mother and daughter [Chilufya] for the love and care they had for me. May the Lord almighty God rekindle their souls to note that they are fondly adored and missed, they were a force to reckon with and have kept my dreams and aspirations alive so as to take me to such great heights to that end this noble task has been accomplished. Above all I am humbled to the Lord through the hand of Jesus Christ, to have given me immense measure of grace that I was able to go through the tedious route of the PhD programme without derailment or incidence that could have otherwise impeded on my progress. Even if this work is dedicated to my family but before them is my everlasting God and may His name always be praised. ***TO GOD BE THE GLORY [DEO GLORIA], FOR THE GREAT THINGS HE HAS DONE!!!!***

MOTIVATION

The interest for me to venture into this Study; *"Strategic Lean Thinking and Value Management for Gravel Roads",* was perceived and conceived in 2008 while I was pursuing my Master of Science (MSc) in the Construction Project Management at Loughborough University, Leicestershire, in England, of the United Kingdom. As a Student at Loughborough, I encountered for the first time the philosophies of *"Lean Thinking"* and "Value *Management"* through Professor Christine Pasquire, my former Lecturer in *"Lean Construction"* and *"Cost and Value Management"* modules.

I should hasten to confess here that these two modules though consisting new or emerging theories were among those that I developed utmost adoration and passion which eventually culminated into my remarkable performance in the same at the end of the MSc programme, at Loughborough University. Professors Pasquire, Alistair, Carrillo, Fotwe and Edwards, invited and encouraged me to stay on to pursue a PhD programme at Loughborough University at the end of the MSc programme in 2009, in these areas. However, although I had impetus to proceed, could not at that time however, take up the offer due to some pressing issues back home, in Zambia. In short, I needed to be back in Zambia as soon as I had completed my MSc programme.

With such pressing demands, Professor Pasquire reluctantly allowed me to leave Loughborough University upon completion of my Studies without entangling myself in other academic studies, but further encouraged me to take up the PhD whenever I felt ready so as to be an ambassador of *"Lean Thinking"* and *"Value Management"* philosophies in Zambia. She inspired me in advancing these Phisolophies in my home Country, Zambia, as they were key drivers to improving performance in many fields of human endeavour, including the Road Construction and Maintenance Management (RCMM). Upon arrival in Zambia, I felt perturbed that I had returned from the United Kingdom with unfinished business, even if I had successfully completed the MSC programme, the main reason for which I travelled there. I should also mention that I was actually yearning to enrol for the PhD research programme in the area of *"Quality Improvement"* and *"Value addition Management"* so as to gain more and in depth knowledge of the philosophies I first interacted with at Loughborough University of the United Kingdom.

Professor Alistair Gibb, the Supervisor for my MSC research project went to a great extent of even arranging for a Scholarship for my PhD programme, which unfortunately I turned down

as I was not ready then, due to circumstances I have earlier alluded to. I am therefore greatly indebted to these gallant learned Men and Women, who triggered and ignited my interest to take up the PhD programme challenge which seemed farfetched then but alive within me.

The passion for me to take up this challenge (PhD) even grew deeper, when I found myself working on the World Bank funded Project under the auspices of the Ministry of Agriculture and Livestock (MAL) and being implemented by the Road Development Agency (RDA). The World Bank Transport and Infrastructure specialist, Ben Gerick, was spearheading Output Performance Road Contracts (OPRCs) for the Construction and Maintenance of gravel roads in Zambia on a pilot basis. In 2010, I was appointed as a focal point person (Coordinator) by RDA Management for this programme while I worked as Chief Engineer – Construction and Maintenance. With the interaction, I had on this programme and experience I was reinvigorated and my almost simmered Loughborough University dream became vividly alive like a gleam or beam of sunlight piercing through a tinny window and so was re-inspired. It became obvious that this was the right time for me to take up the PhD programme challenge in the area of Management, specifically Construction Project Management (CPM).

The nature and state of the Road Network in Zambia also motivated me into selecting the research topic around the Construction and Maintenance of gravel roads. It should be appreciated that approximately 80% of the Zambia Road Network is of gravel standards and if not all, most of them are in a deteriorated state (RDA, 2013). Hence, the reason for my focusing on the research in Construction Project Management (CPM) directed at the improvement of gravel roads. This was also driven by the understanding that I had been working in the Road Sector for over two (2) decades post graduating from the University. My notable vast experience in the Construction and Maintenance of Paved and Unpaved roads in Zambia, offered good platform and basis for me to undertake this study. In short this Study; *"Strategic Lean Thinking and Value Management philosophies in the Construction and Maintenance of Gravel Roads in Zambia"* could not have come at a right time than now.

However, it was not until, UNILUS placed an advert in the Zambian print media in 2011, inviting applications for DBA/PhD programmes, that it clearly dawned on me that time had come to resume this long voyage of pursuing PhD studies. It cannot be overemphasized that this could not come at the right time than now when my main core duties were to do with Construction Project Management (CPM). UNILUS Management is greatly commended for

the initiative and for rolling up its first DBA/PhD programmes, for which I am most delighted and excited to be among the first Cohort of students (candidates).

The encouragement I received from inception of the programme to research topic selection and approval by the Programme Coordinator and Supervisor, Dr. Lewis Chilufya and Prof. Musongole Chibelushi Maxwell respectively, cannot go unnoticed. As for Prof. Musongole, though very critical in appreciating the need to improve gravel roads instead of upgrading them to paved standards, his valuable counsel was however, candidly objective and indelible as a good mentor and motivator. I owe a great deal of most insights in this Study to him for which I will also remain deeply indebted. Dr. C.P. Mushibwe [Co-supervisor], the successor to Dr. L. Chilufya (both now working with ZAOU) offered me great deal of encouragement and rendered the much needed infallible advice and calmly guidance during the course of the PhD Studies. I should conclude by stating that I am most grateful to so many academicians and scholars such as Prof. P. Chifwanikeni, Prof. L. Siaminwe, Dr. R. Kaulule, Prof. S. Kasanda, Mr. Frank M. Kayula (PhD Student) to mention but a few who in some ways rendered me support to enable me embark on this long but worthwhile journey of undertaking PhD Study for the *"Strategic Lean Thinking and Value Management philosophies in the Construction and Maintenance of Gravel Roads in Zambia"* involving theories developed from disciplines of Business and Project Management.

UNILUS, Lusaka, April, 2015.

Kasongo Richard Mwale

Table of Contents

List of Figures

List of Tables

Language and Word Application

LANGUAGE: United Kingdom (UK) and United States of American (USA) English were used interchangeably in this Study. This is because this style of writing has become the normal trend and no hard and fast rules are applied to that regard. Some words are used throughout the Research paper (report) to emphasize the degree to which a recommendation, policy, warrant or criteria requires adherence to and application. The following defines the intent of the commonly used words:

SHALL: Describes a mandatory condition - it must be done regardless of consequence or price,

SHOULD: Describes an advisory condition - it is desirable to do but not necessarily mandatory,

MAY: Describes a permissive condition - it is optional to do but in no way necessary.

CAN: Describes optimistic condition- it is necessarily mandatory recommendation or action

COULD: Describes pessimistic or advisory condition- it is not necessarily mandatory recommendation or action

WILL: Describes non-optional condition – it is necessarily mandatory recommendation or action

WOULD: Describes optional condition – it is not necessarily mandatory recommendation or action

BUT: Describes hesitation condition – the recommendation or action is to be applied or used with caution

AND: Describes other optional condition – additional recommendation or action is also relevantly applicable.

List of Abbreviations and Acronyms

ACEZ- Association of Consulting Engineers of Zambia

ADSP- Agriculture Development Support Programme

AWP- Annual Work Programme

BOQ- Bill of Quantities

BS- British Standards

CBA- Cost Benefit Analysis

CPM – Construction Project Management/Critical Path Method

CREMA- Contracts for Rehabilitation and Maintenance

CRN- Core Road Network

DBB- Design Bid and Build

DBOT-Design Build, Operate and Transfer

DMAIC – Define, Measure, Analyze, Improve and Control

EIZ- Engineering Institution of Zambia

ERB- Engineering Registration Board

EU- European Union

EV-Earned Value

EVM- Earned Value Management

EVS- Earned Value System

FAS-Force Account System

FAST- Function Analysis System Technique

FCT-Funnel Concept Theory

FPS- Ford Production System

GMS- Gravel Management System

GNI- Gross National Income

GRM- Gravel Road Management

GRZ- Government of the Republic of Zambia

GRZ- Government Republic of Zambia

HDM-Highway Design Model

HVOC- High Vehicle Operating Cost

IDA- International Development Agency

IRI- International Roughness Index

ISO- International Standards Organization

IVM- Institute of Value Management

JIT- Just In Time

KFW- Kreditanstalt fur Wiederaufbau (Deutsch)

KNP- Kafue National Park

LCI/IGLC- Lean Construction Institute/International Group for Lean Construction

LP- Lean Production

LT/C- Lean Thinking/Construction

LTE- Lean Thinking Enterprise (Lean Enterprise)

LTT- Lean Thinking Theory

MACO- Ministry of Agriculture and Cooperatives

MAL – Ministry of Agriculture and Livestock

MLGH- Ministry of Local Government and Housing

MMPQM- Maintenance Management and Pavement Quality Management

MMU- Maintenance Management Unit

NCC- National Council for Construction

NCO- National Coordinating Office

NDF- Nordic Development Fund

Np- Net Profit

NRFA- National Road Fund Agency

OPBC- Output Performance Based Contracts

OPRC- Output Performance Road Contracts

PCE – Process Cycle Efficiency

PDCA- Plan, Develop, Check and Act

PERT- Programme Evaluation and Review Technique

PLC- Project Life Cycle

PMI-Project Management Institute

PPIAF- Public Private Partnership in Infrastructure

RCMM – Road Construction and Maintenance Management

RDA- Road Development Agency

REDReSS- Reorganisation, Expansion, Disposal, Refurbishment, Safety/Health and Security

RM- Risk Management

RNI-Road Network Information

RNM- Road Network Management

ROI- Return on Investment

ROIC- Return on Investment of the Capital

ROIC- Return on Investment of the Company

RRIF- Rural Road Investment Facility

SAVE- Society for American Value Engineers

SPRINT- Strategic Programme for Innovation and Technological Transfer

TAM- Total Asset Management

TFV- Transformation Flow Value

TMDs- Trunk Main District Roads

TOC- Theory of Constraints

TPS-Toyota Production System

TQM- Total quality Management

TVS – Total Value Stream

UK- United Kingdom

UNILUS- University of Lusaka

USA- United States of America

USD- United States Dollar

VA- Value Analysis

VAP- Value Added Participation

VCC- Value Co-Creation

VE- Value Engineering

VEA- Value Engineering Association

V_f- Future Value

VFM- Value for Money

VM- Value Management

VO- Variation Order

VOC- Vehicle Operating Cost

Vp- Value for Producer

VP-Value Planning

VR- Value Reviewing

Vs – Social Value

Vu- Value for User

WB- World Bank

WIP- Work in Progress

WOLAM- Whole Life Asset Management

WPLC-Wholelife Project Life Cycle

ZAOU- Zambia Open University

ZAWA- Zambia Wildlife Authority

ZMK- Zambian Kwacha

ABSTRACT

This research topic is entitled '*Strategic Lean Thinking and Value Management for Gravel Roads*'. The study captured 82 respondents as research sample to a case study of Output Performance - Based Contracts (OPRCs) for *the Construction and Maintenance of Gravel Roads in Zambia*. Purposive sampling was used as most research participants were drawn from second generation OPRCs that were active between 2009 and 2014. The study was aimed at devising new Construction and Maintenance Contract methods for gravel roads that are based on "*Lean Thinking and Value Management*" philosophies in Zambia. The established epistemological background to the study is that most of the Zambian road network is of gravel or earth standards and is therefore, imperative that they are well maintained to attain desired service levels to properly serve the intended beneficiaries (the road users). The Road Development Agency[1] Annual Report of 2009 indicated that 33,000 Km of the total 40,671 Km core road network, is classified as gravel roads (unpaved)[2], which are at the moment mostly in a deteriorated state.

The study revealed that currently in Zambia, Gravel Road Construction projects are commonly being realised through the use of traditional Contracts such as admeasured; by the use of Bills of Quantities (BOQs), the Lump sum and Cost plus, etc. These are mainly short term form of Contracts which to some extent, lack some components of sustainable maintenance regimes, thereby rendering the Government and other Promoters efforts futile as gravel roads sooner or later deteriorate just after the first rain season upon their construction. This was theoretical perspective which served as driver to the "Research problem". The study noted that current forms of Contracts did not inspire, aspire and spur the spirit of ownership as the local people were left out in the planning and design stages of gravel road projects.

Despite all the attempts made by Government, through the RDA and other implementing Agencies, the Road Construction Industry in general, has failed to get the best value for money through the use of these conventional types of Contracts. One of the reasons for this failure according to Womack and Jones (2003), 'is that it is hard to define and realise value, this is partly because most Producers [Road Contractors] want to make what they are already making and partly because Customers only know some variant of what they are already getting'. The OPRC Case study observations also revealed similar perceptions from

[1] *The Road Development Agency is the Institutional charged with the responsibility of construction, maintenance and caring of all public roads in Zambia through the act of parliament number 12 of 2012.*

[2] *In this study unpaved roads are those roads surfaced by gravel or earth other than bituminous or concrete materials.*

respondents. This implied that without *'Lean Thinking'* and '*Value Management'* being strategically taken on board, product value that satisfies the customer would seldomely or hardly be difficult to determine and later delivered.

The study acknowledged that *'Lean Thinking'* and '*Value Management philosophies'* are therefore, to serve as catalysts to a better Gravel Road Construction project delivery practice in Zambia. To that effect, Zambia has for some time been implementing Output Performance - Based Contracts (OPRCs or OPBCs) for the construction and maintenance of gravel roads. However, the study noted that Lean Thinking (Lean Construction) and Value Management philosophies are said to be relatively new in Zambia and may not be well appreciated by various business houses including the Road Construction Industry, hence not being fully incorporated in the current OPRCs. The Study has proposed an OPRC Model for Construction and Maintenance of gravel roads in Zambia. This developed from the attributes of Lean Thinking and Value Management philosophies, which aim at enhancing the OPRCs. According to Zietlow (2007), Output Performance - Based Contracts-OPBCs [3] are based on "*Lean Thinking* and *Value Management*" philosophies as they strive to reduce waste and enhance value in Road Construction' value stream. The Study; *"Strategic Lean Thinking and Value Management philosophies in Gravel Roads"*, is therefore a great stride in solving the prevalent problems of the usually poorly managed Gravel Road Construction and Maintenance Projects in Zambia.

KEY WORDS

Lean Thinking Philosophy (LTP), Value Management Philosophy (VMP), Gravel Roads, OPRC, Contracts for Rehabilitation and Maintenance Contracts (CREMA), Strategic Management, Total Quality Management (TQM), Total Asset Management (TAM), Whole Life Asset Management (WOLAM). Transformation Value Management (TFV), *inter alia*.

'Lower the water level to expose the rocks or wastes (Kaikuku)' (Womack and Jones, 2003)

[3] *OPBCs or OPRC-Output Performance Based Contracts which focus on project outcomes referred to as service.*

LEAN THINKING PHILOSOPHY AND KEY CONCEPTS

- **The 5 core principles of Lean**
- **Define Value added and non Valued added activities**
- **Define the 7 most common types of waste and their causes**
- **Review a systematic approach to discover waste within the process**

LEAN THINKING AND BUSINESS FACTS

"Every Organisation is looking for One Single Outcome .....PROFIT or BENEFIT"

"PROFIT is not a single concept but come with many important implications, thus;

- **P**- Process excellence
- **R**- Resource Management
- **O**-Oriented to a goal
- **F**- Financially strong or Functionally focused
- **I** – Innovative based in order to stay ahead of competition from rivalry
- **T**- Timely deployment of business strategies

"Lean Thinking" is forward thinking (Womack and Jones, 2003)

- **B** - Benchmarking
- **E** - Efficiency use of resources
- **N** – Networking and Collaboration
- **E** – Employable methodologies
- **F**- Financially strong or Functionally focused
- **I** – Innovative based in order to stay ahead of competition from rivalry
- **T**- Timely deployment of business strategies

CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION

Zambia has a total road network of about 67, 671 Km and of these, 40,671 Km are classified as the Core Road Network (CRN) consisting of Trunk, Main and District roads (TMDs) (RDA, Annual Report, 2011: p.3, Raballand and Whitworth, 2011: p.1). The Road Development Agency[4] Annual Report (2012: p.8), further states that 33,000 Km of the core road network is classified as gravel roads (and rural or feeder (earth) roads), which is at the moment in a deteriorated state. However, it is these feeder roads that offer connectivity to most agriculture productive areas in Zambia. Unfortunately, during the rainy season, most of these roads are inaccessible resulting in the cutting off communication between communities. Gravel and earth roads pose great challenges when it comes to their maintenance under the conventional type of contracts currently being used in Zambia. The current contract arrangements only offer a one off road construction and maintenance interventions, thereby relegating gravel roads to poor quality conditions, hence rendering them vulnerable in the rainy season. Gravel roads by their nature; easily get deteriorated under wet conditions due to the related adversities. The Government of the Republic of Zambia has been investing heavily in these types of roads. Regrettably no significant economic returns have been realised as gravel roads continue to get washed out every rainy season, resulting in so many emergency[5] roadworks.

> According to Public Private Infrastructure Advisory Facility [PIAF], (2009, p.124), *'the situation in Zambia is typical of many other countries in sub-Saharan Africa who are struggling to maintain extensive road networks from a very limited resource base. Zambia is large (752 000 km2) with a population of around 12 million, [currently estimated at 14 million]. Zambia is classed as a Low Income Country (although at the time of this study, Zambia was reclassified as Medium Income Country) with a Gross National Income (GNI) per capita of USD 630. Total road network is around 90 000 Km of which 20 000 Km is Trunk, Main and District roads carrying the vast majority of traffic outside urban areas. Only 7 250 Km are paved, constructed mostly in the 1960's and 1970's'.*

Since most roads in Zambia were constructed in the 1960's and 1970's, coupled with lack of effective and sustainable maintenance, means that they have lived their life spans and are currently in deteriorated state. Below is the breakdown of the network by road type in

[4] *The Road Development Agency is the Institution charged with the responsibility of construction, maintenance and caring of all public roads in Zambia through the act of parliament number 12 of 2012.*
[5] *Emergency roadworks are unplanned but necessary road maintenance interventions with the aim of restoring accessibility.*

Zambia. According to Shahin (1994), gravel roads maintenance in Zambia lacked appropriate management such as the Output Performance - Based Contracts (OPRC).

Table 1: The Zambian Road Network

Road Type	Responsible Agency	Estimated Network (Km)	CRN Paved	CRN Unpaved	CRN Total (Km)
Trunk	RDA	3,116	3,024	92	3,116
Main	RDA	3,701	2,205	1,496	3,701
District	RDA	13,707	1,362	12,345	13,707
Urban	RDA	5,597	2,812	2.785	5,597
Primary feeder	RDA	15,311		14,333	14,333
Secondary feeder	MLGH	10,060			
Tertiary feeder	MLGH	4,424			
Park roads	ZAWA	6,607			
Community roads	MLGH	5,000			
Total		**67,523**	**9,403**	**31,051**	**40,454**

(Source: RDA, Annual Report, 2009)

In seeking to solve this problem, the Zambian Government has of late embarked on a highly ambitious programme of having to upgrade most gravel roads to bituminous standards despite some of such roads not meeting the minimum requirements (Cost and Benefit Analysis) for them to receive such road maintenance regimes. However, for a Country to economically develop, it is desirable that most of its gravel and earth roads are upgraded to bituminous standards. Nevertheless, due to high demand on the Country's resources to achieve such aspirations coupled with constrained annual budgets, as highlighted in the 2012 Annual Work Plan (AWP), it is difficult to attain such national ambitions in the foreseeable future. The reality is that Zambia will for some time, continue to have a portion of its road network of gravel standards. It should also be noted that upgrading a gravel or earth road to bituminous standards, is a costly undertaking for any Government and hence the exercise has to be approached with much caution (Brushett, 2005). The cost implications explain the reason

why the USA has 45% of its roads of gravel standards (Mannering and Washburn, 2013: p.97). The RDA annual report (2010) indicated that the cost of upgrading a gravel road to bituminous standard was estimated to be about ZMW2.5 Million[6] approximately USD500, 000 per km compared to ZMW300, 000, approximately USD60, 000 per Km for construction and maintenance of a gravel road. Figure 1 below, depicts the condition of most gravel roads in the rain season in Zambia. With such state of affairs, it may be necessary that OPRCs which are perceived to anchor on *"Lean Thinking"* and *"Value Management"* philosophies for Construction and Maintenance of gravel roads in Zambia are promoted.

Figure 1: **Typical condition of most gravel roads in the rainy season in Zambia**

1.2 THE STUDY BACKGROUND

Road Construction and Maintenance contracts in general in Zambia are marred with project time over runs, variations and terminations as contractors in most instances fail to complete the contracts within the approved project time, budget and with compromised quality. In some cases Contracts are only completed after an extension of the intended project completion time. A case in point is the Spinal Road project (Case-study) which was planned to be implemented within 15 months but ended up being extended to 24 months and at a higher project cost than that initially envisaged. Gravel Road Contracts are not immune to

[6] *Refers to rebased Zambian Kwacha (ZMW).*

Contract Project Management problems (Road Development Agency annual reports, 2006-2010). Apart from the Contracts being delayed to complete, they are many cases of reports of poor quality of work output [shoddy works] which thereby fail to meet the needs of the Client. This scenario denies the road users the much needed returns on the infrastructure. When Contracts are completed, it is usually at higher costs as they are in many cases associated with many variation orders (VOs)[7] which unfortunately lead to the Contract sums being higher than initially determined and approved. Because of such problems, value for money for most Gravel Road Construction and Maintenance contracts in Zambia, is not realised. However, the Government of the Republic of Zambia seems to be keen to reverse this trend, as it has stepped up efforts to ensure that Road Construction and Maintenance contracts including those of gravel roads, are completed within the original approved project time, cost and quality. Nevertheless, little success is being achieved, which therefore, is a cause for concern. This Thesis advances the promotion and adoption of *"Lean Thinking"* and "*Value Management"* philosophies for the gravel road construction and maintenance contracts in Zambia. It is envisaged that the lean thinking and value management philosophies will enhance road project delivery and management in the country.

One of the reasons for lack of progress could be that the approach being used, according to the *"Lean Thinking"* philosophies, is based on 'pushing of project work flow'. However, 'in a push system'[8] the production of goods is based upon a plan (schedule) that has been made in advance, which means production and purchase are not initiated by projected customer demand. The operation is driven by the schedule and thus creating waste. But customer or client demand can suddenly change and things may go wrong. What becomes of the schedule then? (Liker, 2004: pp.104-112). The problems being experienced by the Zambian Road Construction Industry cannot merely be eradicated through intensified efforts that compel Contractors to upscale progress of works. Consequently, the perceived customer value may only be realised when *"Lean Thinking"* and *"Value Management"* philosophies are well integrated in the gravel road construction and maintenance processes (Project Life Cycle). *"Lean Thinking"* and *"Value Management"* might also assist in improving gravel road projects' delivery with accrued benefits as it is perceived to be cost effective. Benefits for gravel roads could be attained by use of *"Lean Thinking"* and *"Value management"*

[7] Variation Orders (VOs), changes made to the approved contract leading to increase or decrease in the work scope, project time and cost.

[8] Push Work Flow System, is the type of production process which is based on schedule without driven by Customer perceived Value demand. This according to Lean Thinking is one form of waste generation and therefore not preferred and recommended means of road project delivery.

philosophies which have their foundations on the 'pulling of project work flow'[9] theory. The Contractors would only improve their performance if they are driven by Customer or Client specified quality (Value). The Output Performance Based Road Contracts being implemented to some extent lack more of these valuable ingredients that would otherwise be brought about through the strategic *'Lean Thinking'* and *'Value Management'* philosophies as shown in Figure 2 below:

Figure 2: Deteriorated pedicle road (gravel road)

1.3 STATMENT OF THE PROBLEM OF STUDY

Most Gravel Road Construction and Maintenance Projects in Zambia are described as substandard or those failing to meet prescribed specifications for good gravel roads that are fit for purpose in terms of Quality and Value to Customer perspective. Consequently, most of gravel roads in Zambia are in a deteriorated state and are of poor quality, hence are failing to offer the desired level of service to road users and consequently, limiting connectivity of the rural communities to areas of economic importance (See pictures Fig.2 & 3). This largely could be because the Road Construction industry in Zambia does not strategically apply the *"Lean Thinking"* and *"Value Management"* philosophies. The focus of the study is to investigate whether the "Lean Thinking" and "Value Management" philosophies, are

[9] *Pulling Work Flow System is the type of production process which is based on Customer perceived value demand and aims at reducing waste according to Lean Thinking theory.*

strategic to gravel road construction contracts, for improving the process of construction and maintenance of gravel roads to meet desired quality, value and sustainability in Zambia.

Figure 3: Most Gravel roads in Zambia have deteriorated due to lack of strategic maintenance *(Choma to Prison's farm road, 2013)*

Gravel roads form the highest chunk of the Zambian road network and compliment limited paved roads in the movement of people, goods and services (RDA, Annual Report, 2009). Value of gravel and earth roads is a factor that needs to be well aligned with the Road Users' perceived demands. Value Management (VM) is more about determining what is required in the product or service as desired by the Customer. This usually involves analysis of product functions and seeking alternative ways of meeting such functions at a reduced cost but without compromising on quality. The construction and maintenance of gravel roads could be cost effective if value was enhanced through appropriate methods of road Contract strategies (Fellows *et al*. 2007: pp.231-236). The terms 'Cost' 'Price' and 'Value' can be used interchangeably and are difficult to understand sometimes. However, Cost could be defined as a must to be given, or foregone to obtain a good or service. It is simply what the buyer or purchaser must pay, usually expressed as a sum of money. Price is what the seller receives from the buyer after the exchange of a good or service. Value is said to be the worth of such a good or service *(ibid)*. Answering research questions might solve problems of gravel roads.

The study considered the five factors of *"Lean Thinking"* and *"Value Management"* philosophies as presented by Womack and Jones, 2003 and assessed their incorporation in gravel road construction and maintenance contracts in Zambia, through the use of Output Performance Road Contracts (OPRC), as follows:

- Specifying value of gravel roads from the end user perspective (Specify Value),
- Defining and mapping up value stream for a work process (Identify the steps in the Value Stream),
- Enhance and Maintain flow in work process (Create smooth flow),
- Pulling from Customer Value demand or needs (Customer pulls Value),
- Ensure perfection and continuous improvement of products to meet customer expectations and needs (Pursue perfection-Kaizen).

1.4 PURPOSE OF THE STUDY

The main purpose of the study was to establish knowledge levels on the understanding of *"Lean Thinking"* and *"Value Management"* philosophies in the construction and maintenance of gravel roads in Zambia with the view to improving the quality of gravel roads and enhance level of service for road users' benefit. The study further endeavoured to investigate whether the 2nd generation OPRCs being implemented by the Road Development Agency have been strategically incorporating *"Lean Thinking"* and *"Value Management"* philosophies in their work flow processes.

The following themes underpinned the purpose of the study;

- Establish *"Lean Thinking"* and *"Value Management"* knowledge levels of stakeholders in the gravel road construction and maintenance with a view to improve the quality of road contracts delivery.

- Investigate whether *"Lean Thinking"* and *"Value Management"* philosophies were being strategically applied in the current (Second Generation)[10] Output Performance - Based Road Contracts (OPRCs) being implemented by the RDA.

- Compare value realised from the current Conventional Gravel Road Contract Scenarios and that obtained from Output Performance - Based Road Contracts (OPRCs) – which are based on *"Lean Thinking"* and *"Value Management"*.

[10] *Second generation OPRCs are the current gravel road contracts being implemented by the Zambian Government through RDA under the ADSP programme with part of the financing from the World Bank (WB).*

- Assess the possibility and viabilty of enhancement of the application of *'"Lean Thinking"* and *"Value Management"* principles in the road construction and maintenace of gravel roads in Zambia through Output Performance - Based Road Contracts (OPRCs).

1.5 SCOPE AND LOCATION OF THE STUDY

The study was mainly confined to the Zambian Road Construction Industry, especially to the practitioners dealing with gravel roads. The study was extended to local Training and Regulatory Institutions [NCC] with a view to investigating and establishing whether *"Lean Thinking"* and *"Value Management"* philosophies were being taught to Trainees (Students) of Business Administration and Construction Project Management. This is because these same Trainees are the ones who would later be employed by the road Construction companies or be recruited by the Road Sector Agencies. Practicing Engineers, Managers and other personnel in the Zambian Road Construction Industry, also formed part of the subjects of this study. A Case-study was conducted in Chipata, Katete, Lundazi, Chongwe and Choma on the gravel road construction and maintenance projects which for some time now have been utilising OPRCs. The study was undertaken in order to evaluate the level of strategic application of *"Lean Thinking"* and *"Value Management"* philosophies throughout the Whole Project Life Cycle (WPLC). The data collected from the Chipata, Katete, Chipata, Lundazi, Chongwe and Choma Output Performance Road Contracts (OPRCs) were analysed and results on the road service levels (Performance) compared with those derived from other types of contracts (Traditional or Conventional Contracts). A systematic approach to road management is needed to ensure optimum return on investment.

1.6 RESEARCH OBJECTIVES

The main objective was to investigate whether *"Lean Thinking"* and *"Value Management"* philosophies are strategically being employed as value addition drivers in the construction and maintenance of gravel roads in Zambia under the OPRCs, with the aim of satisfying road user needs. If discovered otherwise, then propose remedies and the way forward for the OPRCs as interventions for construction and maintenance of gravel roads in Zambia.

1.7 DESCRIPTION AND NATURE OF THE STUDY

To achieve the above main study objective, a Case study of the 2nd generation Output Performance - Based Road Contracts (OPRCs) for gravel roads was adopted as the main research strategy. To establish the general understanding and appreciation of *"Strategic Lean*

Thinking" and *"Value Management"* philosophies in the Zambian Road Construction Industry involved with gravel roads, the exploratory and explanatory approaches were used.

Secondly, Case study observations were conducted on the 2nd generation OPRCs currently being implemented by the Road Development Agency, located in Chipata, Katete, Lundazi, Chongwe and Choma districts of Zambia. This was to mainly ascertain the extent and degree of strategic application, of the *"Lean Thinking"* and *"Value Management"* philosophies in the work flow processes in all project phases; namely, planning, design, procurement, implementation (including Monitoring and Evaluation) and commissioning. The results of the Case study observations were necessary for the determination of levels of enhancement of *"Strategic Lean Thinking"* and *"Value Management"* philosophies in the OPRCs and the Zambian Road Construction Industry as a whole with the aim of improving value of roads.

1.8 RESEARCH QUESTIONS AND DOMAIN

As earlier stated under the sub heading 'research objectives', Research questions were mainly developed around the areas that if considered, would otherwise improve the value of gravel roads. *'Lean Thinking'* and *'Value Management'* philosophies strategic utilisation in gravel roads were the main drivers of the research questions. Areas of coverage were not however thoroughly conclusive to say the least, due to the research process complexity coupled with inherent limitations and shortcomings involved with such an exploration.

1.8.1 Research Questions

The following 'Research questions' were developed from the stated objectives. They were developed to explore the research problem further;

1. Are the knowledge and practices of *"Lean thinking"* and *"Value Management"* philosophies well established and perceived by the parties or stakeholders in the Zambian Road Construction industry, namely, the promoters or owners, the financiers or funders, the Trainers, the Designers or Consultants and the Contractors or Constructors?
2. *'Lean Thinking'* and *'Value Management'* have been recognized as distinguished disciplines of Civil Engineering (Construction Management & Project Management) and Operations/Production Management (Scientific Management theory) worldwide. To what extent are these disciplines being advanced in Training institutions in Zambia?

3. Are '*Lean Thinking*' and '*Value Management*' philosophies being currently strategically applied in the Gravel Road Construction and Maintenance projects in Zambia?
4. Are Output Performance Based Contracts or Framework Contracts (OPBCs or OPRCs) a form of contracts based on the '*Lean thinking*' and '*Value Management*' philosophies?
5. Can the strategic application of '*Lean Thinking*' and '*Value Management*' philosophies improve quality of Gravel Road Construction and Maintenance projects in Zambia?

1.8.2 Research respondents

The study participants were drawn from the Road Development Agency (RDA), the National Road Fund Agency (NRFA) and the Ministry of Agriculture and Livestock (MAL-ADSP) as the Client side. Other research respondents were drawn from Contractors and Two Consultant firms namely UWP Consulting Engineers and ASCO Consulting Limited. Other respondents were from the National Council for Construction (NCC) as a Training and Regulatory body. These respondents comprised Engineers, Technicians and other staff involved with the Construction and Maintenance of gravel roads through OPRCs and Conventional contracts.

1.8.3 Researcher's Role in the Study

Although I had worked in the road construction industry for over two decades, namely the Roads Department and the Road Development Agency, I tried to remain neutral and avoided influencing the outcome of results for the study. The inductive approach through constructivism theoretical perspective provided an effective safety measure. As from the onset the study was defined as exploratory, this meant that the researcher's epistemology was not influence the direction and outcomes, so as to avoid biasness of the results that if allowed would impede on the study validity, reliability and credibility. Heuristic enquiries and direct observations conducted were non participatory, meaning that as a researcher, I could acquire data from respondents without coercion and duress.

1.9 RESEARCH NULL HYPOTHESES

The following are the hypotheses which were examined through this exploratory study;

(i) Lean Thinking and Value Management Philosophies are relatively new to most Stakeholders and hence not strategically applied in the construction and maintenance of gravel roads in Zambia.

(ii) OPRCs are suitable for gravel roads compared to the Conventional contracts currently being used, as they enhance customer perceived value for Road users.

As earlier stated this was exploratory research, which depended mainly on the results of Case studies on the OPRCs for gravel roads, the study was therefore, allowed to flow unrestricted so as to develop, capture and examine ideas as they evolved on the above assumptions. Findings, Recommendations and Conclusions were then advanced after the lessons learnt from the study inductively. According to Salkind (2005: p.185), if you are conducting exploratory or descriptive research, you are trying to understand events that are occurring in the present and how they might relate to other factors. You generate questions and hypotheses, collect data, and continue as if you were conducting any type of research. The hypotheses are educated guesses or assumptions that are set out to guide the Study. As this is a mixed research design [Triangulation], the proposed hypotheses were examined through non statistical methods.

1.10 SIGNIFANCE OF THE STUDY

It is envisaged that the results obtained through this study would lead to the improvement of the knowledge of *"Lean Thinking"* and *"Value Management"* philosophies by Stakeholders involved with the Construction and Maintenance of gravel roads in Zambia. It is therefore, expected that after this research, there would be better understanding of *"Strategic Lean Thinking"* and *"Value Management"* philosophies which would culminate into better construction and maintenance of gravel roads, which at the moment were in the deteriorated state and therefore not serving road users effectively and efficiently. This study:

(i) Aims at identifying and recommending for adoption for Contract forms (OPRCs) that would bring about a 'win – win' situation through satisfaction of all parties in the construction and maintenance of gravel roads in Zambia by delivering value according to the Customer demand. 'Value is what the customer wants and the rest is waste '*Muda*' (Womack, *op. cit*).

(ii) Will consider the current work flow processes in the 2nd generation OPRCs to assess whether the *"Lean Thinking"* and *"Value Management"* philosophies are being strategically incorporated. If discovered otherwise, make viable recommendations on the strategic employing of *"Lean Thinking"* and *"Value Management"* philosophies with the aim of adding value through reduction of waste in the work flow processes and thereby improve the quality of gravel roads for rural connectivity and national economical development.

(iii) Will stimulate and encourage the road sector stakeholders to accept OPRCs as viable strategy, embrace and enhance *"Strategic Lean Thinking"* and *"Value Management"* philosophies throughout the Whole Life Project Cycle (WLPC) in gravel road construction and maintenance.

(iv) Will compare and evaluate the current OPRCs process flows and flaws with regard to *"Lean Thinking"* and *"Value Management"* philosophies in the construction and maintenance of gravel roads with traditional forms of road contracts.

1.10.1 Contribution to body Knowledge

The Thesis envisages to making of the following contributions to the body of Knowledge:

- To vividly bring to light that, the attributes of OPRCs were anchored on the Lean Thinking and Value Management philosophies through deeper evaluation;
- Establishing Knowledge levels in Strategic Lean Thinking and Value Management philosophies of Stakeholders involved with the Construction and Maintenance of gravel roads in Zambia.
- Enhance value to Customer perspective by promoting OPRCs as effective Construction Project Management (CPM) interventions founded on *"Lean Thinking"* and *"Value Management"* philosophies, which key stakeholders in the construction and maintenance of gravel roads in Zambia needed, to fully embrace and adopt.

The study would bring afloat principles of Lean and Value in the OPRCs in Zambia.

1.11 JUSTIFICATION AND RATIONALE

In the quest to improve the quality and value to customer perspective for the gravel roads in Zambia through *"Strategic Lean Thinking"* and *"Value Management"* philosophies, this study was necessary for the following reasons;

- The Zambian Government through the RDA, has been piloting OPRCs on gravel roads starting with Eleven (11) Contracts funded by the European Union (EU) in 2006 (1st Generation) which failed to realise the expected benefits due to perceived poor contract procurement and implementation management strategies (RDA, 2009).

- The 1st Generation of OPRCs on gravel roads was mainly believed to have not realized perceived benefits because the Contractors were not conversantly aware that they were based on *"Lean Thinking"* and *"Value Management* philosophies and

hence, did not fully and properly apply them in the road Project Life Cycle (PLC) and the related work flows (*ibid*).

- Starting from the year 2009, RDA with the support of the World Bank (WB) (ADSP-RRIF) and the European Union (EU), has been implementing Four (4) Contracts (2nd Generation) using OPRCs.

- With such well appreciated pilot programmes, the RDA is intended in the future to have most of the gravel roads on OPRCs hence the knowledge of *"Strategic Lean Thinking (LT)"* and *"Value Management (VM) philosophies"* would therefore be very necessary for contracts success (*ibid*).

- The Study when conducted would also assist the Road Sector Agencies and various stakeholders to foster the understanding of Strategic *"LT"* and *"VM"* philosophies, in order to improve the quality (value) of gravel roads in Zambia.

1.12 RESEARCH ASSUMPTIONS

- The Sample would be drawn from the Engineering professionals and other related personnel working with various Institutions (National Council for Construction (NCC), Engineering Institution of Zambia (EIZ), Engineering Registration Board (ERB), Training Institutions, Association of Consulting Engineers of Zambia (ACEZ), Road Development Agency (RDA), National Road Fund Agency (NRFA) e.t.c.) in Zambia.

- The Case study [Primary research data sources] would be conducted on the 2nd generation OPRCs being implemented by the Road Development Agency with the support of the World Bank and the European Union, and these contracts were expected to be completed in 2014, hence covered the research period. Case study depended on the assumption that the OPRCs projects were to continue up to 2014. Consequently, the OPRC case study was successfully conducted as the Contracts remained operational as predicted and anticipated.

- That the data obtained from these Institutions would be reliable, valid for the purpose of this study and respondents in the case studies would be normally distributed and be representative of the research population.

- The Road Contractors and Consultants working on OPRCs would be valuable research respondents in the study and providing insights in the provision of necessary data and information.

- The secondary data to complement the study would be obtained from the RDA (Ministry of Transport, Communication, Works and Supply) and the ADSP (Ministry of Agriculture and Livestock) and the World Bank (WB) publications on OPRCs especially on their implementation and progress in Australia, New Zealand, South and North America and South East Asia without hindrance. This is evidenced by the study literature review presented in Chapter two of the Thesis.

1.13 RESEARCH LIMITATIONS

The successful completion, credibility, validity and reliability of the study would be mainly dependent and influenced by the following two main research limitations for which the researcher would endeavour to control and manage;

- The sample of 82 subjects was used in this study as few Civil, Construction and Road Engineers and other personnel, were involved with the current OPRCs in Zambia. The Research Sample was purposively drawn from Lusaka, Southern, Eastern and Central provinces, where most Road Contractors and Consultants are based for the OPRCs and where institutional bodies such as the Engineering Institution of Zambia (EIZ) and National Council for Construction (NCC) are well established or represented. However, case studies were also extended to some conventional contracts, such as Spinal road and Monze to Niko road in the Kafue National Park so as to compare obtained results with the OPRC contracts observations for the study credibility and reliability.

- The case study conducted in Katete, Chipata, Lundazi, Chongwe and Choma OPRCs was not without logistical constraints and challenges such as uncooperative road users, consultants and contractors who were to some extent proving to be difficult.

1.14 THE RESEARCH THESIS STRUCTURE

The research Thesis is made up of Six Chapters and is structured as follows; Chapter One covers the introduction and background, while Chapter Two presents the literature review. Chapter Three is research methodology while Chapter Four is data analysis. The Case study observations and findings on the 2nd generation OPRCs are recorded in Chapter Five and,

Chapter Six presents the conclusions and recommendations. Thereafter, glossary, references, bibliography and appendices follow through. The subsequent Chapter will provide literature review for the study, which follows the theory of funnel model as strategy of problem solving. The funnel model is used so as to delve on many philosophies and principles encompassing Lean Thinking, Value Management and OPRCs for gravel roads in Zambia.

'Lean thinking, is not an end in itself but a journey to perfection through continuous improvement (Kaizen)' (Womack and Jones, 2003).

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

As already alluded to in section 1.3, Gravel Road Construction and Maintenance is a discipline of the Construction Project Management on which this research was based. The Literature in the application of Lean Thinking and Value Management to gravel road construction and maintenance is scanty as these theories are relatively new in this field [Road Construction industry]. In Zambi,a these theories may not be vividly known or expressed but they form the basis for the Output Performance Contracts (OPRCs) being piloted since the year 2006. According to Zietlow, (2007, pp10-14), OPRCs were first practised in South (Latin) American Countries, North America, New Zealand, Australia, India and South East Asian Countries. These types of Contracts have also been used in South Africa to improve the quality and ensure sustainability of gravel roads. Henderson et al (2004), stated that before the introduction of these Contracts, poor gravel roads were the norm in Western Cape. They attributed low standard of construction and poor road maintenance as the reason for such poorly performing gravel roads. A more systematic approach (*Lean Thinking* and *Value Management*) was adopted in the construction and maintenance of gravel roads. This led to the development of operations Gravel Management System (GMS), which is fully integrated with strategic and tactical level systems, such as Gravel Road Management (GRM), Traffic Counting, Road Network Information (RNI), Maintenance Management and Pavement Quality Management (MMPQM). Further, Hyman (2009), defined Performance Based Maintenance Contracting (PBMC) as a contracting method that provides incentives and/ or disincentives to the Contractor to achieve desired outcomes or results. PPIAF (2009), amplifies this notion by stating that through the OPRCs the relations between the Client (Road Authority) and the Contractor is very different to that of Conventional contracts since the Contractor makes informed decisions to satisfy the road user needs. The system does not detail what the Contractor needs to do, when and where it should be done. Much leeway is given to the Contractor to develop road designs and implementation strategies. Since the OPRCs approach emphasises road product quality/value and performance in order to satisfy the road user needs, it is highly recommended by the pioneer countries that have used it including the United States of America (USA). However, it is not universally accepted owing to its infancy and inherent failures recorded by some practitioners who have used it.

Nevertheless, the responsibilities left to the Contractor are sometimes substantial and may spell a disaster for longer period contracts, if not well management. For longer contracts, the client should pay particular attention to pertinent issues before hand (*ibid*). However, PBMC or OPRC represents a departure from the conventional or standard practices of road construction and maintenance. With this new system of contracting *"Lean Thinking"* and "*Value Management"* philosophies, are utilised to enhance road quality/value and waste reduction. The reason for it being resisted by some practitioners is the limited knowledge on its attributes as it is new to many (*ibid*). The main objective of OPRCs or PBMC is to address the dynamic and vulnerability nature of gravel roads by providing tools that aid proactive *"Lean thinking"* and *"Value Management"* based methodologies, which are drivers to informed decisions on appropriate maintenance actions. Most countries in the Sub-Sahara region do not carry out road maintenance regularly and delayed maintenance direct and indirect costs[11]. Neglected gravel roads steadily become more difficult to use followed by increased vehicle operating costs (VOCs) and lead to poor connectivity of communities (Burningham and Stankevich, 2005). This is because of poor road construction and maintenance strategies such as using contracts devoid of "*Lean thinking"* and *"Value Management"* philosophies. On the contrary, Output Performance Based Road Contracts (OPRCs) incorporate these theories in road construction and maintenance projects (*ibid*). It should also be noted that Road Construction Project Management has evolved over the years to act as a vehicle in delivering projects aimed at serving humanity from various transport and connectivity challenges as presented by nature. The adverse conditions associated with nature, have necessitated human beings to engage in various road construction and maintenance activities in order to ease the effects and also in pursuit of travel comfort enhancement, the human races have always strived. Basically, "Construction activities, on the other hand, have maintained their fundamental role in shaping civilisation all around the globe. Wherever people are, there is some form of construction such as gravel road construction and maintenance. Construction has also been affected by the society in which it takes place and also affected enormously by many aspects and fabric of the society itself (Tezel, 2007)". This is to say that the environment has a bearing on the kind of Construction activities that will be initiated. Construction has mostly been carried out through projects to deliver or attain perceived needs and benefits. Maylor, (2010: p. 4), defined 'a project as a task which has a beginning and an end but should not be repetitive'. For construction

[11] *Maintenance direct and indirect costs are some form of investments that need to be ploughed into maintenance activities.*

projects (including road Construction and Maintenance) to achieve the intended goals and targets, they have to be properly managed. Larson and Gray, (2011: p.3) indicated that;

> *All of Mankind's greatest accomplishment – from building the great pyramids to discovering a cure for polio to putting man on the moon- began as a project.*

By definition, Project Management[12] is said to be a carefully planned and organised effort to achieve a desired objective or need and the Project Management Institute (PMI) further defines a Project as a "temporary endeavour undertaken to create a unique product, service, result" (Larson and Gray, 2011: pp.3-18) . A project is also said to be temporary in nature and has definite start and end dates (Heldman, 2009). So a project is a temporary endeavour undertaken to create a unique product or service (Duncan, 1996, Choudhuri, n.d). Project Management is used in Zambia and the World over in many business sectors including the Road Construction industry. The Construction industry is generally said to be unique in that it sometimes involves working on sites that are remotely located and of different landscape with varying conditions (different project environment) (Bertelsen, et al 2006: pp.3-5). It is therefore, difficult in such conditions for a client to be assured of a product of desired quality in accordance with Contract specifications.

The Road Construction Industry involves several Stakeholders, such as the Client or Promoter, Contractor, Consultant and the road users. Client's main objective is to receive a road facility that meets and satisfies his or her needs. Value for money in every road project delivered, is therefore, of great essence to the Client. The Contractor's main task is that once engaged, may provide the Client with the specified road product (fit for purpose) according to desired quality, within the allotted project time, within project budget and that at least with a profit as he/she has to sustain the business. The Consultant on the other hand, seeks to ensure that the interests of both the Client and the Contractor are reasonably and fairly met. Further, the Consultant has to play impartiality to avoid the violation of the Contract from both parties namely the Client and the Contractor points of view (Hendrickson, 2008,). It should be noted here as Heggie, (n.d), observes that road transport is the dominant mode of transport in Sub Saharan Africa (SSA) carrying closer to 90 percent of the region's passenger and freight transport, providing transport to 70 percent rural inhabitants. However despite the importance of gravel roads most of these roads are poorly maintained and are mainly impassable in the rainy season.

[12] *Project Management refers to the process used to ensure project control and quality assurance, etc.*

Time, Cost and Quality (TCQ) are the three important salient factors of Construction and which have to be managed through project management principles. The deviation in the management of any of these three variables of Construction, results in the failure to meet the intended objectives of the parties. It is for this reason that Construction Project Management (CPM) becomes a very useful tool in order to keep these three factors of Construction, namely Time, Cost and Quality in good and consistent check (Burke, 2004). In order not to lose or confuse readers with the jargons of *"Lean Thinking"* and *"Value Management"* theories as they apply to many business entities or domains, the literature search has deliberately delved in most relevant areas before narrowing down the discourse to the construction and maintenance of gravel roads in Zambia. This approach was upheld by Salkind (2006: p.80), by stating that "the review of literature is not to be a novel, but most good literature reviews build from general argument to a more specific one and set the stage for the purpose of the research". This approach is known as the funnel model[13], the method which I have opted to judiciously follow in the review of literature for this study (*ibid*).

2.1.1 Lean Thinking and Value Management Philosophies

For some time, Road Construction projects have been realised through use of Contracts such as admeasured; through the use of Bills of Quantities (BOQs), the Lump sum, Cost plus, etc. Despite all the attempts made, the Road Construction Industry has failed to get the best value through the use of conventional type of Contracts. The reason for this failure according to Womack and Jones (2003), 'is that it is hard to define and realise value, this is partly because most Producers (Contractors) want to make what they are already making and partly because Customers only know some variant of what they are already getting'. *"Lean Thinking"* and *"Value Management"* could be therefore, a great catalyst to better Road Construction project delivery for which the Zambian Construction industry might benefit from. Zambia through the Road Development Agency has since 2006, been implementing Output Performance Road Contracts (OPRCs), which are believed to operate on *"Lean Thinking"* and *"Value Management"* philosophies. The pilot OPRCs (2nd generation) being implemented on gravel roads in Choma, Chongwe, Katete, Chipata and Lundazi, came into effect in 2009 and were expected to end by the year 2014 (RDA, 2007).

"Lean Construction" and *"Value Management*" philosophies on the other hand, are perceived to be new in Zambia and not well appreciated by various business houses including

[13] *Funnel Model or Theory, is process which begins with a broader view and constricts or narrows down to the most pertinent issues of the research, activity or operation.*

the Road Construction Industry. Conducting this research for the 'Strategic application of *"Lean Thinking"* and *"Value Management"* principles in the Output Performance Based Contracts (OPBCs) with a view to reducing waste and enhancing value in Construction', envisaged to contribute in solving problems of the usually poorly managed Gravel Road Construction and Maintenance Projects in Zambia.

2.1.2 Quality Management

The main focus of *"Lean Thinking"* and *"Value Management"* philosophies in the Construction and Maintenance of gravel roads in Zambia is enhancing road(s) quality to Customer perspective. Fryer *et al*. (2008: p.306), assert that Managers have always been responsible for the quality of goods and services produced by their work teams. In this sense, there is nothing new about quality management. But the emphasis given to delivering more systemically and in every aspect of business has certainly grown over the years. This reaction accounts to at least three factors;

- Poor quality in components, production and service to clients;
- The impact, during the 1980s, of BS 5750 *Quality Systems* and its international successor, the ISO 9000 series; and
- A reduction in clients' tolerance of poor quality.

In Production and Manufacturing, many clients are not keen to accept products of poor quality due to varied range of choices available to them and their well informed position. "Clients perceptions of quality are also very important. Clients quite often assess quality in terms of how they experience the product or building in use, rather than its components and assembly. However, many firms that experienced quality assurance inspections, perceived little, if any, improvement in the services they were offering. Indeed, many firms (including clients) argued that BS 5750[14] was unsuitable for construction" (*ibid*). Nevertheless, road users in most cases have little influence on the quality of road product delivered to them by Contractors. Zietlow (2007), suggests that it would be better however, that road-users perceptions of quality for gravel roads are taken into consideration throughout the Whole Life Project Cycle (WLPC), especially at inception, design and implementation phases. The OPRCs on gravel in Zambia are therefore, not exemption to the above assertion.

[14] *BS 5750 is British Standard code (Quality systems) which regulated quality of products and was the successor to ISO 9000*

2.1.2.1 Benchmarking

Further, Fryer et al. (*op. cit. p.307-308.*), indicated that many firms have introduced benchmarking as substitute to the earlier quality regulating tools such as ISO 9000 and BS5750. It involves studying the best practices and achievements of competitors and others in the field and adopting them as standards for improving the company performance. Benchmarking can be integrated with TQM or used as part of any quality system. It can include looking at the process in, and product/service features of other industries. Indeed, this is sometimes where the most creative improvements can be found. So important is activity in a highly competitive environment that organisation may set up a research department to do their benchmarking activities. Benchmarking is the way organisation enhance quality through a process of learning from other organisations or projects that have excelled in the past in the area of quality and value addition. For the Construction and Maintenance of gravel roads this will call for evaluating contracts such as OPRCs that have been successful with a view to draw lessons from them and if possible replicate them to other gravel roadwork assignments in the quest to improve quality, value and performance to customer [road user] perspective.

2.1.2.2 Road Quality benefits

The benefits of quality for any product such as gravel roads worth to be appreciated by the customer [road user] or client, need not be over emphasised. No well informed road user will desire a road product of poor quality unless such a one does not understand the meaning of quality or value, from his/her own perspective due to lack of informed opinion or position. The desired road user value is that which offers the best product functional attributes “fit for purpose”. “An important approach to obtaining business, from which professional practices and contractors can benefit, is to sell on quality and not on price, as many successful businesses already do. The quality of any product is what should dictate what price it should be sold at to the customer [road user]. Many other companies in other industries other than the Road Construction industry, have found it a better policy to go for a higher value - added product or service, than for low cost, low quality product or service” (Fryer *et al. op.cit.p.310.*). Therefore, a good quality gravel road would be constructed at reasonably higher cost in order that the perceived services value of the customer, the road-user could be realised or enhanced. This may prolong the road facility life and reduce cost of maintenance or better still defer it.

2.1.3 Road Quality from Customer perspective

Quality assurance is to stay in conformity with specifications of a desired road product or service. Total Quality Management (TQM), is the holistic process of ensuring that desired quality of road product or service is attained. "TQM is really a business philosophy based on commitment to customer satisfaction; it involves organising the business to deliver consistent customer satisfaction by careful design of products or services; and creating systems that deliver the chosen quality standards reliably. The growth of global markets and tough international competition will ensure that quality remains high on project or organisation agenda, but overt expression of quality concerns in concepts like TQM may recede, as thorough quality assurance becomes routine-internalised in the culture and management systems of the organisation" (*ibid:p.307.*). At this stage *'Lean Thinking'* and *'Value Management'* principles become necessary to the replacement of TQM for salvaging the customer perceived value. TQM is also complemented by Total Cost Management (TCM)[15], which also holistically looks at project planning and control of resources, cost, profitability and risk (Hollmann, 2012). Schaufelberger and Holm (2002), assert that Total Quality Management is a management philosophy that focuses on continuous process improvement *(Kaizen)* and customer satisfaction which when integrated in gravel road construction and maintenance management, may register better returns for the end users.

2.2 THE LEAN PHILOSOPHY

Womack and Jones, (1996), highlight that *"Lean Philosophy"* emerged in 1900s from the production and manufacturing industries". *'Lean'* does not mean cost cutting but rather places emphasis on the reduction of all forms of waste and enhance value adding activities from the customer point of view. Since *"Lean Philosophy"* is a means of improving quality of products through waste removal, it is not limited to a particular type of industry but is applicable to various types of industries and businesses such as the construction and maintenance of gravel roads. What is of essence however, is how the ***Lean principles*** such as Value, Value Stream, Flow, Pull and Perfection (VVFPP) are incorporated in the work processes. Applying ***Lean principles*** in the construction and maintenance of gravel roads in Zambia implies that the *'Lean Philosophy'* five principles aforementioned need to be systematically, efficiently and effectively utilised to achieve road user perceived results.

[15] *TCM – Total Cost Management Framework, is a technique which considers whole project cost from planning to close out.*

2.2.1 History of Lean Philosophy

Sezen and Erdogan, (2009), explain that *'Lean'* is a systematic approach to enhancing value to customer perspective by identifying and eliminating waste through continuous improvement *(Kaizen)*, by flowing the product at the pull of the customer, in pursuit of perfection. *'Lean'* originated from Toyota Production System (TPS) in the 1900s, which gave emphasis that suited the customer needs and only delivered at the request of such customers. It underpinned its success on the principle of pull process diverting from the original traditional way of production which used the push process (Mass production or Fordism). Toyota is considered as pioneer user of the *"Lean Thinking"* and *"Value Management"* theories as since thus;

> *Many of the concepts in 'Lean manufacturing' originate from Toyota Production System (TPS) and have been implemented gradually throughout Toyota's operations beginning in the 1950's. By the 1980's Toyota had increasingly become known for effectiveness with which it had implemented 'Just-In -Time' (JIT)[16], manufacturing systems. Toyota is often considered one of the most effective and efficient manufacturing companies in the world and the company that sets standards for best practices in 'Lean manufacturing'. 'Lean Manufacturing' or 'Lean Production' first appeared in the 1990 book (The Machine that Changed the World[17])" (Mekong Capital, 2004).*

'Lean Manufacturing' has made tremendous strides to Toyota Motor Corporation which started as small family business called Toyoda with the intention of producing farm tractors to emerge as such a magnificent world class car manufacturing company. Chambers, (2010), resounded that the story of Toyota Motor Corporation is mainly the story of an extraordinary group of entrepreneurs and engineers who performed miracles every day. And it is also, in part, a brief look at this great island nation of Japan in the modern world. Figures 4 and 5 presented here under section 2.2.2, outline *'Lean Thinking'* development and progression as a Philosophy.

2.2.2 Mass Production Thinking Philosophy

Largely the theory of *'Lean Manufacturing'* evolved from the *'Traditional Mass Production thinking'*. In Mass production, Henry Ford felt that production throughput, would be improved if skills and trades were grouped together along the assembly line (Fordism). The following two factors are the perceived benefits of grouping skilled people and equipment together;

---

[16] *Just-In-Time (TPS) manufacturing system aims at delivering a product to the customer just when it needed*
[17] *James Womack, Daniel Jones and Jones Roos: The Machine that changed the World, Simon & Schuster, 1992.*

- ***Economies of scale*** *- Mass production thinking was about squeezing the most production possible at the lowest cost per unit out of every piece of equipment or every worker in a manual operation. Similarly by organising people into teams or departments, you can focus on best practice in each professional speciality and squeeze the highest productivity (or innovation) possible out of each person.*

- ***Apparent flexibility in scheduling –*** *When workers of the same skill are grouped together, it is easier for the department manager to schedule available resources, such as machines and human capital to any job that comes along the assembly line. The group is dedicated to that department and are no longer free to undertake any other work that might come up outside its profession or skill domain.*

In mass production, exchange of information across departments becomes a challenge and results into the formation of a department exclusively for information dissemination and management contrary to *'Lean Thinking'* which encourages feed forward[18] and interaction. Since people and equipment have been organised by speciality, there must be a creation of another speciality, the material handling department or planning department to move material (Liker, 2004: pp90-94). However, in *'Lean production'*, teams are integrated and are organised in working platforms or *'process islands'* capable of handling different work assignments as they emerge, through voluntary worker talent, competency and proficiency. This would result in improved or maximised human capital utilisation and reduction of wastes in the work processes such as waiting and unnecessary labour motion. This also would enhance skills transfer among team members and encourages collaboration and consultation before decisions are arrived at. Wilson (2010), advances that Ohno described the TPS as consisting of many techniques that are designed to reduce the cost of production or manufacturing. This involved removing waste and is built on two pillars namely Just in Time (JIT) and Jidoka[19]. This approach would greatly improve gravel road quality and value as workers involved would be exposed to skills or trades a situation which would translate into customer or user satisfaction. Further, a culture of stopping to fix a problem immediately it is noticed in the work flow process (Value stream), which if not might compromise on gravel road quality or value, would be inculcated in the workers concerned.

[18] *Feed forward – is a process of disseminating information at every stage of work flow (Value stream) even before Customer demand and is more effective as a form of communication than the Feedback process.*
[19] *Jidoka- is the culture of stopping to fix a problem immediately it is noticed in the value stream (Machines with human intelligence) is a foundation for 'building in' quality.*

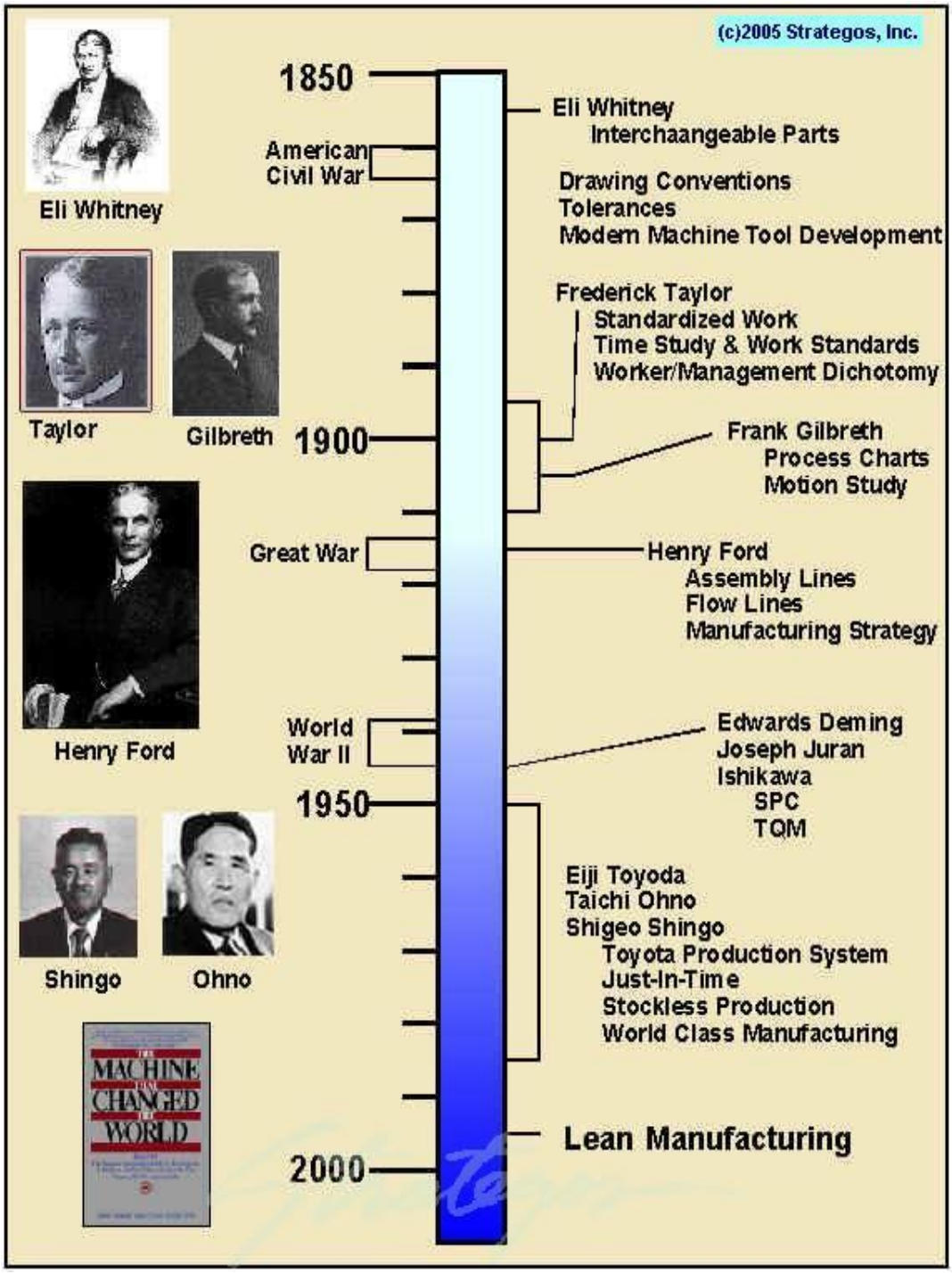

Figure 4: Timeline of Lean Production (Adapted from Womack, 2003)

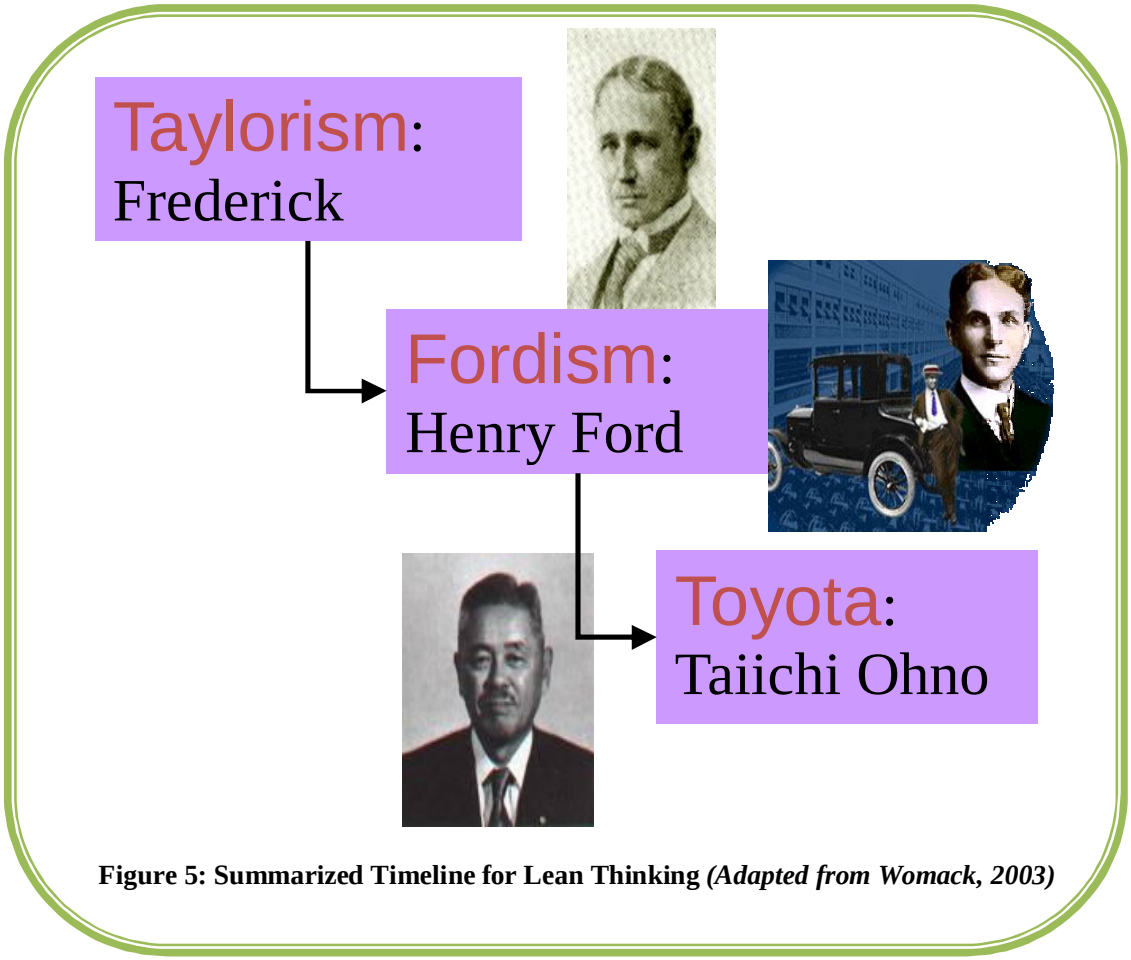

Figure 5: Summarized Timeline for Lean Thinking *(Adapted from Womack, 2003)*

2.2.3 TPS -The Toyota Way

As highlighted by Womack, et al. (1996) and as already been stated in section 2.2, the *'Lean theory'* originated from the Toyota Production System (TPS) which mainly focused on value addition through waste elimination in the production process. In the 1950's Ohno, one of the founders of Toyota Motor Corporation, learnt lessons from the work of Ford whose automobile production company based on the philosophy of Mass production (Fordism) 'Push theory' advanced the automobile industry to greater heights through the lean production philosophy. Many of the key principles were pioneered by Henry Ford, who was the first person to integrate an entire production system, under what he termed "flow production." Following World War II, the Toyota Motor Company adapted Ford's principles as a means of compensating for its challenges of limited human, financial, and material resources. The Toyota Production System (or TPS), which evolved from this need, was one of the first managerial systems using lean principles throughout the enterprise to produce a wide variety of products at lower volumes and many fewer defects than competitors. The

"Lean and *Value"* philosophies, according to Womack and Jones (2003), are not limited in application to production and manufacturing as they can be used in many business entities such as the construction and maintenance of gravel roads through the OPRCs. This is for the simple reason that the *"Lean* and *Value"* philosophies are versatile, flexible and all encompassing by the nature as:

> *The Lean producer combined the advantages of craft[20] and mass production[21], while avoiding the high cost of the former and the rigidity of the latter. Lean producers employ teams of multi skilled workers at all levels of the organisation and use highly flexible, increasingly automated machines to produce volumes of products in enormous variety dictated by the customer orders' (Womack et al., 2007).*
>
> *The most striking difference between mass production and lean production lies in their ultimate objectives. 'Mass-producers' set a limited goal for themselves. This translates into acceptable number of defects, a maximum acceptable level of inventory (waiting through over production and processing) and narrow range of standardised products. To do better, they argue, would cost too much or exceed inherent human capabilities (ibid.).*
>
> *On the contrary 'Lean producers', set their sights explicitly on perfection: continually declining costs, zero defects, zero inventories, and endless product variety as demanded by the customer. No lean producer may have achieved perfection and non will, but the endless desire and quest for perfection, on part of lean producers, continues to generate surprising results worth appreciating' (Womack et. al, op.cit.).*

The 'TPS' has of late become commonly known as the '*The Toyota Way' (TTW)*, (Liker, 2004: pp.35-41). *Because of focus on Thinking, 'TPS' is also now being referred to by Toyota as 'Thinking Production System'*. Lean principles were summarised into 14 principles called '*The 14 Toyota Way Principles'*. These are key *"Lean Thinking"* principles which when holistically and heuristically applied in the Construction and Maintenance of gravel in Zambia roads may offer unprecedented benefits to the users.

2.2.4 Lean Thinking

As already alluded in section 2.2.3, *''Lean Thinking'* was developed from the Toyota Production System (TPS) and focuses on the value adding activities by removing waste *'Muda'* in the work flow process. *'Muda'* is the Japanese word you really must know. It sounds awful as it rolls of your tongue, because *'Muda'* means "waste", specifically any human activity which absorbs resources but creates no value: mistakes which require rectification, production of items no one wants so that inventories and remaindered goods

[20] *'The Craft producer used highly skilled workers and simple but flexible tools to make exactly what the customer asked for, one item at a time' (Womack et. al, 2003).*
[21] *'The Mass producers began to use narrowly skilled professionals to design products made by unskilled or semiskilled workers tending expensive, single purpose machines' (ibid.).*

pile up, processing steps which are not needed, movement of employees and transport of goods from one place to another without purpose, groups of people in a downstream activity standing around waiting because an upstream activity has not been delivered on time, and goods and services which don't meet the needs of customer (Womack and Jones. 2009)'. The *'Lean Thinking'* approach has made tremendous achievement for Toyota that today the Company boasts on being on top of the list of the automobile industry. The principles of '*Lean Thinking'* works for all sectors be it Road Construction or Manufacturing, avoiding it therefore, is missing out on an opportunity to improve road product quality.

As the *'Lean Thinking'* is based on the principle of waste reduction and hence value enhancement in the Value Stream. *'Lean Thinking'* also provides a way to make work more satisfying by providing immediate feedback on efforts to convert waste or '*Muda'* into value (*ibid.*)'. '*Lean Construction'* seems to be a relatively new theory in Zambia and its principles are therefore seldom used in most Road Construction Contracts including the recently introduced Output Performance Road Contracts (OPRC) types for Construction and Maintenance of Gravel Roads. Not employing '*Lean Thinking'* philosophies limits the Road Construction Industry ability to realise its full potential in delivering Value to Clients. This therefore, is a problem needing immediate solutions for gravel roads in Zambia.

2.2.4.1 Lean or Cost cutting

To be *'Lean'* is not to be *'Mean'*. Many organisations have misinterpreted *'Lean Thinking'* to mean cost cutting initiatives and profit extraction from the downstream of the value supply chain. For effectiveness, value should be specified from the customer standpoint. The use of engineers to design product value with the intent of meeting customer needs is not any chance lean. Other executives' belief is that customer may not have capacity to define value and therefore, qualified technical experts are able to specify it on their behalf, claiming that "the customer will want or like it once they explain it".

> ***LEAN IS…*** *A mindset, or way of thinking, with a commitment to achieve a totally waste-free operation that's focused on your customer's success….It is achieved by simplifying and continuously improving all processes (Kaizen) and relationships in an environment of trust, respect and full employee involvement….It is about people, simplicity, flow, visibility, partnerships and true value as perceived by the customer." Ref: David Hogg, High Performance Solutions.*
>
> *"**LEAN IS – from an operations perspective…** Lean production cuts costs & inventories rapidly to free cash, which is critical in a slow economy. It also supports growth by improving productivity and quality, reducing lead times and freeing huge amounts of resources" (ITC, 2004:pp. 2-5).*

2.2.5 Lean Synchronisation

"Lean Synchronisation', or just *'Lean'*, it was originally called *'Just-in-time'* (JIT) when it started to be adopted outside its birthplace, Japan. It is both a philosophy and a method of operations planning and control. Lean synchronisation aims to meet demand instantaneously, with perfect quality and no waste. This involves supplying products and services in perfect synchronisation with the demand for them. When first introduced, the lean synchronisation (*or 'lean' or 'Just-in-time'*) approach was relatively radical, even for large and sophisticated companies. Now the lean, just-in-time approach is being adapted and adopted outside its traditional automobile, high volume and manufacturing roots" (Slack et al, 2010-p431). The Lean theory is an avoidable ingredient of any production process such as Construction and Maintenance of gravel roads. (See figures 6, 7 and 8, traditional and Lean Synchronisation)

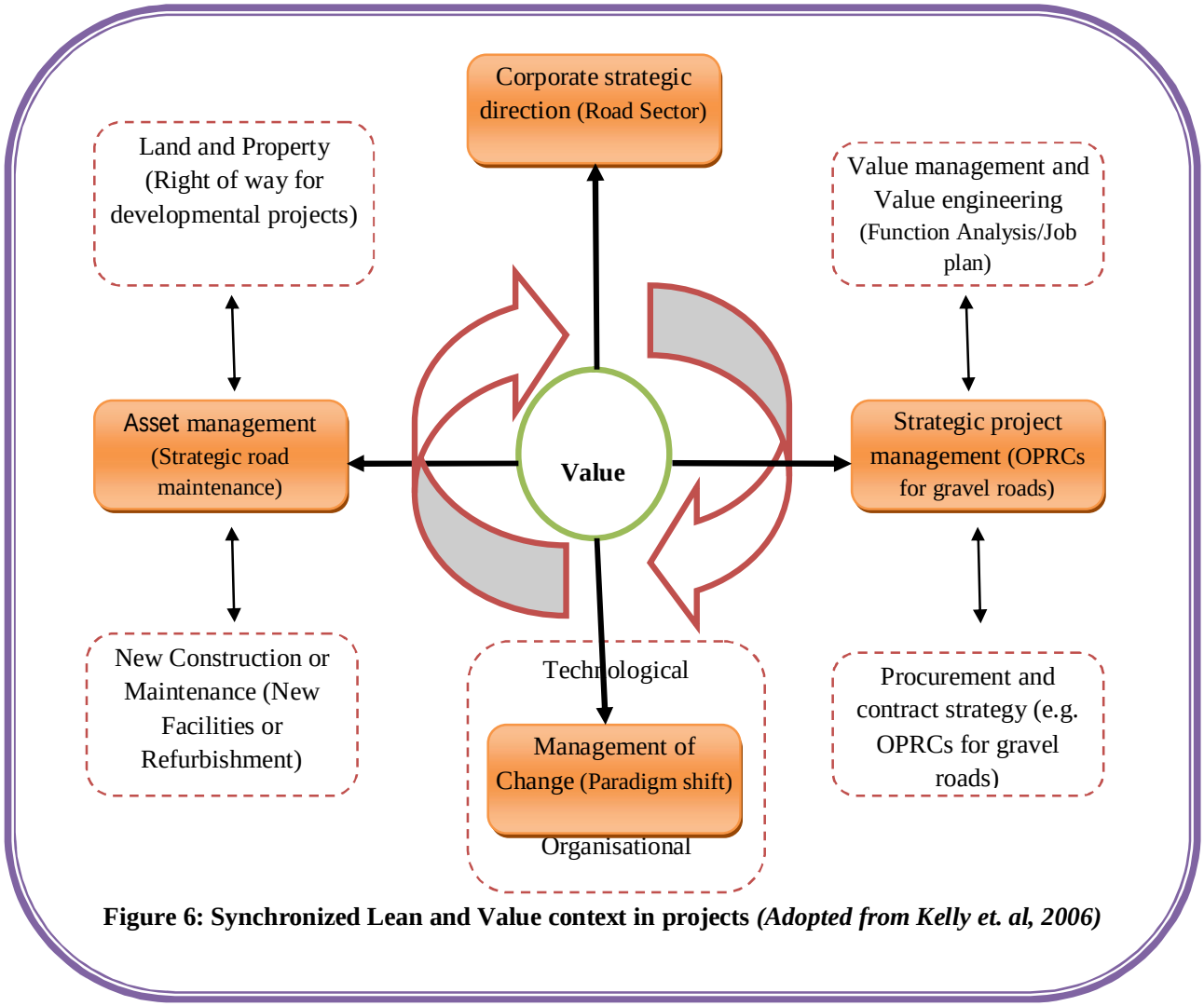

Figure 6: Synchronized Lean and Value context in projects *(Adopted from Kelly et. al, 2006)*

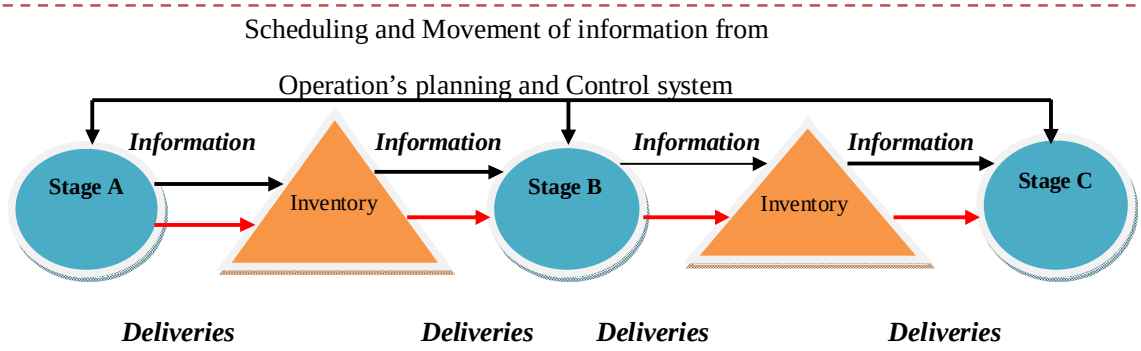

Figure 7: Traditional approach-Buffers separate stages *(Source: Adapted from Slack et al,* 2010)

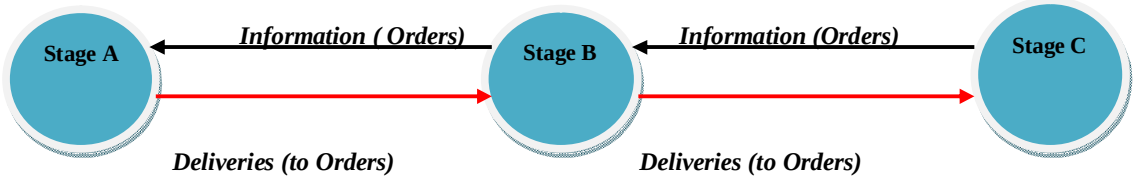

Figure 8: Lean Synchronisation – Deliveries are made on request *(Adopted from Slack et al, 2010)*

2.2.6 Lean Production

- Evans and Lindsay (2011: pp.209-263), assert that *"Lean Production"* refers to approaches that originated at the Ford Motor Company in the early 1900s, but which were refined and modernized or improved by the Toyota Corporation Company (TCC) later in the century". As with the *'Lean Thinking'* philosophy, *'Lean Production'* approaches focuses on the elimination or reduction of all forms of waste. It involves identifying and eliminating non-value –added activities throughout the entire value chain or the value stream to achieve faster customer response, reduced inventories, higher quality, and better human resources. As one article about Toyota observed, to see the Toyota Production System (TPS) in action is to "behold a thing of beauty". *"Lean Production"* is facilitated by a focus on measurement and continuous improvement *(Kaizen)*, cross-trained workers, flexible and increasingly automated equipment, efficient machine layout, rapid setup and changeover, just in time delivery and scheduling, realistic work standards (standardization), worker empowerment to

perform inspections and take corrective action, supplier partnerships, and preventive maintenance. Some benefits claimed by proponents of lean production include the following (Evans and Lindsay, 2011: pp.348-367):

- At least 60 percent reduction in cycle times
- 40 percent improvement in space utilisation
- 25 percent greater throughput
- 50 percent reduction in work in process and finished goods inventories
- 50 percent improvement in quality
- 20 percent improvement in working capital and worker productivity"

"Lean Production" if incorporated efficiently and effectively, may enhance the quality and value of gravel roads in Zambia which in return may lead to boosting the economic activities in the rural or far flung areas. However, to realise the above stated benefits, Companies (Road Contractors) require putting in their very best to ensure that there is detailed planning for effective and efficient implementation of gravel Road Construction and Maintenance Projects. Projects are said to be vehicles that are used to organise team efforts and manage the implementation process including that of gravel Road Construction and Maintenance (*ibid.*). Wastes in gravel Road Construction and Maintenance mean compromising on quality, increased cost, project time overrun and failure to deliver value to Customer perspective. Employing '*Lean Production*' principles would result in improved road product quality and value enhancement aimed at satisfying the client and end users.

Further, "*Lean production*" presents a very different model. Production is managed so that actions are aligned to produce unique value for the customer. Project duration and cost are considered in *"project-as-production system"* terms, making concern for project total cost and duration more important than the cost or duration of any individual activity. Coordination is accomplished in general by the central schedule while the details of work flow are managed throughout the organization by people who are aware of and support project goals (as opposed to activity or local) performance. Value to the customer and throughput, the movement of information or materials to completion are the primary objectives of "*Lean production*". Improvement of results from reducing of waste that is the difference between the current situation and perfection (Howell and Ballard, 1998: pp.2-5).

2.2.7 Lean Construction

''Lean Construction" is a philosophy based on the concepts of *'Lean Manufacturing'*. It is about managing and improving the Construction process to profitably deliver the customer needs. Because it is a philosophy, lean construction can be pursued through a number of approaches (CE, 2004: p.2)'. It is *'Lean Thinking/production'* philosophy applied to Construction hence the term *'Lean Construction'*. "Lean Construction" is therefore, not different to "Lean Thinking" in terms of principles but is stated thus when applied to Construction, consequently, in this study "Lean Thinking" is used in a general sense.

According to Lean Construction Institute (LCI)[22], "Lean Construction (LC)" is production management –based approach to project delivery –a new way of designing and building of capital facilities. "As in Lean Production (LP), LC production management has caused significant revolution in manufacturing design, supply and assembly" (Blakey, 2008). "Application to Construction such as Construction and Maintenance of gravel roads, LC changes the way work is done throughout the delivery process. LC extends from objectives of a LC production system to maximise value and minimise waste, to specific techniques and applies them in a new project delivery process. As a result:

- The road facility and its delivery are designed together to reveal and support customer purposes. Positive iteration within the process and negative iteration is reduced;
- Work is structured throughout the process to maximise value and to reduce waste at the project implementation level;
- Efforts to manage and improve performance are aimed at improving total project performance because it is more important than reducing cost or increasing the speed of an activity ; and
- 'Control' is defined from 'monitoring results' to making things happen'. The performance of planning and control systems is measured and improved.

The reliable release of work between specialists in design, supply and assembly, assures value is delivered to the customer/client and waste is reduced. The LCI's methods are particularly useful for complex, uncertain and quick projects. The organisation challenges that must always be a trade off between time, cost and quality" (*ibid.*). Figure 9 depicts the Project constraints triangle (Time, Cost and Quality).

[22] *LCI- Lean Construction Institute, an Organization which aims at advancing Lean Thinking knowledge*

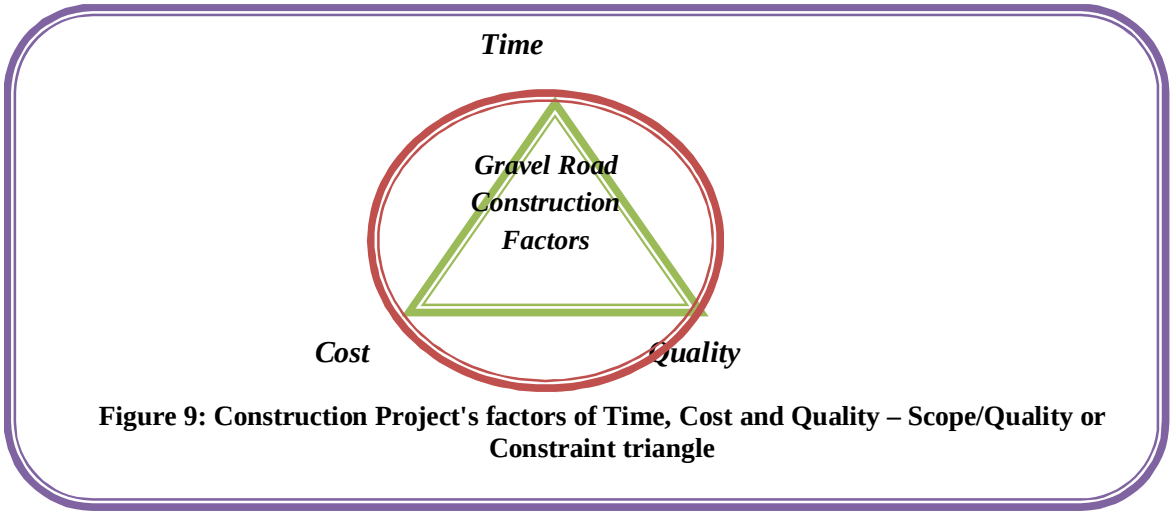

Figure 9: Construction Project's factors of Time, Cost and Quality – Scope/Quality or Constraint triangle

It is argued that construction innovation is significantly hindered by the prevalent theory of Construction said to be implicit and deficient. According to CE, (*op.cit.p2*), there are three main mechanisms through which this hindrance is caused. Firstly, because production theories in general, as well as construction theories specifically, have been implicit, it has not been possible to transfer such radical managerial innovation as mass production or lean production from manufacturing to construction. Direct application of these production templates in construction has been limited due to different context in construction in correspondence to manufacturing. On the other hand, without explicit theories, it has not been possible to access core ideas of concepts and methods of these templates, and to recreate them in construction environment. In consequence, theory and practice of construction has not progressed as in manufacturing. Secondly, it is argued that the underlying theory, even if it is implicit and deficient that Construction industry takes place in different environments and hence, makes the application of Construction innovation even more difficult. Thirdly, it is dynamic in nature as it involves a lot of people with different professional backgrounds, unlike other industries. Any innovation introduced faces a lot of resistances, as people are not of the same discipline in as far as professional backgrounds are concerned. However, through the application of Lean Construction, different professional cohorts are able to co-exist in managing project decisions and activities as the process becomes less procedural rigidity.

2.2.7.1 Lean Thinking in (Road) Construction

'Lean Thinking' is based on the principle of waste reduction and value enhancement in the Value Stream. *'Lean Thinking'* also provides a way to make work more satisfying by providing immediate feedback on efforts to convert waste or '*Muda'* into value (Womack and Jones, *op.cit. p.10*)'. As already alluded in section 2.1.1, *'Lean Construction'* is believed to

be relatively new in Zambia and its principles are seldomely used in most Road Construction and Maintenance Contracts including the recently introduced OPRC types. With this background, not employing *'Lean Thinking'* philosophies limits the Road Construction Industry to realise its full potential in delivering Value to Clients. This therefore, is a problem needing immediate, quick but effective solutions if the quality of gravel roads was to be enhanced in Zambia.

2.2.7.2 The Lean thinking principles

According to Womack and Jones (2003) *'Lean Thinking'* is founded on the following principles;

- Eliminate waste
- Specify Value
- Identify Value Stream
- Value Flow
- Customer pull
- Pursue perfection

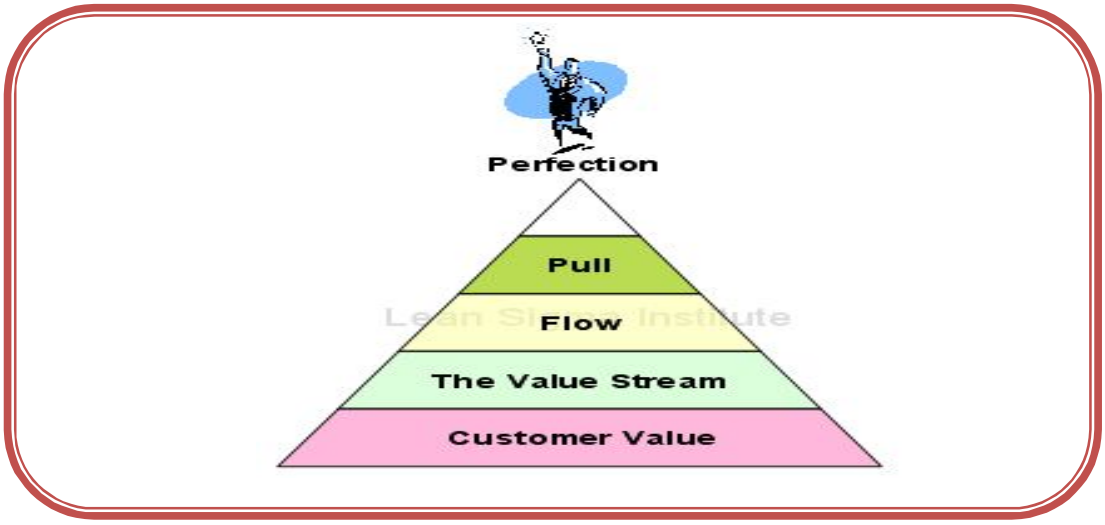

Figure 10: Lean Thinking Principles *(Adopted from Lean Sigma Institute)*

From Figure 10 above, and according to Womack and Jones (2003: p.10), *'Lean Thinking'* can be "summarized in five principles: thus, precisely specify value by specific product, identify the value stream for each product, make value flow without interruptions, let the customer pull from the producer, and pursue perfection".

The *'Lean Principles'* are according to Constructing Excellence elaborately redefined as waste elimination or reduction (the main objective of lean thinking theory) through;

- Precisely specify value from the ultimate customer perspective;
- Clearly identify the process that delivers what the customer values (the value stream) and eliminate all non value adding activities or steps;
- Make the remaining value adding steps/activities flow without interruption by managing the interfaces between different steps;
- Let the customer pull – don't make anything until it is needed, then make it quickly (apply the 'Just In Time' or 'Kanban' principle); and
- Pursue perfection by continuous improvement (Kaizen). According to Liker (2012: pp36-37), the concept of Kaizen is a mandate to improve performance. At the root of Kaizen is the idea that nothing is perfect and everything can be improved.

To achieve the benefits of the above five lean principles, the customer should be at the centre of the whole process. Womack and Jones (2003: pp.16-20) state that;

> *Lean thinking therefore must start with a conscious attempt to precisely define value in terms of specific products with specific capabilities offered at specific prices through a dialogue with specific customers. The way to do this is to ignore existing assets and technologies to rethink firms on the product-line basis with strong, dedicated project teams. This also requires redefining the roles for a firm's technical experts and rethinking just where in the world to create value. Realistically no manager can actually implement all of these changes instantly, but it's essential to form clear views of what's really needed. Otherwise the definition of value is almost certain to be skewed. In summary specifying value accurately is the critical first step in lean thinking. Providing the wrong good or service the right way is waste or muda.*

In view of the foregoing, it is important when it comes to the defining the value of a product, good or service to incorporate the specific customer in the process and at the right time at all junctures. To have good quality gravel roads constructed and maintained in Zambia the ultimate customers who are the road users and local communities need to be made part of the value definition process team right from the onset. Ignoring them is basically to discard the core principles on which lean thinking is founded. Local communities for instance, may have valuable information that the Clients, Consultants and Contractors may need to take on board at inception, design and implementation stages of the project which would result in most of the wastes being removed to ensure enhancement of value to customer perspective. Not being qualified in a certain field does not preclude one's knowledge of what that field is expected of and the possible results and accrued benefits. In Lean Thinking, promotion of partnership of all key stakeholders in order to perfectly arrive at the desired customer value is a core virtue. Road users and local communities are considered well vested in road value decision making.

However, most organisations do not incorporate other players such as the ultimate customer in the value stream mapping process for various reasons, known only to them. Some of these reasons according to Womack and Jones, *(op. cit. pp.37-57)*, are;

> *Partly, this is a matter of confidentiality- each firm feared that those upstream would use any information revealed to drive a harder bargain. And, partly it was a matter of obliviousness. The firms were accustomed to looking carefully at their own affairs but had simply never taken time to look at the whole value stream, including the consequences of their internal activities for other along the stream. When they did within the past year, they discovered massive waste. So lean thinking must go beyond the firm, the standard unit of score - keeping in the business across the world, to look at the whole: the entire set of activities entailed in creating and producing a specific product, from concept through detailed design to actual availability, from the initial sale through order entry and production scheduling to delivery, and from raw materials produced far away and out of sight right to the hands of the customer. The organisation mechanism for doing this is what we call the lean enterprise, a continuing conference of all the concerned parties to create a channel for the entire value stream, dredging away all the muda.*
>
> *Creating lean enterprises does require a new way to think about firm – to – firm relations, some principles for regulating behaviour between firms, and transparency regarding all steps taken along the value stream so that each participant can verify that other firms are behaving in accordance with the agreed principles.*

The Flow chart shown in Figure 11 highlights some of the pertinent factors of the five (5) *'Lean Thinking'* principles, namely; Value, Value stream, flow, pull and perfection (Kaizen). According to Liker (2004), with *'Lean Thinking'* theory, it emphasizes one piece flow, where physically the process is lined up in the sequence that would produce the customer's order in the shortest time. What flow does, is eliminate overproduction and inventory. On the contrary, the *'Mass production'* theory or system, guarantees overproduction in batches, which in turn encourages inventory sitting idle and taking up valuable plant space and, more importantly hiding problems. In the Construction and Maintenance of gravel roads, this one piece flow, would encourage the delivering of activities concurrently and thereby reduce on wastes in terms of delays and overproduction. This to some extent would mean that contract drafting and procurement would be speeded up, with the 'one piece flow system'. Unlike the current scenario where, contract procurements take a long period of time, hence leading to change in scope and budget at project implementation phase. The main benefits of 'One piece flow' as advanced by Ohno are that it *'Builds in quality' 'Creates real flexibility' 'Creates high productivity'* etc. Figure 11 below, compares the principles Lean Thinking and Production at Strategic and Operational levels to understand value and elimination of waste in the value addition stream.

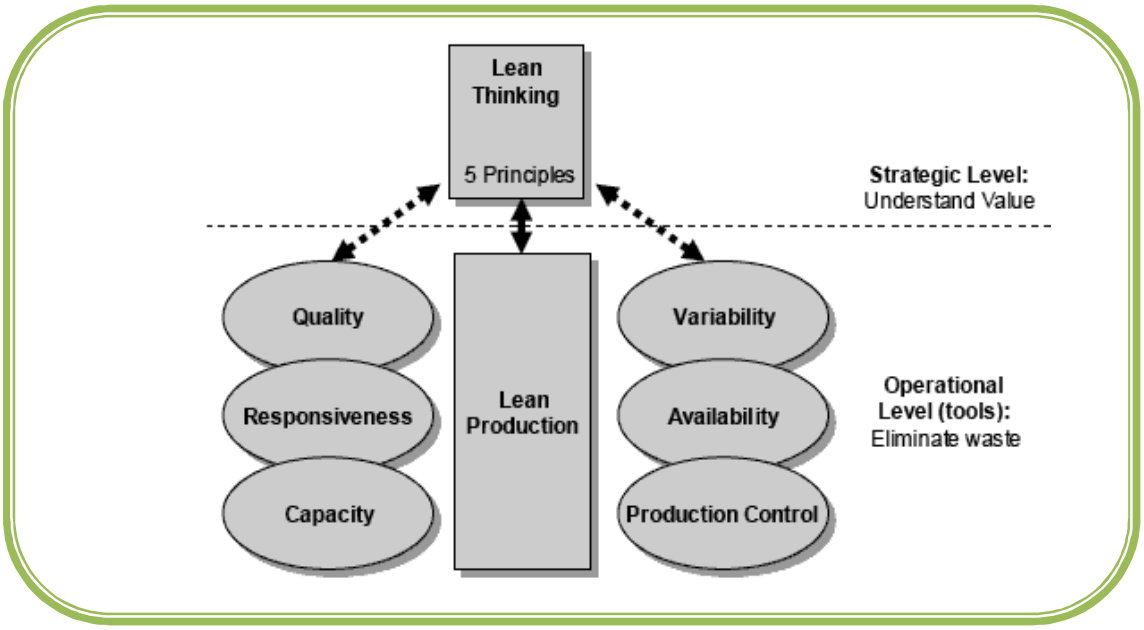

Figure 11: Strategic and Operational Levels of Lean Thinking *(Adopted from Lean Sigma Institute)*

One piece flow system also *'Frees up space'*, *'Improves safety'*, *'Improves morale' and 'Reduces cost of Inventory'*. To achieve a viable specific value stream definition for gravel roads of good and acceptable quality and to customer perspective requires real collaboration and consultation from all parties namely, the ultimate Customer, Client, Consultant and Contractor.

2.2.8 Lean Six Sigma

"Six Sigma has evolved from a metric, to a methodology, to a management system (Motorola University). Motorola is given credit for developing "Six Sigma" but the statistical roots can be traced back to the 1800's, when Carl Frederick Gauss used the normal curve for analysis and around 1924 when Walter Shewhart used control charts and made the distinction of special versus common cause of variation and their link to process problems. The term "Sigma" (σ) is often used as a scale for levels of "goodness" or quality. Using this scale, "Six Sigma" (+/-6σ) equates to 3.4 defects per one million opportunities (3.4 DPMO). Being 'Six Sigma' means having a process that produces only 3.4 defects per million opportunities (3.4 DPMO) despite expected fluctuations. This implies that 99.99% of the outcomes products in million opportunities, should fall within the (+/-6σ) band. Therefore, 'Six Sigma' started as a defect reduction effort in manufacturing and was then applied to other business processes for the same purpose.The desired output of 'Six Sigma' is to reduce defects, reduce cycle time, increase throughput and increase customer satisfaction by *reducing variation* in products and processes, thus giving an organization a competitive advantage" (Avraham, 2009).

Motorola University (n.d) stated as follows;

> *As 'Six Sigma' has evolved, there has been less emphasis on the literal definition of 3.4 DPMO, or counting defects in products and processes. 'Six Sigma' (+/-6σ) is a business improvement methodology that focuses an organization on:*
>
> - *Understanding and managing customer requirements;*
> - *Aligning key business processes to achieve those requirements;*
> - *Utilizing rigorous data analysis to minimize variation in those processes; and*
> - *Driving rapid and sustainable improvement to business processes.*

At the heart of the 'Six Sigma' methodology, is the DMAIC model for process improvement. DMAIC is commonly used by 'Six Sigma' project teams and is an acronym for: *Define opportunity, Measure performance, Analyze opportunity, Improve performance and Control performance.*

The *'Lean Six Sigma'* according to George (2010:p.xvii) is a brain child of *'Lean Thinking Theory'* which takes a holistic approach to improve performance in Business Organisations including those involved with Production and Construction. The main aim of this business or project management strategy is to reduce waste and thereby reduce marginal operational costs so as to increase mark up levels.

'Holistic' Lean Six Sigma, critically addresses all seven of the fundamental requirements in Project and Business organisations for effective operational cost reduction;

1. *Alignment of the reduction effort to Company strategy and its sense of urgency-be it immediate survival, business as usual, or establishing competitive advantage;*
2. *Identification of the greatest levers of operational cost reduction opportunity;*
3. *Understanding of the multiple drivers and root causes of cost (including processes, offerings, customers, suppliers, and distribution channels), as well as their interrelationships and ultimate cost of complexity they create;*
4. *Speed to results, and related effort and investment requirement required to realise the cost reduction;*
5. *Practical and Pragmatic implementation: the cost reduction approach must be robust and universal, able to address a wide array of opportunities, environments, and levels of operational maturity;*
6. *Balance between internal and external forces, ensuring that the cost reduction activity will adversely affect net overall business performance –especially through any degradation of quality, customer service, and market share; and*
7. *Substantially of the cost reduction realized.*

As already alluded, the acronym "DMAIC" according to *"Lean Six Sigma"* philosophy, stands for five interconnected phases; *Define, Measure, Analyze, Improve* and *Control* of the

product throughout the Total Value Stream (TVS)[23] or One Piece Flow (OPF). This is complemented by the 'Lean 5S' principles, interpreted through Japanese words as;

- ***Sieri*** – (Separate) or Sort;
- ***Seiton*** – (Straighten) Store or Put in Place;
- ***Seiso*** – (Clean) or Shine;
- ***Seiketsu*** – (Standardize); and
- ***Shitsuke*** – (Discipline) or Sustain; plus *'Safety'* considerations in all the '5S' and through the Total Value Stream (TVS) of the work process.

From the foregoing, it could be concluded that *'Lean Thinking'* theory cannot be perceived to be relegated to the Production and Construction operations only, but can further be escalated to the various levels of growing business investments. Liker (2004: p.94), indicates that the 'Lean' theory used in production or manufacturing could also be applied to Business and Engineering;

> *The same logic applies to business and engineering process. By allowing individual departments do the work in batches and pass the batches to other departments and you guarantee or encourage delays in getting work done. Lots of excessive bureaucracy ('the red tape') will creep up, governing the standards for each department, and lots of non-value adding positions will be created to monitor the flow. Most of the time will be spent with projects waiting for decisions or action. The result will be chaos and poor quality. Take the right people who do the value - added work, line them up, flow the project through those people with appropriate meetings and collaboration to work on integration and you will get speed, productivity and better quality results. When operations are linked together, there is more teamwork, rapid feedback on earlier quality problems, control over the process, and direct pressure for people to solve problems and think and grow. Ultimately, within the Toyota Way (TTW) the main benefit of one piece flow is that it challenges people to think and improve.*

For Organisations and Companies involved with the construction and maintenance of gravel roads, this is a strategy worth exploring and employing for better product performance. Exercising the *'Lean Six Sigma'* principles as complementary to *'Lean Thinking'* theory, may lead to improvement of Companies capital capability and increased market share. These arrays of opportunities that are embedded in *'Lean Six Sigma'* could be beneficial for the emerging Companies especially those trying to venture in the gravel road construction and maintenance in Zambia as a business or entrepreneurial opportunity.

[23] *TVS- Total Value Stream, in 'Lean Thinking' this is about specifying to detail the work process path from raw materials to product end user stages.*

2.2.9 Complementary of Lean and Six Sigma

In Construction and Project Management, *'Lean and Six Sigma'* principles are seen to be complementary. This is because they both strive to improve quality and value of products in order to satisfy the end user or Customer needs, and are therefore not at variance with each other. George (2003: p.7), asserts that ironically, *'Lean and Six Sigma'* has often been regarded as rival initiatives- *'Lean'* Enthusiasts indicating that Six Sigma pays little attention to anything related to speed and flow, *'Six Sigma'* supporters on the other hand, pointing out that Lean fails to address key concepts like Customer needs and variation. Both sides may be considered to be right and this could be the reason why the two management approaches are deemed complementary in nature. In essence, the two theories work together in unison as asserted by Goerge (2003: p.51);

> *Lean provides the powerful value stream map tool, which crosses functional silos and highlights waste and delays. Six Sigma rarely gets into a discussion of classifying activities as value added, nor is elimination of non-value adding activities a central tenet of Six Sigma. Rather, Six Sigma protocol prescribes eliminating variation first, and, only if that's not possible, then redesigning the process using, Design for Six Sigma (DFSS). Lean claims that process redesign is always required to some extent (to eliminate non-value added activities) when cycle efficiently is less than 10%.*

However, these arguments are often used to advocate choosing one over the other, rather than to support the more logical conclusion, is that we need to blend Lean and Six Sigma in work processes. Why are they then considered complementary in *'Lean Thinking'* and *'Value Management'*? Here is a quick view of the reasons:

Six Sigma.....

- emphasizes the need to recognise opportunities and eliminate defects (waste) as defined by Customers;
- recognises that variation hinders our ability to reliably deliver high quality products and services;
- requires data driven decisions and incorporates a comprehensive set of quality tools under a powerful framework for effective problem solving;
- provides a highly prescriptive cultural infrastructure effective in obtaining sustainable results; and
- when implemented correctly, promises and delivers to improved operating company profit.

Lean.....

- focuses on maximising process velocity;
- provides tools for analysing process flow and delay times at each activity in the process;
- centres in the separation of "Value added" from "non value added" work with tools to eliminate the root causes of non value adding activities and their costs; and
- provides a means for quantifying and eliminating the cost of complexity.

Lean and Six Sigma principles can contribute significantly to improvement of delivering value to customer perspective if used intertwined in a work process, even in the construction and maintenance of gravel roads in Zambia. For the purpose of this study *"Lean"* and *"Six Sigma"* are thinly distinguished and have been treated as one and same management principles. Below are some of the commonly used formulae in the *'Lean Six Sigma'* approaches. According to George, (2003: pp.21-29), "Y is a function of X" equation that relates an output (Y) to inputs or process variables (Xs):

(a) Y = f(X1, X2, X3,……)

This equation holds true at the organizational level as well: any output (Y), such as profit, growth, or ROIC[24], is dependent on the process variables (Xs) such as quality, lead time, offering attractiveness, non-value adding cost, etc., that go into it. In order to improve the results we see ("drive the Y" in Six Sigma parlance), we have to find and focus on the critical Xs that affect that result.

(b) Lead time and process speed

$$Lead\ time = \frac{Amount\ of\ Work\ in\ Progress\ (WIP)}{Average\ Completion\ rate}$$

The above equation is known as Little's law, named after the Mathematician who proved it in order to determine lead times. This equation is used for calculating how long it takes for a task to be completed in work process.

[24] *ROIC – Return On Investment of the Company, which is actually a measure of cost and benefits to establish whether there, is profit or loss registration in any business entity.*

(c) Process Cycle Efficiency (PCE)

Another famous equation used in the "Lean Six Sigma" is that to do with Process Cycle Efficiency (PCE)[25]. This relates to the amount of Value adding time to the total lead time of the process;

$$Process\ Cycle\ Efficiency\ (PCE) = \frac{Value\ Adding\ Time}{Total\ Lead\ Time}$$

A PCE of less than 10% indicates that the process has a lot of non value adding activities or waste opportunity (*ibid.*).

(d) Takt time

Another useful equation in Lean Thinking worth the salt in gravel roads in Zambia, is Takt time, which is simply the rate of customer demand for the group of products produced by one process (Rother, 2010: pp78-100).

$$Takt\ time = \frac{Effective\ Operating\ time\ per\ shift}{Quantity\ customer\ requires\ per\ shift}$$

2.2.10 Lean Thinking and Talent Management

Dessler (2013, pp.128-154), defines "Talent Management"[26] as a holistic *"goal oriented and integrated process of planning, recruiting, developing and compensating employees.* This principle works in line with *"Lean Thinking"* theory norms, because it promotes efficiency through use of value addition and waste removal strategies in Human Resource Management. It involves instituting a coordinated process for identifying, recruiting, hiring and developing high potential employees fit for the tasks for which they are engaged. Talent Management means being more focused in how one manages his or her Company's talents and capabilities. According to Liker and Meier (2007), and Liker and Hoseus (2008), Job Instruction Method (JIM) is the foundation of Talent development and management. As OPRCs uses *"Lean Thinking"* and *"Value Management"* principles, hence, Contractors engaged in the Construction and Maintenance of gravel roads in Zambia, this is one such theory they would need to tap into. Through the use of Talent and Capability competencies, it enables responsible Managers to hire employees who are fit for purpose and multi-disciplined qualified. Such a practice would promote delivery of good quality gravel roads to road users at a lower cost, thereby removing some forms of waste such as idling and over employment

[25] *PCE-Process Cycle Efficiency, a measure of input to output on resources for an Organisation*

[26] *Talent Management; Strategic practice of recruiting, developing and compensating employees to much required competencies for work tasks. This is a principle drawn from "Lean Thinking and Value Management theories"*

(*op. cit.*). This also ensures *"Strategic Human Resource Management"* which means formulating and executing human resource policies and practices that produce the employee competencies and behaviours the company needs to achieve its valued strategic goals, objectives and aims. *Managers call the specific human resource management policies and practices they use to support their strategic aims "Human Resources Strategies" (ibid).* To apply such practices in the hiring of employees in the Construction and Maintenance of gravel roads in Zambia, will culminate into the efficient utilisation of Human capital, which in return might result in the enhancement of quality of a road product.

2.2.11 Lean and Theory of Constraints (TOC)

The Theory of Constraints (TOC) is best understood through the analogy of a chain system. *"The strength of a chain is at its weakest link"* they say. The chain system could therefore, only best be improved through reinforcement or improvement of the identified weakest link. Improvement that does not improve the performance of the weakest link most likely does not improve the 'Total Value System (TVS)' and can be considered waste. Many claim that TOC is just common sense, but it is surely not common practice. More accurately, TOC is about how to improve and manage how the system constraint performs in the context of the total value system (Herbie, *n.d.*). This is quite different; it is about managing the total value system, which is comprised of interdependencies, variability and constraints, to ensure maximum bottom line results for the organization. *TOC is about FOCUSING first on the system's leverage points and then on how all parts of the system impact the operation of the leverage points.* This is the way to achieve *total value system* improvement, not just localized improvements (Avraham, 2009).

> *The Theory of Constraints (TOC) applies the logical thinking processes used in the hard sciences – cause-and-effect – to understand and improve systems of all types, but particularly, organizations. The process a doctor would follow if you went to him with an illness, first Diagnosis, then Design of a treatment plan, and then Execution of the treatment plan, is the same process followed by TOC with the use of three questions, What to Change- What to Change To - and How to Cause the Change.(ibid)*

One of the core beliefs of the hard sciences, is that for many effects there are very few causes. This can also be referred to as the Pareto rule (20/80 rule). Using the construct of "Cause and Effect" becomes increasingly important as we perform scientific analysis. All too often we see organizations treating many "symptoms" instead of addressing the root causes. TOC looks for the core conflict that holds the root causes in place.

In short, the TOC systems approach requires that you first understand the system, its goal and measurements. Then you can apply the five focusing steps:

- Identify the constraint(s);
- Decide how to exploit the constraint(s);
- Subordinate/synchronize everything else to the constraint(s);
- If needed elevate the system's constraint; and
- If the constraint has been broken go back to step one. Don't let inertia become the constraint.

According to Avraham (2009), the application of these steps in a situation where the system constraint is physical is usually obvious and straightforward. But often it's not a physical constraint. The nature of many constraints in organizations is policy constraints. In that case, the Five Focusing Steps break down or could be summarized into the three questions as earlier stated:

1. What to Change?
2. What to Change to?
3. How to Cause the Change?

The TOC methodology looks at the world through the eyes of cause-and-effect logic and focuses on managing *system* constraints, interdependencies, and variability. In view of above stated reasons, it is envisaged that by applying TOC, Lean and Six Sigma, the construction and maintenance of gravel roads in Zambia would significantly improve results on the Customer perceived value delivery. These three, *'Theory of Constraints', 'Lean Thinking'* and *'Value Management'* tools if and when correctly applied would bring about the most yearning benefits expected from good quality gravel roads. At best *'Lean Thinking'* and *'Value Management'* thrives on hybrid value and quality delivering tools. For the Theory of Constraints to be usefully appropriated in the construction and maintenance of gravel roads, it is incumbent upon all Stakeholders involved to understand the Total Value Stream or System (TVS) so as to better identify the related constraints. The Total Value System [One piece flow] should not be limited to the project implementation phases only but to cover the inception and planning stages as well.

2.2.12 Lean enterprise and Network

For Road construction and maintenance contracts to be successful, it demands parties to treat them as enterprises. As in *'Lean Synchronisation', 'Lean enterprise'* pertains to a holistic approach of a business concern, be it road construction or any other. This is simply the

placing of the entire Value stream for specific products relentlessly in the foreground and rethinking every aspect of jobs, careers, functions, and firms in order to correctly specify value and make it flow continuously along the whole length of the stream as pulled by the customer satisfaction and that in pursuit of perfection *(Kaizen)* (Womack and Jones, 2003: p.275). This simply means that *'Lean Thinking'* principles should be employed in effect in any business venture to realise better results that aim at meeting Customer perceived value. To satisfy Customer perceived quality and value, is all about listening and interpreting the Customer voice(s). Lowenthal (2010: pp22-24), interpreted the Customer voice as follows;

> *Customer may not always be able to articulate clearly just what they want in a product or service, but they usually know when they are not getting it. For every product, every customer has a level that he or she wants that product to reach or exceed in respect to one or more of the product's characteristics. If product reaches the desired level, the customer considers it a quality product. If it does not, the customer is likely to look elsewhere.*

In the case of quality and value of gravel roads in Zambia, the customer voice (s) need to be heard and cautiously followed so that the desires of many road users could be incorporated or taken on board from project inception, planning, design, implementation, completion and commissioning stages. The many stakeholders such as client, road users and the general public (local community) need to be fully participative in the work flow process. This also calls for *'Lean Networking'* of Lean Thinkers drawn from all road sector stakeholders, especially those conversant with gravel roads in terms of their construction, operation and maintenance.

2.3 THE VALUE PHILOSOPHY

According to New South Wales Treasury, (2004: p.1), Value Management may be described as analytical process for developing innovative holistic solutions to complex problems. Value Management has the following key characteristics:

- A specific methodology;
- Based upon creative problem solving approach;
- Involves key stakeholders in a managed team approach;
- Focuses on function i.e. What it must do, not what it is;
- Focuses on value-added solutions;
- Based upon an integration; and
- Focuses on project learning.

The greatest gains of value management have been shown when directed towards obtaining maximum value from a total system. The examination of function remains fundamental, however this occurs within the system wide context. It is the systematic analysis of functions, which sets *'Value Management'* apart from other approaches to improving value, such as *'Lean Thinking'*. *'Value Management'* studies should be organized at optimal points in the project life cycle and structured to meet the objectives relevant to the particular stage of the project. Application of *'Value Management'* to most projects including the Construction and Maintenance of gravel roads consist but not limited to:

- Establishing and verifying project objectives;
- Analyzing project briefs;
- Optimising design solution to enhance value to customer perspective;
- Resolving conflicts and improving communication among Stakeholders; and
- Creating and analyzing a range of options for executive consideration.

2.3.1 Value Management and Total Asset Management (TAM)

"Total Asset Management (TAM) reflects priorities for service planning, whole-of-life asset management (WOLAM), extended planning requirements for new works, and new relationships between services planning and asset procurement. Provision for *'Value Management'* study at each step of the TAM process will ensure that the best value is obtained" (*ibid.*). *'Value Management'* principles are therefore, a catalyst to proper Total Asset Management (TAM) to enhance value of a product or service such as gravel roads in Zambia. Outlined below in Figure 12 is a summarized *'Value Management'* Process commonly referred to as the 'Job plan' (Value Study group/Charette). This is a process which considers every element in a work flow in order to establish best functionality and how best value could be achieved.

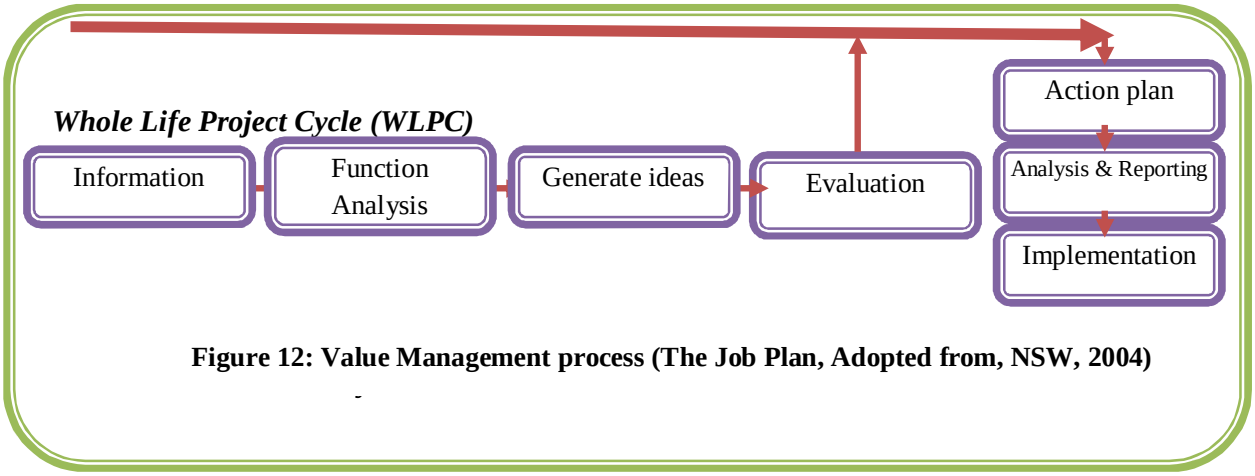

Figure 12: Value Management process (The Job Plan, Adopted from, NSW, 2004)

2.3.3 Value Engineering

'Value Engineering' originated in the US manufacturing industry, where General Electric Company led by Lawrence D. Miles developed VE[27] (in the form of value analysis) during the 1940's (Kelly et al. 2004: pp. 11-22). Therefore, VE method examines the function of product parts in quest of identifying alternatives which could decrease costs without removing the functions (IVM, 2005 and SAVE, 2008). According to Potts (2008), Miles was bothered on how to get alternative components that will perform the same function but at lower cost. When mass production appeared, VE optimized product design by directly linking functions required by customers with their corresponding product parts, illustrating their value-adding role. VE was used to increase value by simplifying products and thereby reduce manufacturing costs and increase profit margins. There are a number of VE technique objectives such as saving money, reduce time, improve quality, reliability, maintainability, and performance. For the improvement of gravel roads in Zambia, Value Engineering can also extend to the use of financial, manpower, and material resources by eliminating unnecessary or excessive costs without sacrificing quality or performance (Alphonse, 1997). Later with the arrival of *Viz.* agile manufacturing, VE was developed to consider customer expectations as value. Statements of objectives were still systematically reviewed and defined as functions to determine what are needed and what are wanted. This allowed for the removal of the cost of unnecessary functions. Thereby, VE changed from retrospectively reviewing existing design to assisting new design development in response to identified needs (Thomson & Austin 2001: p. 4). The idea spread to the UK in the early 60's with the establishment of the Institute of Value Management (IVM). Also in this period of time the VE concept emerged in the building industry as a way of understanding client requirements at the outset of a project (Wandahl, 2005).

2. 3.4 Value Management

'Lean Thinking' is complemented by *'Value Management'* in order for it to obtain enhanced quality and value of products and services to customer perspective. Fryer et al, *(op.cit.)*, present that *'Value Management'* can be defined as a structured approach that seeks to establish what *'value'* means to a client or customer (road user) in meeting a perceived need, by clearly defining and agreeing the project objectives and establishing how they can best be achieved. *'Value Management'* is a system which looks at the value adding activities in the work flow process with the aim of delivering value to customer needs. Kelly and Male (1994,

[27] *VE- Value Engineering is systematic of evaluating the function of products and services so as have them produced or delivered at lower cost while improving the end user value*

p3) amplify that Value Management is a service in which the sponsor of a project, the client, transmits a clear statement of value requirements of that project to the project designers. This approach uses series of interviews to understand value better from different perspectives of various stakeholders. *'Value Management'* (VM) considers the whole value process and incorporates *'Value planning'* (VP), *'Value Engineering'* (VE) and *'Value reviewing'* (VR), Potts, *(op.cit).* All these pertinent steps are followed to ensure Construction projects achieve *'Value for Money'* (VFM)[28] principle. Fewings (2008:p.183), advances a fact that the value of a Construction project including that of Gravel Road Construction and Maintenance is determined by the benefits accrued for the Client or most specifically the end users.

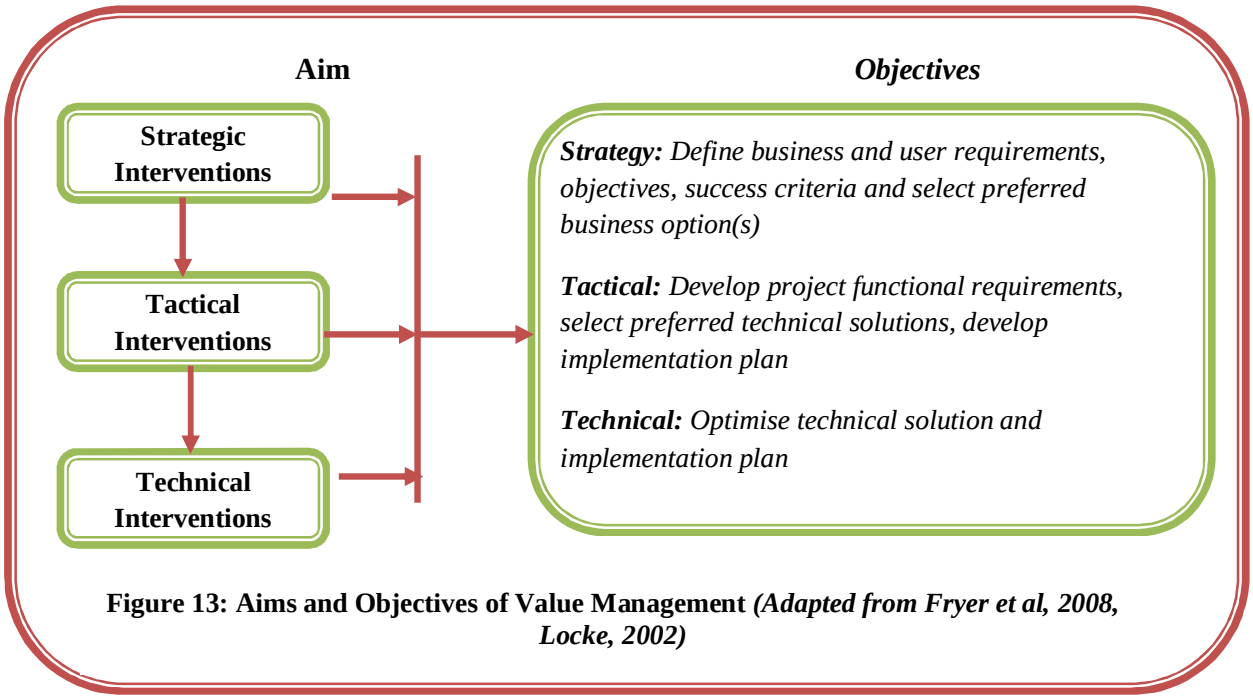

Figure 13: Aims and Objectives of Value Management *(Adapted from Fryer et al, 2008, Locke, 2002)*

Figure 13 outlines VM aims and objectives. With achieving defined functions at minimum cost (or whole life cost), VM is concerned with defining what value actually means within a particular context, agreeing a clear statement of objectives and ensuring that solutions are consistent with those objectives. While *'Value Management'* addresses the WHY questions such as what is the need for this project or process, *'Value Engineering'* is concerned with the HOW. Also, *'Value Management'* is not a single method, but a framework within which proven methods are systematically brought together to identify better value from projects, products and services. In this context, VE is regarded as a sub set of VM. The basic methodology for a VM and a VE study are similar (Hammersley, 2002: pp.1-10).

[28] *VFM-Value for Money is determined by the benefits that are accrued to the Client or End users as result of a product or service*

> Harris et al. (2006), amplified that "*Value Management embraces the narrower technique known as Value Engineering which was originally conceived by the military in the 1940s and later refined by the General Electrical (GE) in the USA, in attempt to meet demand for its products at reduced cost but without compromise in value.*

The three stages of Value Management are Value planning, Value engineering and Value review or appraisal and are as shown in Figure 14 below;

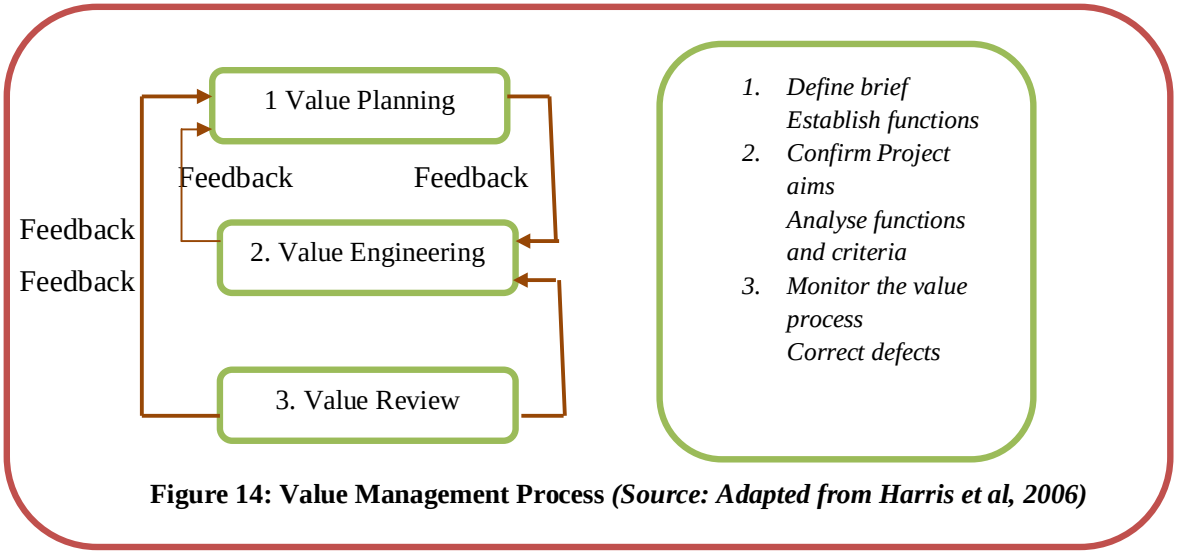

Figure 14: Value Management Process *(Source: Adapted from Harris et al, 2006)*

Fellows (2007: pp.231-236), alluded that

> *Promotion of value of a given product, good or service, seeks to maximise the functional performance which is needed at minimum cost. In so doing, it is acknowledged that, in many practical instances, the performance which is designed differs from that which is needed, in terms of amount and/or type (by function).*

As stated above, *'Value Management'* considers all the processes of the whole project life with maximum concentration on the enhancing value to meet the customer requirements. 'To avoid confusion some practitioners just use the term *'Value Management'* to cover all applications but a simple illustration of the application of VP, VM, VE, VM and VA to a project might be:

Value Planning- Analysing of perceived product value before construction or production

Value Management – decision to invest – do we need a project, project concept and scope – what form of project do we need; outline design – what should be the major elements.

Value Engineering/Methodology – project design; design of project elements

Value Analysis – Improvement of a construction, manufacturing or management process; post project review (Hammersley, *op.cit.pp.1-11*)' and (Kelly and Male, 2004).

2.3.4.1 Value Management in Construction

Section 2.2.7, indicates that Construction in general, is associated with three variables namely, time, cost and quality (Scope) (Burke, 2004). Failing to achieve or satisfy any one of these implies that value as demanded by the Customer or Client would be compromised and might in due course not be realised. *'Value Management'* is not concerned with improving one of the three variables but looks into the work flow process heuristically. As stated already in section 2.3.4,'*Value Management'* evolved from the term '*Value analysis'* which was developed from the work of Lawrence Miles, a Purchase Engineer for General Electric Company in the 1940's. Miles questioned 'if I can obtain the product, I must obtain an alternative which performs the same function (Kelly and Male, 1993). The 'Job Plan'[29] as illustrated in Figure 12, was used to engender logical sequence of activities to achieve a value that would satisfy the client. Value Engineering followed value analysis and is currently in use in manufacturing industry. It became popular in the UK construction Industry in the early 1990's (Kelly and Male, 2002), where it became known as Value Management, (Kelly et.al. 2005)'. 'Value Management (VM) seeks to maximise value in relation to function and cost while Risk Management (RM) seeks to minimise the uncertainty of it not being realised (Fewings, 2005: p.184)'. Unfortunately, most Road Contractors' including those involved with gravel roads, prime focus is the level of profits that they will realise and the Client perceived value becomes secondary which would be mainly left in limbo and unachieved. This again is one of the biggest problems that the Zambian Road Construction Industry may be grappling with. Ultimately, Road Construction Industry is a major culprit when it comes to association with shoddy works by the Government and the general public at large. Is it because the Road Contractors are not satisfying the needs of the customer (road users) in terms of delivering value or good quality gravel road project or the customer does not fully understand value? The problem therefore, may be on how to define *"Value"* from the customer perspective[30]. The *'Job plan'* methodology here applies as a tool for analyzing value through all the project phases so as to fully appreciate product value from the customer eye view or lenses, which ensures that the Customer voice is heard (Lowenthal, 2010: pp22-24).

[29] *Job Plan is a series of activates in a Value Management workshop to analyze value in terms of functionality of a product from customer perspective.*

[30] *The Customer being the general public who are gravel road users*

2.3.4.2 Value

Hays (2004), defines value as the most cost effective way to reliably accomplish a function, which will meet expectations of the customer, while the Oxford English Dictionary defines the word 'Value' as the 'Worth' desirability or utility/functionality of a thing, or the qualities on which these depend (Dallas, 2008). In Construction, the term value is generally taken to mean the balance between how well product satisfies the user expectations, in terms of resources used to deliver it *(ibid.)*. The early Value Management (VM) definition for value was the relationship of function and cost. Function is defined as the intent or purpose of a system, product, or process operating within its normally prescribed manner and mainly inclined to satisfy customer aspirations and needs. While cost is easy to analyse and measure, function is not. This is because the aspiration of it may differ from customer to customer. However, the characteristics of function can be assessed and measured. The basic elements that could allow us to measure the functions, are performance and delivery characteristics. To define the value of users of gravel roads, calls for rigorous strategic planning such as through *'Value Management'*. This would require that all stakeholders in the value chain or supply chain are part of the value definition and addition processes. The value or functionality of gravel roads needs to be clearly understood by all Stakeholders on the onset.

Womack and Jones (2003: p.16) noted that:

> *The critical starting point for lean thinking is Value. Value can only be defined by the ultimate customer. It is only meaningful when expressed in terms of a specific product (good or service, and often both at once) which meets the customer's needs at specific price at a specific time.*

Hays (*op. cit.*), went further to elaborate these two characteristics of function as follows;

Performance: Appropriate performance requires that the product or service have a predetermined level of quality, functionality, reliability, interchangeability, maintainability, producibility, reliability and marketability.

Delivery: The customer requires acceptable delivery, usually at specific place within a given time frame.

The equation below is normally used in various forms to define value by stating the relationship of function and cost;

$$Value = \frac{\text{Function}}{\text{Cost}} = \frac{\text{Performance + Delivery}}{\text{Cost}} = \frac{\text{Benefits delivered}}{\text{Resources used}}$$

While the above equation may imply that value increases by minimising cost, the ability to accomplish the function, or how the product performs and efficacy of delivering the product to the customer perception, may be jeopardized at minimum cost. Value analysis therefore, is a rigorous process which takes a heuristic approach with function and cost being at the core.

Maramaldo (2002), forwarded the above equation which was developed by Lawrence Miles, provides value relationship to the function and cost from the Customer or the User perspective. In the case of the construction and maintenance of gravel roads, the Customer is the Client, which is mainly the Government of the Republic of Zambia or the citizenry at large. The other customers are various road users accessing the gravel roads. The other side of value can be looked at from the Producer or the Contractor point of view. Hence, there are two different types of value for the same object or product (Construction and Maintenance of gravel roads) that may be identified; Value for User (Vu)[31] and Value for the Producer (Vp)[32]. Thus two equations could emerge as follows;

$$Vu = \frac{\text{Function}}{\text{Cost}} = \frac{\text{Performance + Delivery}}{\text{Cost}}$$

$$Vp = \frac{\text{Return on Investment; Net Profit}}{\text{Risk}}$$

According to Lawrence Miles, "when someone considers buying an object, what he or she is looking for is the value of that object or the functions (how the gravel road serves the user) will perform in exchange for a given cost. We may also consider that the Producer (Contractor) of the same product (gravel or earth road) would be looking for the Return on his or her Investment (ROI) and the Net Profit (NP) it will generate when selling it to the user, for a given 'Risk' of such a business for his/her money" (*ibid.*). The customer desires to get the *'Best Value'* from any given product. Best Value according to Fryer, (*op.cit. p.195.*), is that value which seeks to raise standards and provide better quality at reasonable cost. In fact Value of a product or service, makes reasonable sense if it meets the primary needs of the Customer. In today's Customer driven markets, it is not a product or service that matters most, but these have to be driven and delivered from Value to Customer perceptive (Simci-Levi, *et al.* 2009). The current emphasis on Customer value has even been amplified further by establishing the main reasons why one product or service is preferred to another and why one Company would be opted for another *(ibid.).*

[31] *Vu, Value desired/perceived by the end user or customer (road user)*
[32] *Vp, Value perceived by the Producer, Supplier or Contractor*

2.3.4.3 Generated and developed Value

Value for the user (Vu) may further transform into two other types of value namely Social Value (Vs)[33] and Future Value (Vf)[34]. Maramaldo (2002), indicated that if the approach is for pure consumption, or the '***to have*** approach', values will be constantly destroyed, without the opportunity for further development, but if the approach is for self development, or the '**to be** approach', then it is possible to have the value; Vu transformation into Vs, Vf and **new** Vu. Therefore, the improvement in the standard of living of the communities along the constructed and maintained gravel road would culminate into Social Value (Vs) and future value (Vf) respectively. It then follows that several economical developments realised as result of improved gravel roads through *"Lean Thinking"* and *"Value Management"* principles incorporation, may be considered as Future Value (Vf). However, ***value*** definition for gravel road construction and maintenance, can be a very complex issue to comprehend and to mean the same thing to all stakeholders in the road sector. This is because the Client's or Promoter's value (Vu) may be perceived differently from that of the Contractor's or Producer's value (Vp). In principle and as already alluded, Value can be looked at from the producer's or customer's [User's] side and it has also been related to functional aspects of use. Put it simply, Value has utility dimensions even from the gravel roads point of view which are to always be enhanced through improvement of Value adding activities in the work flow processes (Kelly, Morledge and Wilkinson, 2006: p.12). It is the reason why the application of *"Value Management"* philosophy needs not to be overemphasized if value definition which satisfies all parties has to be arrived at (Green 1994, Garnett *et al*. 1998,). This is why *"Value Management"* is defined as management particularly designed to motivate people, develop skills, and promote synergies and innovation, with the aim of maximizing the overall performance of an organisation. *"Value Management"* provides a new way to use many existing management methods and is consistent with quality management, and has been proven effective in a wide range of activities (Kelly, et. al, 2015:p.32). Through *"Value Management"* strategies, stakeholders in the road sector [gravel roads] would be aided in defining value as it applies to each party, by understanding the various product functionalities, quality and other fringe benefits. They [Stakeholders] then make informed decisions on how to proceed when involved in gravel road construction and maintenance projects. A win-win situation for satisfaction of all would as result prevail.

[33] *Vs, Value seen from social improvement on the customer point of view*
[34] *Vf, Value that will emerge as result of product/project development and implementation in the future*

Proper definition of value is a product of an implicit specification of ***Value stream.*** Value stream identifies all steps in the value addition processes for any given product, be it that to do with gravel roads. Liker and Meier (2006: p.37), suggest that by merely improving an isolated process, the flow naturally improves across the entire value stream. Consequently, in the construction and maintenance of gravel roads, it involves identification of all the steps from project inception to implementation phases (*ibid.*). Value addition should then be realised by ensuring that there is ***'Flow'*** in the process. Garnett *et al. op.cit.*, emphasized that;

> *Strategically, flow is concerned with achieving a holistic route through the means by which a product is developed. This therefore, ensures that all forms of fragmentation in Value addition flow are minimised. Another aspect of maximising value is that the value addition process should be applied on the* ***'Pull'*** *and not* ***'Push'*** *principle. This implies that any value addition activity should only be undertaken from the customer needs or demands.*

For gravel roads, more attention should therefore, be paid to the understanding of the needs of the road users with the aim of improving road product quality and value. A better value of gravel or earth road is that which will be appreciated by the road users themselves and ensures that the desired connectivity of rural communities is realised and sustained. According to Garnett *et al.* (1998), the process of product value enhancement has no definite end, as this is a continuous ***'perfection'*** *(Kaizen)* process directed at satisfying the Customer, the gravel road user. According to Liker and Meier (2007: p.26);

> *The highly useful tool looks at the flow of material and information, and associated lead time, across multiple processes. However, the lead time through a value stream is an outcome correlated with inventory in turn is an outcome that results from performance attributes of individual process in the value stream. Therefore, if you want to reduce lead time, you should improve process.*

Hence, value definition is an important factor at the design stage of any road project such as the construction and maintenance of gravel roads. This is because functionality assessment should be rightly done in the first stages of the road project cycle for better envisaged future results. Blakey, *(op.cit.),* indicated that;

> *During the last 40 years or more, the design of the road construction industry has suffered from a number of woes that have significantly affected its ability for projects to finish on time, within budget and with the quality as demanded by the customer.*

Therefore, much attention should be paid to value definition at design stage for gravel or earth road projects through application of *"Lean Thinking"* and *"Value Management"* principles.

2.3.5 Waste Reduction in Construction

According to Womack and Jones, *(op.cit. p.15)*, "MUDA"[35] means wastes and from the Lean Construction point of view, these are activities which are non value adding in the product producing process. Such activities as Overproduction, which are as a result of the Contractor, *pushing* the flow of work through the system (Conventional contracts), rather than allowing the customer (Value perspective) to *pulling* work through the value stream (OPRCs) by demand or need. Unnecessary gathering of materials such as stock piling of road construction and maintenance materials, which will not enhance value in the work flow process, is also a form of waste. This would be referred to as *'pushing'* the activity before it is ultimately needed in the value stream, hence defeating the *'just in time'* philosophy.

To understand the wastes inherent in the gravel road construction projects, it would be necessary to review the meaning of wastes as described in *"Lean Thinking"* and *"Value Management"* philosophies in the general sense. These wastes impact negatively on road project worthiness. In *'Lean Thinking'*, waste as highlighted by Womack and Jones, *(op.cit.)*, is broken down into Seven (7) specific types and as diagrammatically presented in figure 15:

- ***Over- production/delivering*** (volumes of materials not required such as going beyond the specified compliance road quality or service level);
- ***Waiting*** for the work to be ready for the next process (Unnecessary delays and breaks between operations and tasks);
- ***Transportation or conveyance*** (Unnecessary movements such as Plant assigned to haul materials for road construction and maintenance);
- ***Over processing*** – because of poor design (i.e. not producing *just* what the customer or the road user values but going beyond what is specified);
- ***Inventory*** levels that are too high (Unnecessary assembly of resources which may not be needed in the gravel road improved exercise);
- ***Human motion*** (Movement/Making do pretending to be working when not); and
- ***Correction of defects*** (Making unnecessary mistakes (reworking for failing to meet specifications or compliance levels) which can be avoided).

[35] *MUDA is a Japanese word to mean WASTE*

The Seven forms of 'Lean wastes' could be easily remembered by the acronym 'TIMWOOD', to mean Transport, Inventory, Motion, Waiting, Overproduction, Overprocessing and Defects, as illustrated in figure 15 (George, 2010: pp.23-38).

Figure 15: Seven (7) types of Lean Wastes (adapted from George, 2010)

Liker and Meier (2006: p.84) observe that Toyota considers 'Overproduction' as the worst of the seven types of wastes, as it leads to the other six types of wastes. Unfortunately, these types of wastes stated above, may not have been given the necessary attention required in the construction and maintenance of gravel roads in Zambia. For instance, in the OPRCs being implemented by the RDA sometimes the Contractor is instructed to remove unsuitable materials from the work site which have already been hauled for purpose of road construction and maintenance due to poor communication and collaboration, which according to the tenets of '*Lean Thinking'* principles is a form of waste (RDA, Annual Report, 2007).

2.3.6 Earned Value Management

For better gravel road product in Zambia, *'Lean Thinking (LT)'* and *'Value Management (VM)'* principles, have to intertwine with *'Earned Value Management (EVM)'*[36] in order that the expected benefits in terms of undertaking a given project within a specified period of time, cost and scope. Larson and Gray (2011) and Fleming and Koppelman (2010), state that

[36] *EVM- Earned Value Management is the process of planning and implementing in puts in order to realize value to customer perspective.*

"the Earned Value System (EVS)[37] or Earned Value Management (EVM) starts with the time – phased costs that provide the project budget baseline, known as the planned budgeted value (PV) of work scheduled". "Earned Value Management (EVM) is a system for planning and controlling project cost and time performance. Hence, EVM establishes a work package earned value baseline by integrating project scope, time schedule and cost objectives (Chitkara, 2011: pp.464)".

Chitkara (2011: pp.586-596), further explains that Earned Value Analysis (EVA) serves two objectives as it applies in *"Lean Thinking"* and *"Value management"* philosophies:

> *(a) To analyse cost changes resulting in time and cost over – runs or under-runs for taking timely corrective actions such as modifying cash flow, updating financial forecasts and project profitability expectations.*
> *(b) To update key personnel on anticipated cost changes in their field of responsibility, so as to create cost consciousness for exploring means of minimising wastage and reducing costs.*

While performance of a business entity is evaluated on the basis of financial expenditure and incomes, it is however different when it pertains to assessing performance of any given project, such as for gravel road construction and maintenance. To be in tandem with "*Lean thinking"* and *"Value Management"* principles, it is preferred that performance is measured by utilising three pertinent factors, namely schedule, budget and scope of any given project. When assessing the accrued benefits from gravel or earth road construction and maintenance contracts, the Earned Value System (EVS) proves to be another useful tool. Earned Value System (EVS) is therefore, considered to be part of Value Management.

> Burke (2004: p.224), asserts that *"Although the earned value technique was initially set up to track the project progress of cost and time, in practice however, it is often more appropriate to track progress measured as manhours (labour input) and time. It is also essential for effective project control that performance is measured while there is time to take corrective action.*

The Earned Value System (EVS) can also be applied to the Output Performance Based Road Contracts (OPRCs) for gravel roads as Monitoring and Evaluation tool. This is with the understanding that these types of Contracts remain active for a long time (3-5 years or more) and could easily be derailed if not properly managed. *"Lean Thinking"* and *"Value Management"* theories discourages waste generation, promotes value addition and strategic planning as alluded above when applied to gravel or earth road construction and maintenance.

[37] *EVS- Earned Value System, defined approach to evaluate and monitor product value addition in the work or production process.*

Gravel road contractors are entrepreneurs whose aim is to create value through innovative efforts. In OPRC contracts, Contractors could be motivated by the fact that they would remain in business for a reasonable long period of time. This arrangement encourages the spirit of entrepreneurship and innovation to the company owners. Stokes and Wilson (2010: pp.3-56), asserted that "entrepreneurship is an emergent process of recognising and communicating creativity so that the resulting economic value can be appropriated by those involved through value creation process". This in fact is the basis of the underpinning principles of *'Lean thinking'* and *'Value managemen*t' which in turn serve as a driver for gravel road quality enhancement.

2.3.7 TFV- Theory in Value Management

As earlier alluded to in section 2.2.4, *'Lean Thinking'* theory seeks to explore five concepts in the production of commodities or offering of services to meet Value to customer perspective. These are aimed at enhancing value through concentration of Organisation's capabilities in value addition activities. Henceforth, reducing the eventual waste and this would later culminate into lower production costs and maximised return on investment (ROI). These five drivers as used in production and manufacturing are Value definition, Value stream mapping, Flow, Pull and continuous improvement or perfection. While Value management considers the functionalities of such products or services as demanded by the end users (the Customers), and explores and implores for various ways of meeting Customer specified quality and value effectively. The paradox one hopes to solve is to deliver to the Customer such products or services at lower costs without compromising on quality and value. Value as already been defined is what the customer is ready to pay for that product or service. The problem therefore, is to transform the raw materials in a desirable product or service to meet Customer perceived value and quality. Koskela, (2000), held that production is all about value creation or enhancement to satisfy Customer perceived needs. Koskela (2000) coined the Transformation –Flow- Value theory which he simply referred to as *TFV theory*. It was further argued that raw materials needed to be transformed in a product or service with the sole aim of satisfying the Customer specified value or quality. Thus, it was noted that had to be achieved through employment of uninterrupted process (Transformation, Flow and Value). Hannagan (2008: pp.152-153), asserted that operationally, a business performs a conversion or transformation process through which it adds value to a commodity or service, in the sense that value of output is greater than the cost of inputs and the process involved. Whatever the business, it starts with raw materials, whether these are goods or services, and, at whatever

stage of production it is, the process it applies to them adds value. The concept of value can be said to be the relationship between satisfying an organisation's many conflicting needs and the resources required to meet those needs. The fewer or lesser the amount of resources used or the higher the satisfaction, the greater the value (Venkataraman and Pinto, 2008: pp.169-184). It goes without saying therefore, that in order to deliver gravel roads that meet Customer or Road user value, the three concepts of TFV[38] theory need to be very well understood and effectively applied in the work flow process or value stream.

2.3.8 Strategic Management in Construction

Lean Construction and Value Management are said to have evolved from value analysis through Strategic Planning and Management disciplines. Strategic Management is therefore, defined as follows;

> *Strategy is the long term direction of an Organisation or business endeavour which implies a more comprehensive view of all work flow processes (Scholes et.al, 2011:p3)' and Cole, (2006:p3), added that Strategic Management is fundamentally about setting the underpinning aims of a project or an organisation, choosing the most appropriate goals towards those aims, and fulfilling both over time.*

The Client's Value system comprises a number of interacting parts derived from the structure and strategic management process operated by the Client Organisation itself (Kelly, *et. al.* 2006: pp.14-15). According to Kerzner (2011), strategic planning is a process of formulating and implementing decisions about an Organisation of project future direction. As stated above, Strategic Management is an important tool for quality and value of gravel road delivery for road user benefit in Zambia. It is most unlikely however, that most Road Contractors including those engaged in the current OPRCs, are employing strategic planning and management in the Contract Administration and Management. This is because most of them focus on the monetary benefits and pay little attention to strategic planning in order to deliver value to customer perspective. It is for this reason that Contractors engaged in the Construction and Maintenance of gravel roads would be better placed to yield good results in enhancing quality and value if they put up a sound and credible strategy to achieve set road project aims and objectives in due course.

2.3.9 Collaboration in Road Construction

Collaboration is becoming an important tool for enhancing value of work output in Construction projects and other Business endeavours. Greer and Plunkett, (2007,p.203),

[38] *TFV: Transformation-Flow-Value, a system of transforming materials into products of perceived value flowing through some mapped value stream.*

present that when parties collaborate, they identify needs and work to satisfy their own needs as other party's needs in a win – win situation. Collaboration does not imply that parties are not assertive or that they are ease bargainers. Instead, they actively and cooperatively pursue a resolution of the conflict that satisfies their needs as well as the other parties' needs. With such approaches, the parties are often said to be tough on problems or that they attack problems while they remain soft or easy on people. With collaborative approaches to conflict, the parties form an integrative and long lasting solution, which addresses the underlying problems. On the contrary, this approach to conflict resolution in Projects or Organisations is time consuming and does not work well where there is long – lasting hostility or an absence of mutual trust among stakeholders. Nonetheless, it is clearly an approach that parties should pursue as an ideal when circumstances are appropriate. This approach should be deliberate and not pushed on parties desiring appreciable results in Project and Organisation management. Collaboration and Consultation are said to be best road project management tools for the following reasons;

> *Why collaborate? Because it works and because we can – more now than ever, given advancement in digital technology. Why the industry has been slow to adopt new collaborative delivery approaches is deeply rooted in fragmented and frugal nature of its membership. To foster true Collaboration behaviour – Collaboration that can withstand the inevitable challenges presented by complex Construction projects – requires the right people performing right tasks within an environment that promotes trust and mutuality of expectation over shared project out comes. Teamwork produces optimal results in nearly all fields of human endeavour. Military engagements, Marketing Campaigns and sporting contests all depend on closely coordinated team effort. The failure to work as a team often results in failure or worse (O'Connor, Jr. 2009).*

It has been noted that there is low level of collaborative or consultative efforts for the parties namely, Client, Contractor and Consultant in the Contract Management process of the OPRCs being implemented by the Road Development Agency on behalf of the Ministry of Agriculture and Livestock and financed by the World Bank (RDA, 2009: p.10). This has led to misunderstanding of linkages from Planning, Design, Procurement, Implementation and Commission (Handover) on the Output Performance Road Contracts (OPRCs). For instance, the first generation contracts somehow failed to realise appreciable results due to lack of collaborative planning. Contractors did not buy into the client's needs to understand what was required of them in the implementation of this type of contracts-OPRCs. The client, although was promoting the OPRCs as suitable contracts for construction and maintenance of gravel roads, other pertinent issues remained masked due to lack of transparency, novelty and

collaboration. Consequently, this created problems of implementing insufficient design and BoQs. The result was that contracts were not operating as scheduled as they had lagged behind, coupled with numerous variation orders and failing to deliver to customer demand and satisfaction. The higher risk share became almost unbearable for the Contractors, the reason for the poor quality and sluggish progress at the beginning of the contract implementation phase. Nevertheless, Value delayed is a form of waste according to the principles advanced in *"Lean Construction"* and *"Value Management"* theories (*op. cit.* p.10). Zietlow, (2007: p.5), agree with the notion that;

> *Performance Contracts shift much of the risk, which is normally assumed by the road administration, to the contractor. Therefore, the potential bidders have to be given sufficient time to prepare their bids. This time of course is much longer than in the case of "traditional" maintenance contracts. Performance Contracts are essentially management contracts and traditional (Conventional) road construction or maintenance contractors often do not have the required qualifications necessary for this type of contract. Consulting firms with extensive know-how in managing other contractors and experiences in pavement management systems seem to be more suited for the job. In Virginia, for example, the Performance Contract is managed by a firm, which has been formed by two consulting firms. Most of the maintenance works are subcontracted, allowing for an efficient resource allocation (just on time principle). A joint venture of a road construction firm and a consultant might also work well.*

A joint venture arrangement between a novice Contractor and experienced Consulting firm is one in which collaboration can be supported for better OPRCs management in Zambia more especially that this system is just in its infancy and in developmental phase (*ibid*). Collaboration is a major driver of OPRCs, "since Performance Contracts are new for road construction and maintenance administrators and Contractors alike, close cooperation between both parties is vital for appreciable success. Both sides have to be comfortable with the contractual arrangement(s) and understand the risks involved in the work flow process. In all Performance Based Road Contracts (OPRCs) that have been let until now, road administrations (Agencies and Boards) and contractors have closely worked together in preparing the bidding documents" (Zietlow, 2007: p.5).

This non collaborative trend is not only evident in the OPRCs but it is the same for almost all road contracts that are being prepared by the Road Agencies on behalf of the Zambian Government. Most contracts suffer overruns in terms of budget and time. On most occasions, Variations have been made in terms of change in quantities or contract specifications which have to be refined because of ambiguity and information insufficiency. Some contracts have had their scopes reviewed and in some cases these have either been reduced or increased.

Contractors have in some cases been frustrated as result as they have been made to undertake works which were not in the original scope at the bidding stage. All these shortcomings could be minimised or completely avoided if from the onset of road project conception, various stakeholders were involved through the collaboration efforts. Due to lack of sound collaboration and real consultative efforts, some road contracts have encountered disputes requiring some form of adjudication or arbitration to be resolved and chat the way forward for the concerned parties (RDA, Annual Report, *op.cit.*).

In view of the foregoing sentiments, there is henceforth urgent need to accelerate the level of advocacy on the integration of Collaboration for gravel Road Construction and Maintenance projects in Zambia through enforcement of *"Lean Thinking"* and *"Value Management"* philosophies. Zietlow (2004: p.9), advises that the experiences of the client in contracting coupled with competencies of contractors through collaborations and consultations play a big role in the success of OPRCs. Effective collaboration has worked for CREMA contracts in the Latin American countries such as Brazil and others, which had resulted in many gravel roads being improved to maintainable standards and perceived value delivered to users.

2.3.10 Value Management and Human Resources

At the centre of value addition, is the component of reliable and credible human resources or capital. A well motivated and respected labour force will ensure that the intended customer in any project such as the Construction and Maintenance of gravel roads is satisfied.

> *Whatever their role, people add value to resources by influencing others, including internal and external stakeholders- those parties who affect, or are affected by a project or an organisation's actions and policies. The challenge is that stakeholders will have different priorities, so managers need to influence them to act in ways they believe will add value (Boddy and Paton, 2011: pp.327-348).*

As Kelly, *et al.* (2015), argue that Value Management is distinct from other management approaches by bringing together simultaneously attributes not normally found into a single management ethos. To enhance value and quality for gravel roads in Zambia, all stakeholders such as the local community, contractor's workers, client staff and local institutional leaders need to be involved in the road project process from definition to commissioning (Whole life project cycle – WLPC). The interests of all the labour force must be analysed and where necessary make appropriate attention to prominent areas of concern. This would in the long run curtail the emergent problems that would unfortunately plunge the project into failure mode later on. The Managers at the top of the pyramid should endeavour to aspire encourage and inspire those at middle and lowest levels to enhance value delivery to the Customer.

With OPRCs strategy, such as that to do the current pilot contracts in Zambia, Project and Contract Managers have an important role to play in ensuring that workers are well skilled to carry out specific activities involved in the construction and maintenance of gravel roads in the quest to improve quality and thereby enhancing value from the customer perspective. This involves identification of various talents as exhibited by individuals in work teams or groups.

> *Attention to the skills and abilities of managers is perceived as a key element of retention 'put simply, employees leave managers not companies or organisations'. Retention initiatives can help organisations to keep skills, knowledge and experience required to fulfil long-term goals as well as reduce the costs and disruption associated with high labour turnover and frequent recruitment. However, in order to maximise employee contribution it is important that employees not only stay, but are also actively engaged at work (Beardwell and Claydon, 2010: p.185).*

In view of the above assertion, Project Managers have a daring task in the process of applying *'Lean thinking'* and *'Value Management'* principles to enhance quality and value of gravel roads in ensuring that valuable workers are motivated to stay through talent recognition and skills development. All forms of favouritism, victimisation and discrimination should be avoided at all costs and workers should be rewarded through equitable means. This means that employees are to be meritoriously rewarded for their work assignment accomplishments. OPRC road contractors should pay or reward workers commensurately to work tasks and assignments accomplished to the satisfaction of customer value perception. Project managers and other senior contract management staff in all firms, should aspire to motivate and thereby inspire the valuable labour force to be retained until the completion of the particular project. Managers should always take note that;

> *Discrimination is a process of judging people according to particular criteria. However when most people use the term discrimination they tend to mean unfair discrimination or unfair treatment. The word is mainly used to denote that the criteria on which discrimination has occurred are unjust. The social case is that managers (Road project Managers) have a moral obligation to treat employees with fairness and dignity. Part of these involves ensuring that decisions are made without resorting to prejudice[39] and stereotypes[40] (ibid. p.201).*

It should also be noted that work indentifies people or individuals of who they are and the values which they believe and uphold, discriminating them will therefore, mean loss of belonging and may culminate in their low personal esteem and intrinsic status. Mullins, (2010: p.129), alludes that;

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[39] *Prejudice means holding negative attitudes towards a particular group or individual, and viewing all members of that group in a negative light, irrespective of individual qualities and attitudes (Beardwell and Claydon, 2010-p201)*

[40] *Stereotyping is the act of judging people according to assumptions about the group to which they belong (Beardwell and Claydon, 2010-p201)*

Work can help fulfil a number of purposes including providing the individual with a sense of identity. Many people are themselves primarily in terms of their career and what they do at work. It defines who they are". It is a well known fact that human beings are different and may display different social inclinations and orientations but when they are organised in workable teams they are prepared to inhibit personal inclinations for the sake of achieving a common good, provided that there exists a conducive and supportive environment. "Our sense of self is shaped by our inherited characteristics and influences in our social environment. The process of growing up-such as impact of early family life and country in which we live –has significant part to play in our identity. Most social scientists would agree that both inherited and environmental factors are important in our development, and it is the way in which these factors interact which is the key to our adult personality. However, scientists differ with regard to the weight they place on these factors-some believing that our personality is heavily influenced by our inherited characteristics and will never change, otherwise believing the reverse (ibid: p.129).

In achieving quality and value enhanced gravel roads in Zambia, such observations should be carefully considered by all Project and Contract managers and should aim at investing in human capital (workers) through identification of their achievements and attainment of set project targets. This will obviously call for concerted efforts from both managers and the work team members themselves.

2.3.11 Change Management for Road Construction and Maintenance

Carnall (2007: p.3), in his introduction, states that "everyone says that change is difficult. It is difficult to conceive because one must inevitably deal with people issues and an uncertain future. The more so to implement because consequences can be difficult to predict, harder to track and therefore can create a dynamic, all of their own. In particular everyone claims that major change is hard because of the so called 'soft' or people issues. However, the truth is that change is sometimes an inventible action which one can seldom avoid. Change management is not for the timid but champions. One may also agree with the assertion that we are ever faced with change in most times of our lives and we can only yield to be on the safe side accepting than resisting it. In advancing change in the way this Country wants to look at the quality and value of its gravel roads, it should be acknowledged by various stakeholders that this may not be an easy task but the motivation is that it is inevitable that such a change is effected sooner than later, if benefits are to accrue from these gravel roads countrywide. However, change according to Martin and Fellenz (2010: p.64), is if anything met with resistance, such as *"individual resistance, technical resistance, political resistance, cultural resistance and structural resistance"*.

It should be acknowledged that before the formation of the Road Development Agency (RDA), the Zambian gravel public roads were mainly maintained by the defunct Roads Department through Force Account (FA) approach. This method proved for some time as an effective and reliable system used in the management of the Zambian road network. However, with the passage of time, the method became unsustainable as it could not realize the expected accrued benefits, as roads deteriorated to levels as could be seen in Figure 3, leading to the formation under the Act of Parliament, of a new Institution now known as the Road Development Agency (RDA). The Public Roads Act No. 12 of 2002, promoted the private stakeholder participation through contracting methods of managing Zambian public roads. The Public Roads Act No. 12 of 2002 placed all public roads under the jurisdiction of the RDA to promote harmony and thereby reduce fragmentation which had existed in the past (Public Road Act No. 12 of 2002. RDA Annual, Report, 2008). It also reduced risk and burden on Government as the execution of road works were to be carried out by the private sector. Such changes meant that Government through the RDA, would then be operated with a *"Lean"* Organizational structure to play the supervisory role. Alongside the Public Roads Act No. 12 of 2002, were the Road Traffic Act No. 11 of 2002 and the Road Fund Act No. 13 of 2002 which allowed the formation of the Road Traffic Safety Agency (RTSA) and the National Road Fund Agency (NRFA) respectively. All these efforts were targeted at promoting collaboration, consensus and harmony within the Road Sector institutions, with the aim of arriving at a coherent system of Construction, Maintenance and general management of the operations arising from the Zambian road network. These among other reasons were meant to ensure that the Road Sector might actualize value for money that in return could benefit the perceived vulnerable road users both the Zambian nationals and foreign public road users alike. These efforts could be aimed at realizing the principles of Lean Thinking and Value Management theories for which the attributes advanced under the auspices are harmony, consensus and collaboration among the Road Sector players.

Change Management in Organisations such as those dealing in Gravel Road Construction and Maintenance could be a difficult thing to accept, adopt and implement. Nevertheless, despite the resistance in accepting change, many business organisations have made remarkable improvement after strategically making necessary changes, resulting in removing the bottlenecks in the Value stream or work flow process. 'Numerous industry professionals have lamented the inefficient and adversarial nature of construction services procurement and delivery. The following assessment is gaining acceptance (*ibid.*).

O'Connor, Jr. (*op.cit.*), asserts that the construction industry (in which road construction and maintenance falls) is highly fragmented and has been deplored for being very adversarial. Construction owners are risk evasive, while contracting parties interpret contract clauses differently and for their own benefit. Productivity levels are low compared to other industries and have even dropped over time in some countries. The design/bid/build procurement culture had, until fairly recently, influenced public-sector construction project transactions and processes. Purely price-based selection strategies (BoQs) entice bidders to lower their bids to win contracts, relying on subsequent claims to recover their costs. However, this scenario could well be different in enlightened private-sector negotiated contracts with selected project teams. This assertion emphasizes the reason why Stakeholders should explore more areas of collaboration to ensure that the road project (contract) planning and implementation take less hurdle path. The significance of using other selection criteria is not merely to redress the present mismatch between client and contractor perceptions, but also to reduce the gap between expected and actual performance. Contracting parties often work at arm's length in disjointed relationships, usually motivated by divergent objectives and hidden agendas. Other consequences include time and cost overruns, poor quality, customer dissatisfaction, lengthy and costly disputes, and disruption of relationships among the contracting parties (*ibid.*)'.

In supporting the above assertion Mullins, (op.cit.p129), stated that;

> *Sensitivity to individual needs and differences, especially in terms of resilience, becomes particularly significant when organisations or companies embark on change initiatives. Even when the change appears externally imposed, the management of people takes on different dimension in terms of the sensitivity required. In this situation there is an implicit requirement of changes in attitudes and beliefs. Such changes may lead to new mindsets, new attitudes, and new perceptions that enable people to cope and adjust to different world(s). At these times effective management is vital; managers are therefore, expected to understand strains that employees feel during times of change, but at the same time able to deal with their own stress levels.*

In fostering change and to ensure that gravel roads in Zambia attain the customer perceived quality and value, through use of Output Performance Based Road Contracts (OPRCs), the issue of effective human resource or capital management should not be underrated or be left on the fence. Human beings are not objects to be tossed about, for they are capable of responding according to the nature and type of stimulus action. For any change to be accepted those that the action will affect need to be part of the change process. Failure to do that, is to spell a major disaster or catastrophe as results of the change that is being forced on people or

workers in particular. Contractors must fully be involved in the promotion of OPRCs for them to appreciate the paradigm shift or change. Carnall (*op.cit.p.189*), concluded that;

> *To achieve change we must recognise that change is desirable and feasible. In order to make a smooth implementation without hurdles, we must get people to recognise that change is needed and inevitable.*

This is supported by Fryer et al. (*op.cit. p.173.*), in Sir John Egan's report which was published in the 1990s. This (*Rethinking Construction*) issued a challenge to the construction industry to commit itself to change. Change that might lead to drastic and dramatic improvements in overall performance must well be explained to concerned stakeholders to avoid unnecessary resistance and frustration. As a wakeup call to the construction industry for which construction and maintenance of value enhanced gravel roads, is not exempted, Change management will normally need five key drivers identified as follows;

- Committed leadership;
- A focus on the Customer;
- Integrated process and teams;
- A quality driven agenda; and
- Committed to people.

Importantly, Egan (2005) set targets against which efficiency gains could be compared. Namely, annual reductions of 10% in construction cost and time, reduction in defects in projects and reportable accidents together with increased productivity turnover, and profits of 10% per year. The above stated drivers for change can all be referred to as a brain child of the Lean Thinking and Value Management philosophies, as they all strive to reduce waste to maximise value to customer perspective (Egan, 2005).

Change Management, is therefore, said to be crucial to improving value addition processes in the Zambian Road Construction Industry. There is need for the current OPRCs to explore areas that need change for value enhancement. The Change management is not only in the domain of Contractors, but Clients and Consultants at large. This could be the area of great concern for the Zambian Road Construction Industry at the moment and the trend needs to be immediately reversed if gravel roads were to be improved to serve the intended purpose which is to complement efforts for poverty and underdevelopment emancipation of the rural communities and the nation as whole (RDA, 2006-2010).

2.3.12 Health and Safety for enhanced value gravel roads

Construction and Maintenance of gravel roads of desired quality and value will require good health and safety management programmes. "The approach reflects total quality management (TQM) and tries to engender a top management commitment to change and a culture that encourages bottom - up participation which is motivated towards improvement. The key management issues are a basic policy framework , accountable persons, safe designs, comprehensive planning and organisation, good supervision, segregated or restricted areas, availability of personal protective equipment (PPE)[41], careful sequencing of work activities which impact on each other and training and induction process with monitoring, evaluation and checking" (Fewings, *op.cit.p.247*).

Gravel road construction and maintenance projects like any other construction operation could be dangerous and hazardous to people. However, there exists at the moment a culture in Zambia which does not promote good health and safety practices on road work sites. Project and Site managers are so reluctant to provide workers with personal protective equipment (PPE) and when confronted on the issue, they shift the blame to workers whom they accuse with being complacent and carelessness when it comes to health and safety matters. They indicate that workers are not responsible over health and safety issues as they dispose off or sell personal protective equipment or simply do not want to use or wear them, a habit which discourages project managers to continue investing in health and safety programmes. On the contrary, workers accuse Contract and Project managers of being negligent and unconcerned of their plight in the area of health and safety (RDA, 2009).

The other notion that adversely affect the improvement of Health and Safety systems in road construction and maintenance, is that like any other type of construction, it has been believed from time in memorial that this industry is for the resilient and strong and such as the law of the jungle 'survival of the fittest' has always prevailed. "The attitudes of Construction workers and Managers towards safety are undoubtedly a major factor in poor accident record of the industry. Many see construction as a rough job for the tough and self reliant people. Some of them believe that building to tight deadlines at low cost, is incompatible with high safety standards. On the other hand, Construction workers accept that their work is demanding and risky, although they usually underestimate the risk. Group norms [peer pressure] may cause individuals to ignore safety measures for fear of appearing cowardly or

[41] *PPE-Personal Protective Equipment, Health and Safety clothing and equipment issued to workers in order for them to be adequately protected from the hazardous effects.*

weak to their workmates. Further, some managers and workers try to avoid complying with safety regulations and sometimes make collusive arrangements to avoid them. This is done through illegal awarding of bonuses to workers so that they undertake hazardous work without safety equipment, especially on days like Saturdays and Sundays when there is seldom any one to compel them" (Fryer *et al. op.cit. pp.271-272.*).

2.3.12.1 Health and Safety policy in gravel road projects

In order to deliver value to customer perspective through strategic application of lean thinking and value management principles in gravel road projects, a sound health and safety policy need to be developed and implemented by all road construction companies. Fewings, (*op.cit. p.248*), points out that all businesses require a health and safety policy in written form where five or more people are employed. The purpose of the policy is to have a clear statement of commitment to health and safety of employees and to direct the accountability for safe systems of work to be named to people. A director or partner must be named with executive responsibility for policy to be carried out. Where the firm is larger, there must be a separate health and safety manager who is responsible for monitoring health and safety systems, receiving feedback, arranging training and communications and seeking to improve and maintain system up-to-date. Smaller companies often share an agency that provides a majority of these services for them. A good Health and Safety policy and management can better be developed through the use of the management framework shown in figure 16 below:

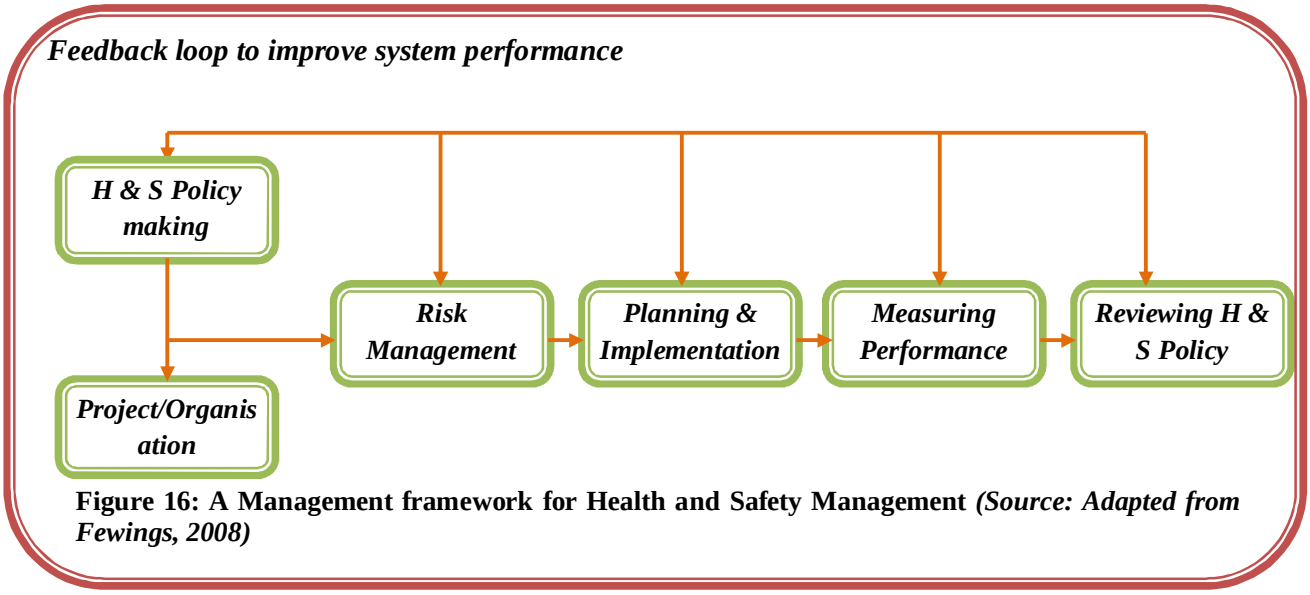

Figure 16: A Management framework for Health and Safety Management ***(Source: Adapted from Fewings, 2008)***

2.3.12.2 Lean Thinking and Value Management for Health and Safety

To achieve the aspirations of having to uplift the existing quality of gravel roads in Zambia, through strategic application of *'Lean Thinking'* and *'Value management'* principles, more

needs to be done in the area of health and safety on Construction and Maintenance work sites, particularly those under the second generation OPRCs. Currently, the Construction industry seem to have negated this area and enforcing agencies have also somehow slumbered leaving Contractors to treat their workers with less regard concerning their health and safety. *'Lean Thinking'* is a philosophy which aims at reducing all forms of waste in order to enhance value from customer point of view and '*Value management'* involves mutual engagement of all project stakeholders including those that will be affected with the activities of any project be it that of Construction and Maintenance of gravel or earth roads. As both the Contractors and road workers at large seem to blame each other for poor health and safety systems, a more collaborated approach need to be propagated using *'Lean Thinking'* and '*Value Management'* underpinnings (Zietlow, 2007: p.4). The health and safety practices on road sites leaves much to be desired and if left in their current form will spell doom for the road construction industry, to say the least. Collaboration through Value management workshops (the Job Plan)[42], will be a precursor to turn the situation around for this relegated area of health and safety in the Construction and Maintenance of gravel roads in Zambia (Hammersley, 2002: pp.1-10).

2.4 OUTPUT PERFORMANCE ROAD CONTRACTS – The Lean and Value perspectives

According to Zietlow (2007), the Output Performance Road Contracts (OPRCs) or Performance Based Contracts (PBCs) are perceived to be a solution for the highly vulnerable gravel roads. However, assumed limited knowledge by most stakeholders, namely the Client, Contractor and Consultants (CCC), that these type of contracts are designed on the philosophies of ***'Lean Thinking and Value Management'***; could be the reason why, positive results have taken long to be realised, despite 1st generation OPRCs being implemented in 2006 (RDA, 2009). In this study, the acronyms (OPBCs) and (PBCs) shall be used interchangeably, to simply mean Output Based Performance Road Contracts (OPRCs) as applied in gravel road construction and maintenance *(ibid).*

Howell and Ballard (1996) allude that 'Lean Construction focuses on eliminating waste in the work flow and adding value in the Value stream which results in the reduction of cost and delivering a project to Customer satisfaction and within the project time'. Lean Thinking and Value Management techniques are therefore, based on pull and not push systems of work

[42] *Job plan- Value Management workshop aimed at sensitizing stakeholders on the functionality of the work product and output benefits.*

flow. These techniques are hence, necessary to enhance the OPRCs for the gravel road construction and maintenance in Zambia because they tend to address the needs of road users by defining value at design stage. The OPRCs are also operated on the principle of continuous improvement and standardisation of methods and levelling of workloads *(Kaizen, Kanban, Heijunka and Jidoka)* to enhance the skills of Contractors thereby improve value of the gravel road product. The other feature of OPRCs is to ensure that mistakes are corrected whenever they are discovered this is to say that production is stopped until the problem is fixed - *Jidoka* (Liker, 2010: p.40).

2.5 OUTPUT PERFORMANCE ROAD CONTRACTS – The Evolution and Experiences

According to Zietlow (2007: p.2), the Output Performance Road Contracts (OPRC) model has been used by many countries across the global as a method of alleviating the problems faced concerning the construction and maintenance of roads especially gravel roads. Most of the countries have embraced this method due to the splendid attributes that they possess. In the first place OPRCs have proved to be cost effective as they are long term and thereby avoid unnecessary procurement processes. Procurement processes could sometimes be laborious and painstaking, due to fact that the exercise demands high level transparency and thoroughness to avoid unnecessary suspicions, especially when award of contracts turns out to be controversial and faces petition contentions. According to Chitkara (2011: pp.402-465) Time and Cost are interrelated, the longer it takes to procure a project the more expensive it may become. Nicholas (1990: pp.340-372) adds that, virtually any project has three dimensional factors namely, cost, time and scope. These factors are the main thing Lean Thinking and Value Management become of great essence in many projects such as gravel road construction and maintenance. Further, the OPRC model ensures that the factors of cost and time are steadily coordinated and moderated and thereby making the process more effective (op.cit). This and many more benefits, are the reason why the Output Performance Based Road Contracts (OPRCs) are most preferred by most Latin American countries such Brazil and Uruguay, to mention but a few (Zietlow, 2007: p.4). The OPRCs may also follow the principles of Earned Value Management (EVM) as alluded to earlier on, the process that allows the tracking of value generated at any particular time during the project implementation to ensure that time and value are realised (op. cit). For instance "Virginia Department of Transportation (VDOT) estimated to save with OPRC contract approximately 16% over the five and one-half year contract period maintaining the highway in its existing

conditions. A report issued by VDOT in December 2000 showed that actual conditions indicated significant improvements resulting in further savings. In addition, VMS[43] has implemented a number of pavement material innovations, including Roadflex, Novachip, and a crack seal program that has improved the service life of the interstate highways. With a "just-in-time" delivery of maintenance services the contractor engages resources – labour, materials and equipment – on an as needed basis. This lowers total cost by avoiding excess inventory and under utilization of resources (Zietlow, 2007: p.10)". According to Zietlow (2007: pp.10-14) "just in time" approach is one of the tools of Lean Thinking which have been incorporated in the Construction and Maintenance of roads by the OPRC pioneer Countries such as USA and those of Latin America. Tamin et al (2008), state that in South East Asia, countries like Indonesia took on board OPRCs in the Construction and Maintenance of their national roads. It was revealed that the benefits of PBC would be gained if contractors were allowed to develop their creativity and innovation during design and construction, improve their productivity and efficiency during operation, and identify accurately the risks transferred to them by service users. Tamin et al (2008), also described that in Indonesia, national roads had to be operated as planned according to the design Annual Average Daily Traffic (AADT) and control on overloading had to be exercised during the roads' design life in order to benefit from PBC. As long as these requirements were fulfilled, simulations on gravel national roads had shown promising results, which included lower investment compared to DBB[44] project delivery system, better guarantee of road condition during design life, and only a slightly higher monthly performance cost compared to the usual maintenance cost. Further it was observed for the Indonesia case according to the US Department of Health and Human Services (2002) which stated that the main components of PBC consist of: 1) Performance Worked Statement (PWS) which specifies expected work output including performance indicators, 2) Acceptable Quality Level (AQL) which describes allowable variation of performance standard value for each performance indicator, 3) Appropriate incentive offered to contractors when their performance exceeds the agreed standard and a penalty imposed when a contractor's work output is below standard, 4) Quality Assurance Surveillance Plan (QASP) which is a plan to evaluate contractor's performance and used to assure the fulfillment of performance target.

[43] *VMS Inc- Is a company which was awarded the first Road Asset Management Contract using OPRCs method by the Virginia Department of Transport in the USA. The innovative approach aimed at providing a high and well defined quality of service to the road user at lower cost.*

[44] *DBB- Type of Contract (Conventional) based on the Design Bid and Build approach. The expending of Bill of Quantities (BOQ) and Specification compliance is the basis on which the Contractor is paid for any work executed.*

2.5.1 Performance Management

The Theory of Output Performance Based Road Contracts (OPRC) does not only limit its delivery of undisputable benefits to the Project processes but goes further to address the shortcomings of human capital management. The OPRC approaches, when applied appropriately, can produce wonderful results in the area of people and change management. This is because, as asserted by Greer and Plunkett, (2007: p.502), Performance Management is a systematic approach that involves determination of employee performance appraisal or evaluation, conducting the performance appraisal session, and rewarding results. As such, it involves removing barriers to performance in the work environment and value stream, increasing the quality of internal and external communications of the Organisation or that between Supervisor and Employee, such that there is more of regular coaching relationship and a supportive or mentorship environment. These attributes if adopted, in Project and Business operations could bring about improvement in the performance of employees of the Companies engaged in the Construction and Maintenance of Gravel Roads in Zambia, through Output Performance Based Roads Contracts (OPRCs). Human capital is a tangible form of investment that if used appropriately, could lead to improved portfolio capability that may in return aid Organisations or Companies in providing desired competitive advantage used in surviving the adversity of competitive rivalry faced in the business market environment (Johnson et al. 2011: pp.83-111). The high skilled and well motivated human capital could therefore, be seen to be key ingredient of the OPRCs for the gravel roads in Zambia. The personnel should consist both the Lean Six Sigma (LSS or L2S) black belts and Champions[45] to achieve desired results for gravel roads (Lowenthal, 2010: pp30-123).

2.6 OUTPUT PERFORMANCE ROAD CONTRACTS – The 'CREMA' Contracts (Contracts for Rehabilitation and Maintenance- Latin America)

Zietlow (2007: p.2) indicates that "the development of Output Performance Road Contracts started in the late 1980s and early 1990s. The OPRCs approaches could be said to have been in use for over three (3) decades in the world as tools of project delivery to enhance quality of service of roads. It is recorded that the first country to use these types of road maintenance contracts was British Columbia in Canada for which it contracted out its road maintenance in 1988. But performance standards, were still more oriented towards work procedures and

[45] *Black belts and Champions are Project Managers (Leaders) and Directors (Sponsors) highly trained and conversant with the Project Lean Six Sigma (LSS or L2S) attributes.*

materials to be used, rather than result oriented, very much limiting the contractor in the application of new technologies". This scenario was like the Zambian case.

The model was later used by Argentina in South America which concessioned approximately 10,000 kilometres of its national roads, using end result performance specifications for the maintenance services and a penalty system for not meeting response times for rectifying deficiencies. In the mid 1990 the maintenance of another 10,000 kilometres was contracted out using similar performance specifications. These contracts were also referred to as CREMA[46], contracts for rehabilitation and maintenance". "CREMA refers to Contracts for Rehabilitation and Maintenance" or known as Performance Contracts for Road Rehabilitation and Maintenance in Argentina (*ibid*).

Zietlow (2007), highlighted that many South American countries (Latin America) followed suit and adopted the model, seeing that the results were exceedingly impressive. Table 2 below shows the timeline on evolvement of OPRC and CREMA contracts with comments on the levels of achievement.

Table 2: Origins of Output Performance Based Road Contracts (OPRCs)

YEAR	COUNTRY	NETWORK (Km)	COMMENTS
1980s	British Columbia (Canada)		Not fully adopted
1990s	Argentina	10,000	Well adopted
1990s	Uruguay	359	Successful
1993	Brazil, Chile and Columbia, etc.	40,000	Successful
1995	Australia	459	Well adopted
1996	United States of America (Virginia)	402	Successful
1998	New Zealand	406	Successful
2000	United States of America (Washington D.C)	119	Successful

Consequently, the adoption of OPRC model is not limited to Countries and States listed in the above table (Table 2) but has now become a norm or strategy for construction and maintenance of paved [Bituminous] and unpaved [Gravel] roads for many Countries world over. Literature admits that after the year 2000, OPRCs have spread worldwide. The model has also been adopted by Asian countries such as India and Indonesia due to their benefits in

[46] *CREMA refers to Contracts for Rehabilitation and Maintenance adopted as OPRC in South America*

ensuring that gravel roads are maintained to serviceable standards all year round (Lancelot, 2010). They also ensure proactive reaction to road defects when noticed.

2.6.1 OUTPUT PERFORMANCE ROAD CONTRACTS – The Accrued Benefits

Stakenvich et al. (2005) and Tamin (2010), observe that "OPRCs are types of contract in which payments for the management and maintenance of road assets are explicitly linked to the contractor successfully meeting or exceeding certain clearly defined minimum performance indicator". By their nature these contracts are motivating to the Contractor engaged to implement road contracts as they are able to plan for the level of capital and conduct cash flow forecasting. Since, the contractors are involved well in the initial stages of the planning and design stages of the project, a platform exits for them to make informed, sound and exhaustive consultations, it is likely that the budget so proposed may be realistic. This also ensures effective collaboration among parties. The *'Lean Thinking'* and *'Value Management'* principles encourage the project planning, development and implementation strategies that are driven from the pulling effects of the needs of user [Road user]. On the other hand *'Value Management'* philosophies promote the critical thinking or assessment of road product functionality through analysis of various methods or ways of satisfying such arisen user needs through a sound collaborative and consultative processes such as Participatory Review Action or Appraisal (PRA) and Participatory Learning Approach (PLA) (Mulwa, 2008). In view of the foregoing, the PBCs may be preferred to other forms of road Contracts such as the Conventional or Traditional, namely the Admeasured (BOQ based) or the Design Bid and Build (DBB), the Turnkey and the Force Account system (FAS) as it is normally referred to when the Client opts to directly execute the project in house resources, to name but a few. Zietlow (2007: p.2) indicates that

> *The traditional way of contracting out road maintenance is based on the amount of work being measured and paid for on agreed rates for different work items. These are also referred to as unit price contracts. By contrast, Performance-Based Road Management and Maintenance Contracts (herein after referred to as Performance Contracts) define minimum conditions of road, bridge, and traffic assets that have to be met by the contractor, as well as other services such as the collection and management of asset inventory data, call-out and attendance to emergencies, and response to public requests, complaints and feedback. Payments are based on how well the contractor manages to comply with the performance standards defined in the contract, and not on the amount of works and services executed. Performance Contracts are defining a product and it is up to the contractor, how to achieve this. Therefore, work selection, design and delivery are all his or her responsibility. Hence, the choice and application of technology and the pursuit of innovative materials, processes and management are all up to the contractor. This allocates higher risk to*

the contractor compared to traditional contract arrangements, but at the same time opens up opportunities to increase his or her margins where improved efficiencies and effectiveness of design, process, technology or management are able to reduce the cost of achieving the specified performance standards.

The fact that Contractors through the use of OPRCs are able to determine their destinies by designing and planning for their project finance budgets, there might be a higher chance that they would be highly satisfied with the contract price and highly motivated to freely and responsibly deliver the road product to their customers or road users. Liautaud (2001) concludes that the application of PBC allows a more sustainable road management and maintenance throughout the service life, so that in the long run this will result in a quite significant capital cost reduction or government spending decrease.

2.6.2 OUTPUT PERFORMANCE ROAD CONTRACTS – Performance Indicators

These types of Contracts are customer best value oriented, and aim at satisfying the end users/road users of the facility by availing them with a desired road level of service. Since these Contracts do not mainly depend on the measuring of work output in terms of quantities executed as in the Bills of Quantities based Contracts/Admeasured Contracts, it is important to employ specific performance indicators in appreciating gravel road service output referred to here as service levels. Zietlow (2007: p.6), out lines the following indicators as applied in the Contracts for Rehabilitation and Maintenance Contracts (CREMA) in South American Countries with salient objectives;

To minimize total systems cost, including the long-term cost of preserving road, bridge and traffic assets and the cost to the road user, and to satisfy comfort and safety of road users.

In order to avoid ambiguity, Zietlow (2007: pp.6-7), further indicates that performance indicators have to be clearly defined and objectively measurable. Typical performance indicators are:

The International Roughness Index (IRI) to measure the roughness of the road surface, which affects vehicle operating cost. The absence of potholes and the control of cracks and rutting, which effect safety and pavement performance. The minimum amount of friction between tyres and the road surface for safety reasons; The maximum amount of siltation or other obstruction of the drainage system to avoid destruction of the road structure and the retro reflexivity of road signs and markings for safety purposes.

As traffic conditions vary from road section to road section, different sets of parameters will create minimal system cost, taking into account road maintenance and vehicle operating costs. The application of the Highway Design Model (HDM)[47] can be helpful to define some of these parameters, such as the IRI (ibid).

Table 3 below highlights some of the performance indicators used in the CREMA contracts in Latin America;

Table 3: Performance Indicators for Output Based Performance Road Contracts (OPRCs)

Asset Class	**Component**	Performance Indicator
Pavement	Potholes Roughness (asphalt) Roughness (bituminous) treatment) Rutting Cracks	No potholes IRI < 2.0 (Argentina), IRI < 2.8 (Uruguay) IRI < 2.9 (Argentina), IRI < 3.4 (Uruguay) < 12mm (Argentina), < 10mm (Uruguay, Chile) Sealed
Gravel surfaces	Potholes Roughness Thickness of gravel layer	No potholes IRI < 6 (Uruguay), IRI < 11 (Chile) 10 cm (Chile, Uruguay)
Shoulders	Potholes Cracks Joints with pavement	No potholes Sealed Vertical alignment < 1cm (Chile, Uruguay), sealed (Peru)
Drainage system	Obstructions Structures	No obstructions. Should allow for free flow of water (Chile, Uruguay) Without damages and deformations (Chile, Peru)
Road signs and markings	Road signs Road markings Reflectivity of road markings	Complete and clean (Argentina, Chile, Peru) Complete and visible (Argentina, Chile, Peru) 160 mcd/lx/sqm. (Argentina) 70 mcd/lx/sqm. (Uruguay)
Right of way/Road reserve	Vegetation Foreign elements	< 15cm height (Argentina, Uruguay) No foreign elements allowed

Table 3, presents some examples of Performance Indicators Applied in Different Performance Contracts in Latin America (Source: Adopted from Zietlow (2007) CREMA Contracts)

[47] *HDM-Highway Design Model used to determine what kind of interventions would be required for any road facility being considered for Rehabilitation and Maintenance.*

For each performance indicator there is a response time and often a penalty defined for non-compliance. For example, in the CREMA contracts for each pothole more than 2 cm deep, a penalty of US$ 100 is being applied for each day it stays open (ibid). Table 4 presents a list of selected performance indicators and response times of the CREMA contracts;

Table 4: Performance Indicators for OPRC CREMA Contracts

Feature	Contract Standard	Response Time
Potholes on highways with > 10,000 vpd	Not more than 3 potholes with a diameter greater than 70mm on any 10km section	48 hours
Potholes on all highways	No potholes greater than 150mm in diameter	48 hours
Depressions and Rutting	No ponding greater than 30mm in depth at any location	6 months
Edge Break	No more than 2m of edge break within any continuous kilometre greater than 0.5m	1month
Lined Channels	No lined channels with more than 10% of the cross-sectional area obstructed, and free of vegetation	1 week

Like in the CREMA contracts used in the South American Countries in road asset management, Output Performance Based Road Contracts (OPRCs) practised in Southern and Eastern provinces of Zambia have used the following performance indicators;

- **Accessibility :** To ensure and offer uniterrupted road connectivity to users ;
- **Travel speed :** Road users travel at not less than 40 Km/h minimum speed ;
- **Ride quality** : Free of Potholes/Deformation, Corrugations and rutting/depressions ;
- **Durability :** Drainage, vegetation, road levels, road width, shoulder level ;
- **Reliability :** Dependable road accessibility; and
- **Exogenous :** Road user comfort and dust reduction through sustainable maintenance.

The OPRCs being piloted in Choma, Chongwe, Katete, Chipata and Lundazi are being modeled from the CREMA[48] contracts of the Latin America modified to suit the local environment. The RDA monitors the performance indicators or service levels and applies

[48] *CREMA – Contracts for Rehabilitation and Maintenance of Roads in Latin American Countries (South America)*

penalties to the Contractor's monthly payment for failure to meet the specified criteria and lack of compliance. For the pilot OPRCs in Zambia, the defect response time factor is not being applied which is a bottleneck in motivating the Contractor to remain compliant at all times. At the helm of these contracts are the philosophies of Lean thinking and Value Management which all strive to satisfy customers according to their perceived needs. These Contracts are also said to be cost effective as they aim at reducing wastes by removing all non value adding activities in the value stream or chain (RDA, Annual report, 2009).

2.6.3 OUTPUT PERFORMANCE ROAD CONTRACTS – The mode of Payment

The RDA, Report of 2009, indicates that the mode of payment employed in the OPRCs being piloted in Zambia follows two methods namely;

- ***Road Improvement works :*** Unit rates are used to pay for emergency rehabilitation and Spot improvement works. The item of works executed from the Bill of Quantities are paid using the tendered rates.
- ***Road Maintenance works:*** Service level criteria are paid based on – Lumpsum dependant on performance indicator compliance.

Zietlow (2007: p.9) presents that Performance monitoring is key to the success of OPRCs contracting road maintenance. Appropriate control procedures as well as penalties for non-compliance to performance indicators have to be well defined in the contract documents. Procedures defined in various contracts, as well as experiences, also vary. This obviously calls for considerable efforts to ensure that random checks are carried out by the Client's personnel or his representatives (Consultant or Project Managers). These random checks meant to verify performance indicator compliance can be conducted twice a month or reduced to once a month when the road inspectors have gained experience over time. The penalties applied for non compliance as a form of sanctions negatively impact on the Contractor's cash flow as they dwindle the capital base with time. However, these sanctions according to *'Lean Thinking'* and *'Value Management'* philosophies become drivers or motivating forces that culminate into better performance of a given OPRC Contractor. In the first instance and if the Contractor is not clear with the characteristics of the OPRCs, the applying of penalties for non compliance can be so devastating to the contractor and recipe for frustration of the Contract which if not well managed could lead to complete flop or failure. This can be exhibited in the recorded experiences of the RDA's first and second generation OPRC Contracts which suffered ferocious setbacks (RDA, Annual Report, 2007).

2.7 LEAN THINKING AND VALUE MANANAGEMENT THROUGH OUTPUT PERFORMANCE ROAD CONTRACTS –The Zambian Experience

The spontaneous decision to upgrade so many gravel roads to bituminous standards even if they may fail to meet the minimum economic viability levels for such road interventions, has not only created unnecessary burden on the national budget but also has led to diversion of attention from maintenance of other already existing paved roads which are also in a deteriorated state. This means therefore, that even if Government is investing colossal sums of money in upgrading of gravel roads to bituminous standards (Link Zambia 8000 and Pave Zambia 2000 projects); it could be consequently losing investment in not maintaining the already paved or tarred roads which are also in dare need of repair. It could therefore, be feared that if this trend is not quickly checked, Zambia may not realise its pipeline dream of having all the roads in a fairly good state. Unfortunately, going by the backlog in the number of roads requiring maintenance, the undesired result is obvious and unless the trend is reversed, Zambia should be braced for the worst road network in the Sub Saharan Africa region, now and in the immediate future.

It should be noted however, that this researcher is not advancing the notion of having the gravel roads to continue in their states, but on the contrary that they are steadily upgraded to bituminous standards where possible and with the availability of funds by Government. Upgrading of gravel roads should only be prudently carried out after a comprehensive Cost Economic Benefit Analysis (CBA) has been conducted and results dictate that such roads qualify for such interventions. This according to *'Lean Thinking'* and *'Value Management'* principles would be considered a 'Pull' approach. At the moment the 'Push' approach is being used in the selection and determination of gravel roads to be upgraded to bituminous standards. This is not supported by the *'Lean Thinking'* and *'Value Management'* principles and may be referred to as wasteful. Although the basis of selection of whether to upgrade gravel road or not is primarily for connectivity, but this criteria might not be adequate and might easily be abused if not well managed. This is why a complementary Cost Economic Benefit Analysis or Study (CBA) could be most suitable tool of the selection process. However, it is the buffer time between now and the time when such ambitions are realised, that is most important to consider, which served as a key driver for this study to be conducted. Consequently, as long as most of the Zambian road network remains to be in gravel and earth standards, it will call for much more concerted efforts to ensure that their

existence become valuable in servicing the Zambian people effectively and meaningfully. Not to over emphasize the fact that, if rural communities and the nation as whole are to benefit from these roads, the OPRCs with the incorporation of *'Lean Thinking'* and *'Value Management'* principles appear to be the most appropriate solution for the moment.

Further, the funds that have seemingly been wasted by Government in the construction of gravel roads, which never extend their service life beyond one rainy season if no maintenance regime is provided, can better be invested or utilised through the use of OPRCs which are said to be based on the philosophies of *'Lean Thinking'* and *'Value Management'* and thereby having roads with extended life spans which will obvious culminate into better service to the road users and eventually lead to the recouping of the much needed economic benefits and returns for the Country, which I believe if well harnessed, could be ploughed back into other economic developmental projects in the Country.

Nevertheless, as part of the solution to this problem, Zambia through the Road Development Agency (RDA) and with the assistance of the World Bank through provision of a grant, has been implementing value for money type of Road Contracts coined 'Output Performance Road Contracts (OPRCs)' or 'Output Performance Based Road Contracts (OPBCs)'. These Road Contracts which were procured in 2009 under the Agricultural Development Support Programme (ADSP) of the Ministry of Agriculture and Livestock (MAL), are meant to have gravel roads in a maintainable state through a system of having a Contractor who will remain on Site for a period of Five (5) or more years thereby ensuring that these type of roads are well maintained and ready to offer the desired service to road-users. The RDA being the institution charged through the Public Roads Act No. 12 of the 2002, with the responsibility of Construction and Maintenance of all public roads, is implementing these Contracts under a programme called Rural Road Improvement Facility (RRIF)[49]. The ADSP is a programme intended to commercialise Smallholder farmers in most agriculture potential areas which are in the initial phase situated in Choma, Chongwe, Chipata, Katete and Lundazi districts. The Road Contracts required the Contractor to initially rehabilitate roads that were in deteriorated states and thereafter, have them placed on a maintenance programme through an effective Maintenance Management Unit (MMU)[50]. Since these framework contracts [OPRCs] are a new phenomenon in Zambia, the Contractor(s) and Consultants were faced with great

[49] *RRIF stands for Rural Road Improvement Facility, a component of the Agricultural Development Support Programme (ADSP) of the Ministry of Agricultural and Livestock*
[50] *Maintenance Management Unit is select team of the OPRC to implement the maintenance regime.*

challenges in the initial stages of their implementation. This led to the Contractor recording high losses and unnecessary delays in completing improvement works. The Client could not be handed over for use the rehabilitated gravel roads within the specified period which caused both the Client and Supervising Consultants unnecessary and immense problems to have these contracts brought back on track (RDA, 2010).

2.7.1 OUTPUT PERFORMANCE ROAD CONTRACTS –The Way Forward

With the promising benefits being received from the OPRCs, in Zambia, RDA has been considering to have more of gravel roads rehabilitated and maintained through these form of contracts which are seen to be value enhancers.

According to the RDA, Annual report of 2009, there are intentions as a way forward for OPRCs in Zambia to place gravel roads to the tune of 33,000Km on these type of contracts which are said to follow *'Lean thinking'* and *'Value management'* theories,

The RDA, Annual reports also indicate that the improvements on the next group of OPRCs will include but not limited to the following;

- Focusing on reducing risk (Designs, clear and easier conditions of contract, *inter alia*);
- Improve on financial and payment and penalty model; and
- Improve on the measurement and payment model.

2.8 CONCLUSION

The public road network has been identified as the largest public infrastructure asset. Estimation of road asset values and costing out the implications of deferred maintenance to the economy and the road user have given a great impetus to maintenance prioritisation. For Sub – Saharan African countries, this may be a particularly important consideration as they generally carry higher road assets values per GDP than the average. Thus the costs to road users of a degraded network are very high and constrain national economic developmental potential (Brushett, 2005, Heggie and Vickers, 1998). *'Lean Thinking'* provides a way to specify Value to customer perspective, formulate a Value stream or lining up value creation activities in work process which advances better results. This should also ensure that there is flow or continuous performance of those activities without unnecessary interruptions (Womack and Jones, 2003). The activities or operations are never pushed but pulled by

demand with perfection of such tasks being at the core of any process (Womack and Jones, *op. cit. pp.10-98)*. Lean Thinking aims at meeting or satisfying Customer needs through the use of five key principles being, *Value, Value stream, Flow, Pull and Perfection*. *"Value Management"* augments *"Lean Thinking"* principles by employing critical thinking and reflection to ensure that wastes are avoided or minimised. On the other hand, Value Management (VM) concerns determining what is to be done or required in order to satisfy the end users of facilities, goods and services. Usually in a hierarchy of functions and classification of functions and structuring, organising and controlling the processes involved to provide the functions to the greatest degree possible within a set of constraints (Fellows et al. *op.cit. pp.231-232*). The VM process uses the form of planning called 'Job plan' which is a value management study having five phases, being, *Information gathering, Speculation, Evaluation, development and presentation of facts so established (ibid,p.233-234).*

In view of the foregoing attributes, it is believed that strategic application of *'Lean Thinking'* and '*Value Management*' principles may lead to the improvement of planning and implementation of gravel roads construction and maintenance contracts or projects. Lean Thinking was coined by Taiichi Ohno, the Chief Executive of Toyota Motor Company, Eliji Toyoda and Shingeo Shingo,who developed the Toyota Production System (TPS) which gave emphasis on value addition activities and therefore removing all forms of waste known as *'Muda'*. In so doing, they ensured that the Customer got satisfied by receiving the perceived products, goods and services (Womack and Jones, *op. cit. pp.100-246*.). This was after discovering that the Mass production theory advanced by Henry Ford of the General Motors Company, the theory which was later commonly known as 'Fordism'(Liker and Franz, *op. cit. pp.225-274.*). Lean Thinking which was developed in the Motor industry or sector was adopted by various other sectors and was therefore, referred to as *'Lean Production', 'Lean Construction', 'Lean Enterprise'*, etc. Liker and Franz, (*op. cit. pp.261-314*), presented that;

> *It started in the Automotive, and then spread to other heavy manufacturing companies, then to small- to medium -sized manufacturing companies, then to the U.S. defense bases that repaired and overhauled weapon systems. By about 2005, it had spread very broadly to banking, call centres, government, mining, public utilities, warehousing, retail, and many others on a global scale. But the big price for the lean movement was the health care.*

The review of literature has established important phenomena, which asserts that *'Lean Thinking'* and '*Value Management'* theories are tools used to improve efficiency in Business and Project Management for which gravel road Construction and Maintenance in Zambia

cannot be an exception. The main benefits of *'Lean Thinking'* and *'Value Management'* principles are that once strategically applied; brings about minimised wastage of resources in the production line and hence lowering the cost. These principles can be well appreciated in the Zambian Road Industry, if all stakeholders such as Clients, Consultants, Contractors, Trainers and Regulators are all involved in spearheading the adoption of such strategies. These could be achieved through collaborative and consultative efforts where parties are encouraged or motivated to openly engage each other in order to understand value perception from different points of view. Collaboration would in this case help to 'lower the rocky river'[51] so as to expose the obstacles which can later be seen and removed from the work flow process.

The consulted literature established that Road Contracts could possibly be effective if they used methods that are based on *'Lean Thinking'* and *'Value Management'* principles. For gravel road contracts to be properly delivered the interests and the needs of the road users and the clients at large must be well perceived and understood. According to Latham (1994: p.3), Clients are at the core of the construction process and their needs must be met by the industry players such as contractors. Strategic application of *'Lean Thinking'* and *'Value Management'* philosophies by well dedicated parties is likely to produce appreciable and tangible results that would finally satisfy customer needs. Gravel roads are equally necessary for any national development as they service the highly productive rural communities or populace. *'Lean Thinking'* and *'Value Management'* key features or ingredients are the cost effectiveness and discarding of non value adding activities, which mainly tend to increase cost margins but comprise quality and value of the desired products. In order to register meaningful benefits in gravel road construction and maintenance, *'Lean Thinking'* and *'Value Management'* philosophies should be applied in an integrated and collaborated manner. This therefore, implies that no stakeholder should be seen to be left out or remain on the fence or as a spectator. Everyone, involved in the process must actively participate from inception to implementation and finally to commissioning stages. OPRC contracts being piloted in some districts of Zambia have been identified to fit in these requirements and scenarios. OPRCs in Zambia need however, to be enhanced with

[51] *The Rocky River is an analogy in 'Lean Thinking', that likens production wastes to the rocks in the river which only can been seen and removed if the water level was lowered.*

better understanding of *'Lean Thinking'* and *'Value Management'* for them to yield better results. Under this new arrangement, Contractors should strive and endeavour to satisfy the Clients needs for effectiveness. Unfortunately this has not been truly the case for Zambia and other OPRC pioneer countries in the past as indicated by Egan (1997: p.8), who noted after the survey conducted in the United Kingdom Construction industry, the following;

- *more than a third of major clients are dissatisfied with contractors' performance in keeping to the quoted price and to time, resolving defects, and delivering a final product of the required quality;*
- *more than a third of major clients are dissatisfied with consultants' performance in co-ordinating teams, in design and innovation, in providing a speedy and reliable service and in providing value for money.*

From the foregoing, it could be deduced that without *'Lean Thinking'* and *'Value Management'* theories in gravel road construction and maintenance desired road quality that meets client perceived needs would seldom be realised. Literature has very well elaborated the facts anchoring both *'Lean Thinking'* and *'Value Management'* as being the removal of waste and enhancing activity methodologies. In earnest *'Lean Thinking'* aims at understanding Value, Value stream, Flow, pull and continuous improvement while *'Value Management'* is concerned with the product function and seeks best ways of producing such an item at lower cost with a view to satisfy the customer and thus delivering Value for money gravel roads.

Having provided the Research background knowledge and various grounded theories, in *'Lean Thinking'* and *'Value Management'* philosophy, using the 'Funnel model or theory[52] approach' and through the Literature search conducted and presented in Chapters Two, Chapter Three now follows. Chapter Three, covers the Research Methodology as earlier alluded. The next chapter provides a linkage of *'Lean Thinking'* and *'Value Management'* philosophy as it is applied to Output Performance Based Road Contracts (OPRCs) in Construction and Maintenance of Gravel Roads through Research Methodology.

OPRC: "What gets measured gets done."(Peter Drucker, 2004)

[52] *'Funnel model or theory' approach is a systematic process that seeks to solving problems from the broader view and then narrow down to real or critical issues in order that no stone is left unturned or exposed and to only surface later in future.*

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter outlines the research philosophy and methodology used in the study. The data collection, analysis and presentation techniques are described. In order to obtain data that best answers the research questions, the study considered to employ the research philosophy that allowed exploration of the phenomena of study with a view to establish knowledge inductively. Saunders et al. (2012) assert that the philosophy one adopts will be influenced by practical considerations. However, the main influence is likely to be the researcher's view of what is acceptable knowledge and the process by which this is developed. Depending on the researcher's preferred choice and reasons, the acceptable knowledge could be gained through objectivism or subjectivism philosophical standpoints *(ibid)*. Although triangulated approach was employed in this study but the process was more of the qualitative methodology. The preferred study methodology depended on the research philosophy underpinning and research problem, which allowed open questions in some instances, hence the opted exploratory study. The study sought to establish the level of understanding of *'Lean Thinking'* and *'Value Management'* philosophies in the Gravel Road Construction and Maintenance in Zambia. Further, the study also proposed monitoring and evaluation strategies which would verify whether the *'Lean Thinking'* and *'Value Management'* philosophies were being applied in the Output Performance Based Road Contracts (OPRCs) being implemented by the Road Development Agency in Zambia and to what extent. Thus the use of case studies through Likert scale questionnaires in the data and information gathering was opted since the study was exploratory in nature (Saunders, 2012: p.171 and Naoum, 2007: pp.3-34).

The road users and other stakeholders were met and interviewed using different structured and semi structured questions depending on the situation and the tasks that they were involved in. The questions and statements were developed according to the roles of different stakeholders in the construction and maintenance of gravel roads in Zambia. Both conventional and Output Performance Road Contracts were observed in the study for which this chapter highlights. Several visits to the roads which were constructed or maintained using different methods of contracts and confirmation of such interventions could only be made or reached by exploratory and explanatory efforts as earlier stated in section 1.7 of Chapter One.

3.2 THE STUDY CONCEPTUAL AND THEORETICAL FRAMEWORK

The "The Lean Thinking and Value Management philosophies have existed since the 1900's starting with the work of Ohno, which was later amplified by Lawrance D. Miles in the 1940's (Womack and Jones, 2003). Koskela (2000) suggested the concept of New Production Theory through an exploratory study, which perceived production as process of transforming products from one stage to another [input to output] through value addition with the aim of satisfying demand to customer perspective, through a pull system or the "Just in Time" approach. It was further argued that products passed through three conversional phases [process] namely; Transformation, Flow and Value and thus later this was known as TFV – Theory (Koskela, *op. cit*). Ballard (2000), also explored "Lean" and "Value" philosophies through the study of the "Last Planner System" which he defined as a product control component to the traditional project management system. "The Last Planner System, was thus understood as a mechanism for transforming what **should** be done into what **can** be done, thus forming an inventory of ready work from which Weekly Work Plans (WWP) can be formed. Including assignments on Weekly Work Plans (WWP) is a commitment by the Last Planners, what they actually **will** do (Ballard, p.3-4, 2000)". Conceptually, the Study; *"Strategic Lean Thinking and Value Management in gravel roads in Zambia"* is mainly a follow up on the above mentioned two studies. From the research problem under this study, gravel roads in Zambia are in deteriorated state due lack of sustainable maintenance strategies. This according to Zietwlow (2007), was as a result of using traditional forms of contracts which lacked "Lean Thinking and Value Management philosophies as contained in the Output Performance – Based Road Contracts (OPRCs). The study endeavoured to explore the problem with a view to establishing why gravel roads were in such poor state when better maintenance interventions were available such as OPRCs.

3.2 .1 The Study Philosophy

Dawson (2013) suggests three epistemological[53] and theoretical perspectives namely; Objectivism, Subjectivism and Constructivism as various ways in which knowledge could be acquired depending on the researcher's standpoint and study purpose. Through Objectivism, knowledge is acquired deductively, with the understanding that human knowledge and values are objective; they exist and could be discovered. The Subjectivism theoretical perspective however, suggests that there is no underlying truth and that, reality of knowledge is only what one perceives or formed through his/her frame of reference [The World view]. This partly,

[53] *Epistemology is a branch of philosophy concerned with theory of knowledge. This refers to what one accepts as knowledge.*

depends on the acquired experiences (Dawson, 2013, p.8). As this is an exploratory study, through OPRCs case studies on gravel roads, Constructionism theoretical perspective, was opted as it suggests that knowledge is constructed and not discovered from the world. Dawson (2013) argues that the only reality that one knows is that which is expressed by human thought. Meaning and knowledge are therefore, human constructions through induction. This includes interpretivism, such as symbolic interactionism and observational techniques. This encouraged critical enquiry through analysis and evaluation of acquired and existing knowledge *(ibid).* As knowledge is inductively acquired, constructionism theoretical perspective was best suited approach for the study, through exploratory strategy. Exploratory is a valuable means to ask open questions to discover what is happening and insights about a topic of interest (Saunders et al., 2012). This study employed phenomenological and heuristic enquiries to obtain data from respondents 'domain.

3.2. 2 The Study Epistemology

As alluded in section 3.2.1, the background knowledge to the research problem was mainly acquired through document analysis on the Construction and Maintenance of gravel roads through conventional contracts and OPRCs. The depth understanding of the Philosophies of Lean Thinking and Value Management, were also delved onto by literature search. Primary consultations with various Stakeholders such as Client, Contractor and Consultant's representatives provided sound platform on which the study could be spearheaded. Such preliminary knowledge, would also determine other causes of actions such as the methodology to be adopted. This also offered the researcher an opportunity to gauge the existing knowledge gaps to appropriately define the study scope, capable of solving the research problem. In addition, it aided the study, in the formulation of research questions, domain, data collection and analysis techniques.

3.3 RESEARCH DESIGN

As stated in section 3.1, the exploratory research strategy was used through Case-studies of Output Performance Based Road Contracts (OPRC) for gravel roads in Zambia. A triangulated or mixed research design that combines both quantitative and qualitative methods was employed in this study. This is on the basis that Quantitative research methods generate the numerical data while the non numerical data of the study are generated by the Qualitative research methods. Through the Triangulation approach, the two methods complimented each other as the study was quasi qualitative and the researcher ensured that issues of biasness were minimised through effective control (Fellows and Liu, 2006).

3.3.1 Research process

As earlier stated in section 3.2 this study was conducted largely through case studies following these approaches;

(i) The use of structured, semi structured and unstructured questionnaires and interviews as data collection tools.

(ii) Undertaking direct observations on the OPRCs with a view of establishing the baseline road quality and value and how this could be used to ascertain degree of application of *'Lean Thinking'* and *'Value Management'* principles in gravel roads in Zambia.

Further, to accomplish this study the following steps were pursued:

- Undertook interviews with Clients (Managers), Consultants and Contractors to obtain their views on the knowledge and levels of application *'Lean Thinking'* and value addition techniques in the work flow process. This included getting several and diverse opinions on how *'Lean Thinking'* and *'Value Management'* principles could positively contribute to the Road Construction industry.
- Obtained the opinions of the Engineers, Academicians and Students on the road construction industry through use of questionnaires and interviews on how they viewed the level of appreciation of *'Lean Thinking'* and *'Value Management'* principles and how these would turn around the Zambian Road Construct Industry especially for gravel roads. To also establish levels of knowledge that student engineers are receiving from the construction industry and higher learning institutions to optimally improve quality of gravel roads.
- Drew up consensus from stakeholders (Clients, Consultants, Contractors and other Stakeholders) on how they perceived the current practice in the Road Construction Industry in Zambia and what improvements could be made to improve value addition through reduction of waste in the work-flow processes for gravel road construction and maintenance, coupled with the mindset and maintenance culture change.
- Obtained opinions and views from the National Council for Construction (NCC) on the level of competence of Road Contractors engaged to construct and maintain gravel roads which they register and regulate and thereby gauge their sufficiency and adequacy in the knowledge of *'Lean Thinking'* and *'Value Management'* to aid confident application of the same on road construction industry. Other professional bodies such as the Engineering Institution of Zambia (EIZ) [Some members of EIZ Council] were also incorporated in the study to establish whether the current practices

on road construction industry especially dealing with gravel roads were enhancing product value that would satisfy the end users.

3.3.2 Case study

As earlier indicated in section 3.2.1, the case study on OPRCs was the main strategy used for this study. According to Salkind (2006), a case study is a method used to study an individual or an institution in a unique setting or situation in as intense and as detailed a manner as possible. Since the OPRC road projects were being implemented between 2009 and 2014, this was perceived as most optimal approach. Since the OPRC road projects were located in several districts and under different contracts, this study treated them as sub case studies. The OPRC case studies were complimented with observations of Conventional contracts that were carried out during the same period that this study had targeted. In the course of undertaking this study it was necessary to be mindful of the advantages and disadvantages of this research strategy and ensured that through it, issues of inherent strengths and weaknesses in terms of validity and reliability of data collected and results obtained were well managed to avoid impediment of flow and ultimate quality. Issues of trustworthiness and confidentiality were also observed during the course of the study.

To collect data for this study, through the OPRCs, case studies, the following methods were used:

3.3.3 Data collection

Primary and secondary sources of data were used in this study. As stated in section 3.2.2, the Primary data were obtained through the case - study on the performance and operation of the OPRCs. The Secondary research data were obtained from the RDA, annual reports and the World Bank literature on the construction and maintenance of gravel roads through OPRCs in Zambia. Data was collected from the purposive selected sample of respondents, consisting of RDA and NRFA Engineering and Finance staff. Another group of respondents captured in the sample, were from the NCC and ADSP [a Unit in the Ministry of Agriculture and Livestock]. This was done upon receiving consent from Senior Management of the targeted Institutions. This also included OPRCs Contractor's Senior Management and Site Managers. Some of the secondary research data were drawn from Journals compiled by the Institute of Lean Construction (ILC) such as Lean Construction Journal (Pasquire, 2005) and other related materials on the theory and implementation of Output Performance Based Road Contracts (OPRCs). This was for the sake of establishing and building up of grounded theories on *'Lean Thinking'* and *'Value Management'* as advanced by various authors.

3.3.3.1 Questionnaire technique

The questionnaire technique designed to a five order point likert scale within the OPRC case studies was used as one of the data collection tools. Questionnaires were sent out to the research respondents for completion to later return them for data analysis. The advantage of this method over others is that time is saved as respondents could complete them without any direct intervention from the researcher (Salkind, 2006, p.138). However, this method proved to be somewhat problematic as some respondents failed to complete the questionnaires in good time, leading to the loss of substantial amount of time and as such, protracted the period in which the study could have been concluded. In order to speed up the process most of the respondents were followed up but without coercion to ensure that questionnaires were completed and collected for data analysis.

3.3.3.2 Interviews

Face to face interviews were conducted to compliment the questionnaire technique as a data collection tool. These mostly involved some senior managers of Client, Contractor and Consultants organisations. However, some engineers and other practitioners captured in the research sample were interviewed upon the completion of the questionnaires to ensure that the data collected were more credible and reliable to the study. The interview technique was considered to be more effective compared to the questionnaire protocol due to the following three main advantages; (i) Flexibility in approach in terms of questions clarity; (ii) gave opportunity to observe nonverbal behaviour of the respondents; and (iii) to control the direction of questioning, speediness of the respondent and length of the interview *(ibid)*.

3.3.3.3 Observational technique

The direct observations tool was used through site visits to OPRC and Traditional designed contracts to complement efforts of the above mentioned methods to collect data for the study. Salkind (2006) defines this technique as where the researcher stands outside of the behaviour being observed and creates a log, notes, or an audio or video record the behaviour. Thus a log book was kept to record results of the observations. During these site visits road users were interviewed and photographs taken.

The above methods were used to collect data from research respondents of both OPRC and Traditional contracts with the consent request of the University of Lusaka [UNILUS] so as to ensure study legitimacy. Consent request letter was presented to the Senior Management of targeted institutions as stated in section 3.2.3. The collection of data from respondents only commenced upon receiving consent from authorities, which was mainly verbally made.

3.3.4 Data collection reliability and validity

As stated in section 1.13 of Chapter One and section 4.4.2 issues of reliability and validity of data collected were also considered to avoid internal and external threats that would otherwise compromise the reliability and validity of data collected and results obtained (Gravetter and Forzano, 2009, pp156-184). Fellows and Liu (2006) defines Reliability, as that which concerns the consistency of measure and Validity, as that which concerns how a measure does measure the concept it is supposed to measure. It is the credibility of the measure and its results. In this study, the data collection tools [Likert Scale rating] were first administered as pretest to selected respondents test their credibility before being employed.

3.4 RESEARCH POPULATION AND SAMPLING

The study considered the Zambian Road Construction Industry Stakeholders as the population, from which the research sample was drawn. The study targeted the section of the road sector dealing with gravel roads. The larger majority of research respondents were Engineers and other Stakeholders involved in the construction and maintenance of gravel roads. Principally, the research sample (Respondents) was drawn from Companies, Clients, Road Users, Consultants, Training Institutions, Students, practising Engineers, Managers and other stakeholders in the Zambian Road Construction Industry.

3.4.1 Research Sample

A sample of 100 Engineers and other personnel in the road sector, were targeted in this study, due to limited number of respondents involved with OPRCs. Purposive sampling was used in the selection of respondents as the OPRCs were being piloted on selected gravel roads in Zambia. Saunders et al. (2012) asserts that with Purposive sampling, one needs to use judgement to select cases that will be enable one to answer his or her research question(s) and to meet the set objectives. For this reason, it is sometimes known as Judgemental sampling. It is often used when working with very small samples such case study research and when one wishes to select cases that particularly informative. Thus, the Purposive sampling was opted over Convenience sampling due to the weaknesses of the later. According to Gravetter and Forzano (2009), the most used sampling method in behavioural science is probably the convenience sampling. In convenience sampling, researchers simply use as participants those individuals who are easy to get and already involved in the subject matter. However, convenience sampling is considered a weak form of sampling because the researcher makes no or meaningful attempt to know the population or use a randomly process in the selection. The researcher exercises very little control over the representativeness of the sample and,

therefore, there is a strong possibility that obtained sample is biased. However, research participants were not predetermined from the 'Population' of Road Construction Industry but selected on the first come and availability basis, hence, Purposive sampling technique was utilised in the selection for respondents for the study. Further, for the purpose of this study the problems or disadvantages involved with the sampling process opted, were mitigated as the respondents considered were those drawn from the Road sector and most particularly those involved in gravel road construction and maintenance particularly under the OPRCs. The 100 respondent sample size, was therefore, purposively arrived at due to limitation and suitability of research respondents, resources and available research time. This is because the study needed to be conducted within the period between 2009 and 2014 when OPRCs would continue to be active. "Lean thinking philosophies enhance value of products and services to customer perspective and reduce waste in any production process thereby lowering cost of production or manufacturing" (Womack and Jones, 2003). It was important therefore, to investigate this notion through obtaining views from various groups of respondents. As earlier stated in section 3.3, the respondents included all various Stakeholders, such as Clients, Consultants, Contractors and Trainers involved with the Construction and Maintenance of gravel roads in Zambia, so as to minimise the biasness.

Out of the total 100 targeted sample size, only 82 respondents were captured. The captured Eighty (82) respondents consisted Forty (40) Engineers drawn from Clients accounting for 48.78%. There were also Sixteen (16) Engineers, drawn from Consultant firms translating into 19.51% of total respondents captured. Fourteen (14) respondents came from Contractor firms making 17.07% and lastly Twelve (12) respondents were drawn from Training Institutions (NCC) with the proportion of 14.64% of the total respondents captured. It should be noted that for purposes of this study, a total of Hundred and Five (105) questionnaires was sent out and only Eighty Two (82) were responded to representing about 78.1% of the response rate and 82% [100 respondents] of the targeted rate respectively. The number of respondents were considered moderate for the study taking into account that at least more than 50% of the targeted sample size [100 respondents] was captured on the basis of availability (Salkind, 2006: pp.133-134 and Nulty, 2008). According to Nulty, (2008), 50% of response rate is regarded as adequate in Social research. Considering that this study used opinion and perception as means of measurements to make inferences, the response rate of 78.1% was considered to be reasonably adequate with respect to reliability and validity as earlier stated in section 3.2.4.

3.4.2 Questionnaire design

In order to measure perceptions, opinions and attitudes of respondents, the questionnaires were designed using a Likert Scale rating. This data collection technique was opted as it is usually used for obtaining perceptions and attitudes of research respondents. Likert Scale is simple to develop and is used widely in Social sciences, Business and Management research (Salkind, 2006). The Likert Scales are designed and developed using the following steps:

1. Statements are written that express opinion or feeling about an event, object, process or person;
2. Items that have clear positive and negative values (in the developer's judgement) are selected;
3. The statements are listed, and to the right of each statement is a space for the respondent to indicate degree of agreement or disagreement, using five point scale such as:

   SA- Strongly Agree (5);
   A- Agree (4);

   N- Neutral or U-undecided (3);

   D- Disagree (2); and

   SD- Strongly disagree (1).

Respondents are asked to circle or check/mark their level of agreement with each item. The Scale could be constructed with odd or even variables (*ibid*). In this study five point scale variable was used. Likert Scales uses only definitely favourable and unfavourable statements, and excludes the intermediate opinions (Ghosh, 2011). Gravetter and Forzano (2009: pp.364-366), define the Likert Scale as a type of rating scale named after its founder Rensis Likert, who developed the five – point response scale to be used in behavioural research. Using the Likert Scale respondents are required to indicate the perceptions, opinions and attitudes by ticking or marking any of the ratings on the given scale. The Scale is presented with equal spacing between response choices so as to stimulate interval measurements. As such Likert Scale questions are sometimes analysed as continuous data in perceptions, opinions and attitudes measurement type of research.

3.4.2.1 Likert Scale Rating

As stated in section 3.3.2 above, for this study the Likert Scale rating questionnaires were used as data collection tool. The scale is of equal spacing so as to simulate interval scale measurement, and the responses from rating are usually treated as interval measurements and is simple to develop (Gravetter and Forzano, 2009: pp.364-366 and Salkind, 2006:pp.133-135).This is why the Likert Scale is treated as continuous scale when being analysed with each set of 1,2,3,4 and 5 treated as equal points along a continuum (Brown (1999, MGS 9920: p.3, n.d). The balanced Likert Scale of equally spaced points along a continuum was used in this study so that the Mean and Standard Deviation are reported in the data analysis. As far as Rensis Likert was concerned, attitudes towards any object or any issue varied along the same underlying negative to positive dimension. Hence, for the purpose of this study, the Likert scale statements and questions have been analysed as continuous scale varying from negative to positive for which rating 1 is to the negative and 5 to the positive extremes respectively as shown in Figure 17 below.

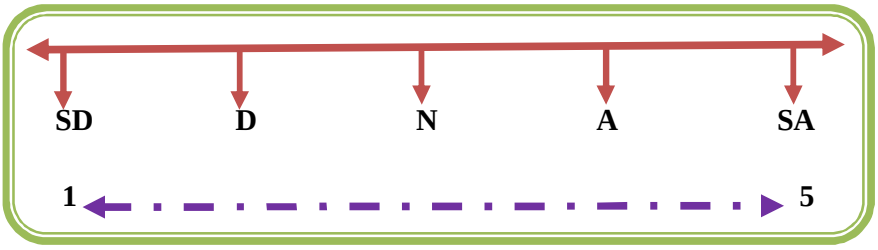

Figure 17: Likert Scale rating along a Continuum - Balanced Scale type

3.4.2.2 Types of Likert Scale

As already been mentioned in sub section 3.3.2.1, there are two commonly used Likert Scale types, namely the "Old number point scale" and Even number point scale". Normally the 'Old number point scales' are known as "Balanced Scales" which normally have a neutral midpoint, represented as 'undecided', neither agree nor disagree', while the 'Even number point scales' are termed as "Unbalanced Scales". The advantage of the unbalanced scale is to give respondents options of remaining undecided on the opinion of the statement or question and for the balanced scale to make them have critical reflection when making decisions. In this study, the balanced Likert scale rating was adopted so as to reduce the potential biasness. The reasons for this option are as stated in sections 3.3.2 and as a way of making respondents give opinions and not necessarily stay on fence.

3.4.2.3 Likert Scale – Strengths and Weaknesses

The following are some of the known attributes of Likert Scale rating as a tool for collecting data;

Strengths: Simple to construct, likely to produce a highly reliable scale and easy to read and complete by respondents or participants (Dane Bertram, CPSC, 681, n.d).

Weaknesses: Central tendency bias (Respondents or participants may avoid extreme response categories), Acquiescence (Respondents or participants may agree with statements as presented in order to "please" the experimenter or researcher), Social desirability bias (Respondents or Participants may tend to portray themselves in more socially favourable light than being honest), Lack of reproducibility and lastly Validity may be difficult to demonstrate (Is the researcher measuring what was set out to measure?) (Dane Bertram, CPSC, 681, n.d).

The Weighted Mean, Weighted Standard deviation, Consensus and Dissension values, were calculated to clearly demonstrate the nature and understand the responses of respondents on the Likert Scale questionnaire. The number of items in each Likert Scale rating category was counted (frequency) and Weighted Mean, Weighted Standard deviation, and Consensus (as a percentage) were calculated. This is because from the raw data, it is difficult to identify trends and make meaningful comparisons. Counting the overall total (frequency) might suggest highest value wins, but degree of Consensus (the Agreement of respondents on the central tendency statistic), suggests otherwise (Tastle, et al., 2005). Standard deviation or dispersion also indicates the variability of score measures which translates into the degree of consensus and dissension (the Dissension degree). Salkind (2006: p.155), defines variability as the degree of spread or dispersion that characterises a group of scores and it is the degree to which a set of scores differs from some measure of central tendency, most often the mean or weighted mean for the Likert Scale rating questionnaires.

The Likert Scale was opted for the study as one of the tools for collecting data due to its merits when considering preconceptions and attitudes of research respondents over certain factors. The Likert Scale rating ensures that respondents' responses are within the relevant domain of possible options to be meaningful to the research. Since, the study in "Strategic application of *'Lean Thinking'* and *'Value Management'* principles in gravel roads in Zambia" was mainly to draw opinions, attitudes, perceptions and consensuses of various Stakeholders in the quality of gravel roads, this tool was preferred.

3.4.3 Data Analysis Techniques

Since this study was conducted using triangulation methods, namely qualitative and quantitative research methods, descriptive and inference statistics were used in the analysis of the data. The measures of central tendency (averages) such as the Mean and Mode were

computed to help understand respondents' perceptions through their responses. The Variability measures such as the Standard deviation for the data were also computed in order to help understand the degree of spread of the data.

3.4.4 Likert Scale Analysis

Since the Five Point Likert Scale Rating was used as one of the data collection tools, the data analysis method used are mainly those that highlight the descriptive statistics such the measures of central tendency (Mode, Median and Mean) and Variability or dispersion such as the Variance and Standard deviation. Tastle, et al. (2005: p3) indicated that:

a) *The dispersion of values about a central value, i.e., the weighted mean, permits an assessment of the strength of collective perceptions without placing a focus on the arbitrary numerical interval assignment. Thus, a collective set of ordinal scale values that yield a narrow dispersion can logically be viewed as possessing greater agreement or consensus than with a wide dispersion. The logic is identical to that of the standard deviation except that the standard deviation; weighted or otherwise, is real number that lends little value to understanding the values on which it is based. The consensus measure, on the other hand, informs the investigator of the sense of dispersion using commonly understood concept of percentage.*
b) *The Mean and Standard deviation each require a fixed interval, zero value, and a continuous scale, none of which are available in the ordinal data. The total consensus is 100% or 1, and thus the dissension is 100% - consensus percentage or 1- consensus percentage. Viz.;*

Table 5: Likert Scale Analysis – Consensus and Dissension (Computation example)

	SA	*A*	*N*	*D*	*SD*	*Tot*	*wTot*	*wMean*	*wStdDev*	*Cns*	*Cns%*	*Dis*	*Dis%*
Q1	*6*	*0*	*0*	*0*	*6*	*12*	*36*	*3.0*	*8.0*	*0*	*0%*	*1*	*100*

c) *The consensus measure also functions very well as a of dispersion, using the weighted standard deviation column, the values are graphed against consensus measure, yielding an R^2 of 0.996.*

3.4.5 The Funnel Model – OPRC case studies

The study followed the order of 'Funnel Concept Theory or model (FCT)' in the carrying out of the Literature review, development of the research strategy and when undertaking OPRC case studies. A broader overview of the theory and practice of OPRC road projects were undertaken in order to incorporate the principles of *"Lean Thinking and Value Management"*. The research conceptual process was therefore consistent with the principles of *"Lean Thinking and Value Management principles'* which aim at resolving problems from a broader view to a narrower point of view to attain a refined solution through reduction of non value adding activities (wastes). This is also the approach taken by this study when reviewing the literature on which it is underpinned. The reason for such an approach was for

the study, to consider and analyse several issues related to OPRCs and how they would be most appropriate forms of contracts for the construction and maintenance of gravel roads when *"Lean Thinking and Value Management philosophies'* are incorporated in work flow processes. Figure 18 amplifies on the 'Funnel Concept Theory or model (FCT)' as a way of critically viewing and solving problems.

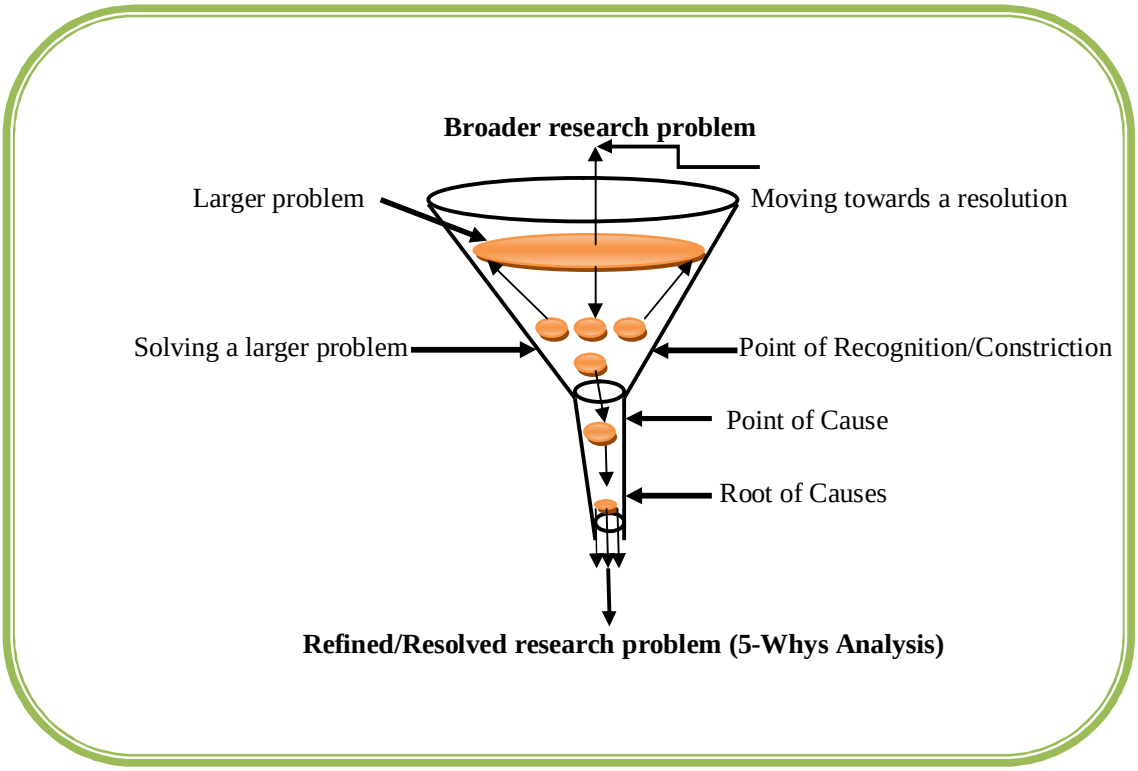

Figure 18: Funnel Theory, the problem solving continuum *(Adapted from Liker, 2006)*

To better understand and resolve the problem of gravel road construction and maintenance in Zambia, through this study, the principles highlighted in Figure 18 above, for problem solving, were employed. According to Liker and Meier (2006: pp330-331), if one does not consider a problem or situation in a larger context, limitations to possible solutions as well as the total impact of solving a larger problem may later result. Thinking in this way (as in Figure 18), allows one to identify the real problem and thus provides three distinct advantages:

(a) Ensuring that the most significant opportunity has been captured maximizes results with minimum effort;

(b) Taking a larger view opens the possibility of solving the research problem by correcting causes in addition to the ones initially identified; and

(c) The lower-level cause identified may be very difficult to correct (which is why it is perceived as the largest problem or view), and focusing only on this difficult condition will preclude consideration of larger and ease causes which may lead to greater opportunities.

It is for this reason that in reviewing the literature on 'Lean Thinking and Value Management philosophies' that a broader view was initially opted. Generally, Scientific and Strategic Management theories were therefore briefly considered. The "Statement of the Problem" dictated the type and order of the study objectives developed through "Funnel Model Approach" to optimise collection of data from respondents. To clearly understand the problem of gravel roads in Zambia with regard to their deteriorated state, experiences of other countries employing OPRCs in the construction and maintenance of gravel roads were reviewed. Later, the study narrowed down the issues to those directly affecting gravel roads in Zambia through synergy. The research questions development also followed the above stated process (Funnel Concept Theory). An approach for this study of considering broader view of the research questions in the area of gravel road construction and maintenance, which later constricted into Output Performance Road Contracts for gravel roads, was considered to be a better research strategy. This was to reduce the danger of negating or relegating other important factors for better execution of the study. In the next chapter data presentation, analysis and discussion are outlined.

'Develop a Thorough Understanding to problem solving' (Liker and Meier, 2006)

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION OF RESULTS

4.1 INTRODUCTION

This chapter gives presentation and analysis of data collected from respondents. The descriptive data analysis has been used to draw inferences. In order to evaluate and gauge opinions of respondents on Lean Thinking and Value Management principles for gravel roads, some research data collected needed to be analysed through quantitative data analysis techniques.

As a recap, the data collected were obtained from the following:

- Client's implementing Agencies and Road users;
- Contractors (Conventional and OPRC Contracts);
- Training and Regulating Institutions; and
- Consulting firms (Design and Supervising Engineers).

Interviews and Questionnaires were used to collect data from the respondents. The interviews were semi – structured to give the respondents' free-will thinking, but also to keep them within the study topic domain.

4.1.1 Likert Scale Questionnaire Rating

Questionnaires contained closed ended questions using a Likert – scale, ranking, dichotomous "Yes/No" type of questions. The questionnaires contained quantitative and qualitative type of questions mainly structured in a Likert scale such as 'Very Poor' (1) to 'Very Good' (5), 'Very Low' (1) to 'Very High' (5) and 'Strongly Disagree' (1) to 'Strongly Agree' (5). This scale was used as the study was about obtaining and gauging respondents' attitudes and opinions on Lean Thinking and Value Management applications for gravel roads in Zambia.

4.1.2 Questionnaire description

The questionnaires were constructed with a view to address the following variables or issues; the knowledge levels of Lean Thinking in Gravel Road Construction and Maintenance, appreciation of Value Management principles on Gravel Road Construction and

Maintenance, application of Lean Thinking and Value Management theories in Output Performance Based Road Contracts (OPRCs) for the Construction and Maintenance compared with the use Conventional or Traditional Road Contracts and assessment of Collaboration levels for parties involved with the Gravel Road Construction and Maintenance Contracts or Projects from planning, design and implementation stages. The study targeted at least 100 Engineers and other stakeholders from Client Institutions, Training or Regulating bodies, Consulting firms and Contracting or Construction Companies. The questionnaires had similar questions and were divided into six sections namely; Section A, Section B, Section C, Section D, Section E and Section F. The questionnaires were thus structured as follows:

(i) **Section A:** Respondent details/information;
(ii) **Section B**: Lean Thinking Theory in Gravel Road Construction and Maintenance;
(iii) **Section C:** Value Management Theory in Gravel Road Construction and Maintenance;
(iv) **Section D:** Output Performance Based Road Contracts (OPRCs) in Gravel Road Construction and Maintenance;
(v) **Section E:** Collaboration in Gravel Road Construction and Maintenance (Planning, Design and Implementation stages); and
(vi) **Section F:** General Comments and Observations.

4.1.2.1 Section A: Respondent details/information

As earlier stated under heading 4.1, this section of the questionnaire was designed to provide necessary information about the respondents included in the studies. The different personnel engaged in the Construction and Maintenance of gravel roads were identified according to the ultimate roles they played.

4.1.2.2 Section B: Lean Thinking/Construction Theory in Gravel Road Construction and Maintenance

This part of the questionnaire's main objective was to explore and assess the knowledge levels of Lean Thinking theory in the Construction and Maintenance of gravel roads in Zambia. This section was ideally necessary in order to address the first research question which stated thus;

> Are the knowledge and practices of *"Lean thinking"* and *"Value Management"* philosophies well established and perceived by the parties or stakeholders in the Zambian Road Construction industry, namely, the promoters or owners, the financiers

or funders, the Trainers, the Designers or Consultants and the Contractors or Constructors?

This is with the understanding that most gravel roads were being constructed using Conventional Road Contracts which are mainly the admeasured or Bill of Quantities types. As defined earlier in Chapter One "The bill contains anticipated work quantities and is prepared by the Client to be issued to the Contractor who then enters unit rates to develop and propose a contract price for such works. This forms a bid or offer to treat or consider by the Client. If accepted the Client then enters into the Contract by having it signed as a binding agreement to both parties (Harris et al. 2009). The essence was therefore, to establish whether these types of Contracts were incorporating Lean Thinking principles in the various processes of the project's life cycle for gravel road Construction and Maintenance in Zambia. Various Stakeholders were consulted, in order to gain a better understanding of the scenarios obtaining on the ground where the use of Lean Thinking Philosophy in the Construction and Maintenance of gravel roads was concerned in Zambia. The Questionnaires were administered to 82 Research Respondents as earlier been stated in section 3.3.1.

4.1.3 Section A:-Total Number of responses received from questionnaire survey

A total of 105 questionnaires were distributed to respondents and only 82 responses were received representing 78.1 percent response rate. The following table below shows the distribution frequencies of responses.

Table 6: Number of Responses received from Questionnaire Survey *(Road Sector/Practitioners)*

Category	Frequency	Percentage responses
Client	40	48.78
Contractor	14	17.07
Consultant	16	19.51
Trainer	12	14.64
Total	**82**	**78.1**

4.2 DESCRIPTIVE STATISTICS

Strategic Lean Thinking and Value Management for gravel roads in Zambia, as a study generated both quantitative and qualitative data and hence, descriptive data techniques were used in the analysis. The responses were summarised as follows:

4.2.1 Section B: LTT – Lean Thinking Philosophy in Unpaved Road Construction and Maintenance

This section of the questionnaire sought to establish Lean Thinking Philosophy knowledge levels among the stakeholders in the Construction and Maintenance of gravel roads in Zambia. Table 7 below presents the opinions of respondents on the Lean Thinking Philosophy and how it would enhance road projects.

Table 7: Lean Thinking Philosophy in Gravel Road Construction and Maintenance

Code	Questions/Opinion Statements	SD	D	N	A	SA	Total
B1	Lean Thinking is a new term to many industries is the World	1	3	14	50	14	82
B2	The term Lean Thinking is new to you and your Organization	2	6	10	49	15	82
B3	To what extent is Lean Thinking being applied in Gravel Road Construction and Maintenance Contracts/Projects in Zambia?	30	29	18	5	0	82
B4	Lean Construction is a new philosophy in Gravel Road Construction and Maintenance Contracts in Zambia?	1	3	10	45	23	82
B5	Lean Thinking philosophy could enhance the quality of Gravel Road Contracts/Projects and Management in Zambia	0	0	5	30	47	82
B6	The Road Contractors need more knowledge in Lean Thinking philosophies for Gravel Road enhancement in terms of serviceability and sustainability in Zambia	0	1	1	27	53	82
	Likert Scale (Interval scale)	1	2	3	4	5	

4.2.2 Section C: VMT– Value Management Philosophy in Unpaved Road Construction and Maintenance

This part of the questionnaire sought to establish Value Management Philosophy knowledge levels among the stakeholders in the Construction and Maintenance of gravel roads. Table 8 below presents opinions of respondents on the Value Management Theory and how it would enhance road projects throughout the whole life process, from inception, planning, design, implementation and completion to commissioning phases.

Table 8: Value Management Philosophy in Gravel Road Construction and Maintenance

Code	Questions/Opinion Statements	SD	D	N	A	SA	Total
C1	To what extent are you familiar with VMT	8	12	31	21	10	82
C2	Value Management is a new philosophy in Gravel Road Construction and Maintenance in Zambia	2	12	14	39	15	82
C3	Value Management could enhance the quality of Gravel Road Contracts/Projects in Zambia	0	1	2	31	48	82
C4	The Scope/Design of works for Gravel Road Contracts/Projects is determined by the Client, Donors/Funders	0	2	5	34	41	82
C5	Perceived value of Gravel Road Contracts/Projects is determined by Clients and Donors/Funders	0	2	5	39	36	82
C6	Value Management philosophy is not well perceived and therefore not applied in Gravel Road Contracts in Zambia	1	7	12	38	24	82
	Likert Scale (Interval scale)	1	2	3	4	5	

4.2.3 Section D: -Output Performance Based Road Contracts (OPRCs) in Gravel Road

This section of the questionnaire sought to investigate the use of OPRCs in the Construction and Maintenance of gravel roads in Zambia. Table 9 below outlines study respondents' opinions on the use and understanding of Output Performance Road Contracts (OPRCs) and how it would enhance road projects.

Table 9: Output Performance Based Road Contracts (OPRCs) in Gravel Road Construction and Maintenance

Code	Questions/Opinion Statements	SD	D	N	A	SA	Total
D1	Gravel Roads are an important part of the Zambian Road Network in terms of connectivity and economic growth	0	0	0	10	72	82
D2	How would you describe the quality of most Gravel Roads without maintenance for a period of two years or more after construction in Zambia?	49	24	7	2	0	82
D3	Gravel Roads are difficult to sustain and are susceptible to deterioration and cannot survive a rainy season without Periodic and Routine Maintenance	1	4	2	27	48	82
D4	Gravel Roads by nature are not suited for short term or 'One off' Road Contracts (Conventional Road Contracts)	3	3	1	34	41	82
D5	Long term Road Contracts or Output Performance Road Contracts (OPRC) are suitable for Gravel Roads in Zambia	0	0	2	30	50	82
D6	From the experience with the Projects you are implementing/supervising, OPRC is designed to operate on the Lean Thinking and Value Management philosophies	0	6	14	34	28	82
D7	Strategic application of LT and VM philosophies could enhance quality of Gravel Roads in terms of Serviceability and Sustainability in Zambia	1	0	1	35	45	82
	Likert Scale (Interval scale)	1	2	3	4	5	

4.2.4 Section E: – Collaboration in Gravel Road Construction and Maintenance

This part of the questionnaire aimed to investigate the level of collaboration and consultation among various stakeholders in the Construction and Maintenance of gravel roads. Table 10 below presents respondents opinions on the Value Management Theory and how it would enhance road projects.

Table 10: Collaboration in Gravel Road Construction and Maintenance (Planning, Design and Implementation)

Code	Questions/Opinion Statements	SD	D	N	A	SA	Total
E1	There is no much Collaboration among Client, Consultant and Contractor at Project planning, design and implementation stages	0	4	5	38	35	82
E2	Most Gravel Roads fail to meet value to Customer perspective, hence they incur cost and time overruns due to change in Work scope resulting in Variation Orders	0	4	1	48	29	82
E3	Most Gravel Road Contracts fail to meet value to Customer perspective due to unclear or vague product value by the Client and Donors	1	9	14	41	17	82
E4	The function of Gravel Roads could sometimes be over emphasized [value perception] by the Client and Donor/Funder which may not very well be understood by the Contractor due to lack real Collaboration at Planning and Design stages	0	4	2	60	16	82
E5	Understanding Lean Thinking and Value Management philosophies may lead to improvement of meaningful Collaboration for the Gravel Road Project team (Client, Consultant and Contractor)	0	0	1	33	48	82
E6	Collaboration is a Lean Thinking and Value Management tool which if used correctly may lead to Construction and Maintenance of Gravel Roads of good quality to meet Customer needs	0	0	1	28	53	82
	Likert Scale (Interval scale)	1	2	3	4	5	

4.3 ANALYSIS of Questionnaire Responses

4.3.1 Likert statement - B1: Lean Thinking (LT) is a new term to most industries in the Word;

The essence of this statement was to try and establish the levels of Lean Thinking knowledge by parties engaged on gravel road Construction and Maintenance in Zambia. This was meant

to gain understanding on whether many stakeholders in the Zambian Road Sector were conversant with the Theory and its attributed benefits in as Value enhancement and waste elimination were concerned. As earlier stated, the Likert scale (rating) was used with 'SD or 1' as 'Strongly disagree', 'D or 2' as 'Disagree', 'N or 3' as 'Neutral or Medium', 'A or 4' as 'Agree' and 'SA or 5' as 'Strongly agree'. The graph below shows combined and summarised responses received from various respondents;

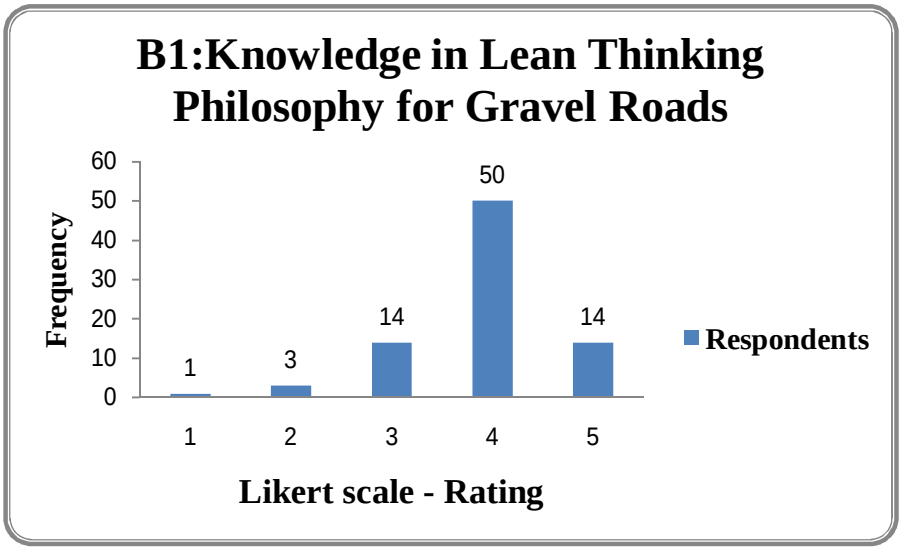

Figure 19: Road Practitioners Lean Thinking/Construction Knowledge in Gravel Roads

Figure 19 above depicts that most respondents believed that the term Lean Thinking was relatively new to most industries in the World. Out of the 82 Engineers and other road practitioners [various management and support staff] that responded to the questionnaires, 61% (50) agreed that Lean Thinking was a new term, 17% (14) strongly agreed with the notion that Lean Thinking was a new term to most industries in the world. Another group of respondents of 17% (14) were neutral or uncertain with their opinions. Three, out of the 82 respondents disagreed that Lean Thinking was a new term while One respondent strongly disagreed that Lean Thinking was a new term to most industries in the World as can be shown by the graph [figure 19]. When analysed statistically from measures of central tendency parameters, this can be translated in weighted Mean of 3.89, which is near Likert scale rating of 4, the Mode being also of the Likert scale rating 4 and the Weighted Standard deviation of 0.76. This indicates that 68% responses fall between 3.13 and 4.65 of the weighted mean. Respondents according to the analysis exhibited consensus of response at 80.3% with a dissension in response of only 19.7 %. This shows high consistency in response as there was low dissension compared with their consensus.

From the above analysis it is being suggested that Engineers and other Stakeholders involved in the Construction and Maintenance of gravel roads had the notion that Lean Thinking was a new term to most industries in the world including the Zambian Road Sector. In view of the above analysis it could be deduced that most Engineers and other Road Practitioners had no or possessed very little knowledge about the Lean Thinking philosophy and its principles and therefore not applied in the Construction and Maintenance of gravel roads in Zambia.

4.3.2 Likert statement – B2: The term Lean Thinking (LT) Philosophy is new to you and your Organisation

The rationale of this likert statement was to gauge the levels of knowledge in Lean Thinking Philosophy for every Engineer involved in the gravel road Construction and Maintenance. Project Engineers and Site managers together with other road practitioners were also targeted. Responses are presented in the graph as shown in Figure 20 below:

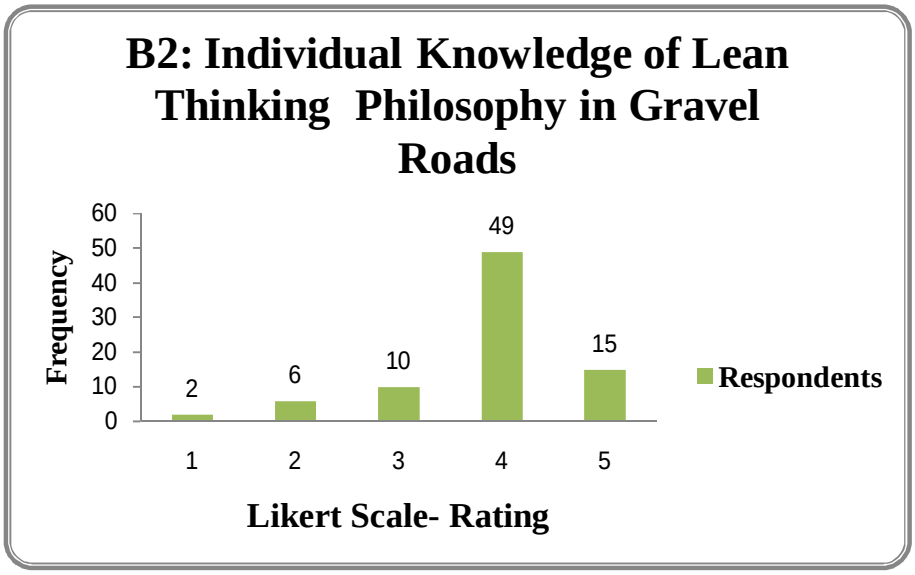

Figure 20: Engineer's Knowledge in Lean Thinking Philosophy for Gravel Roads

Figure 20 above, shows that out of 82 respondents, 18% (15) indicated to have 'Strongly agreed' with the statement, 60% (49) merely 'Agreed' that Lean Thinking was a new term or philosophy to them and their Organisations, 12% (12) were 'neutral' on the issue and held the view that they were not sure whether they were familiar with the term Lean Thinking or not. 7% (6) disagreed with the statement and only 3% (2) respondents 'Strongly disagreed' with the statement. When applying statistical analysis through use of measures of central tendency, this like in Likert statement B1, indicated weighted Mean of 3.84, which is near Likert scale rating of 4, the Mode being also of the Likert scale rating 4 and the Weighted

Standard deviation of 0.88. This shows that 68% responses fall between 2.95 and 4.73 of the weighted mean. According to the analysis shown above, Respondents indicated consensus of response at 76.8% with dissension in response of 23.2 %. This also shows high consistency in response as there was low dissension in response compared with their consensus.

The analysis indicated that individual Engineers involved with the gravel road Construction and Maintenance were not very familiar with Lean Thinking philosophy and therefore could not appreciate the benefits accruing to its principles. It could further be adduced from the analysis that most stakeholders in the road sector were not conversant with the Lean Thinking philosophies and hence not being fully applied.

4.3.3 Likert Question – B3: To what extent is Lean Thinking Philosophy being applied in Gravel Road Construction and Maintenance Contracts/Projects?

The responses obtained from respondents for this question are shown in the graph below:

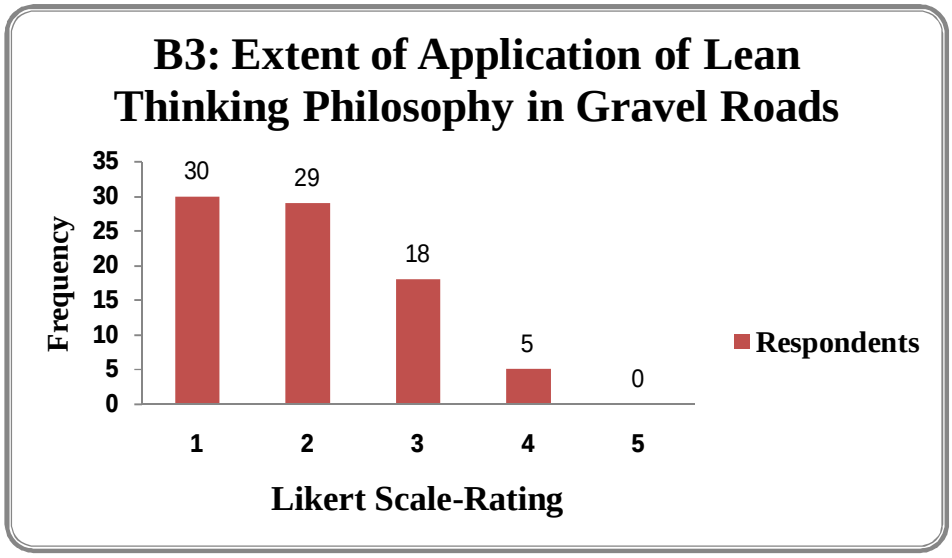

Figure 21: Extent of Application of Lean Thinking Philosophy in Gravel Roads

Figure 21 above also shows that out of 82 respondents, there was no one who claimed that Lean Thinking Philosophy was 'very highly' applied in gravel roads, Only 6% (5), indicated that the Philosophy was 'highly' incorporated in the gravel road project processes, 22% (18), of respondents indicated that the Philosophy was applied at 'medium' level. 35% (29) of the total respondents stated that Lean Thinking was 'lowly' applied in gravel roads. 37% (30) of the research respondents felt that Lean Thinking Philosophy was 'Very lowly' adopted in the Construction and Maintenances of gravel roads in Zambia.

The analysis of Likert statement B3, indicated weighted Mean of 1.9, which is closer to Likert scale rating of 2, the Mode being also of the Likert scale rating 1 and the Weighted Standard deviation of 0.91. This adduces that 68% responses fall between 1.06 and 2.88 of the weighted mean. According to the analysis shown above, Respondents indicated consensus of response at 53.9% with dissension in response of 46.1 %. This shows slight high consistency in response as there was reasonable dissension in response. Although there was reasonable dissension in responses, the majority of respondents however, held the opinion that Lean Thinking Philosophy was minimally applied in the Gravel Road Construction projects/contracts in Zambia.

4.3.4 Likert Statement– B4: Lean Construction is a new Philosophy in Gravel Road Construction and Maintenance Contracts in Zambia

The statement aims at establishing whether the Lean Construction was considered as a new Philosophy in gravel road Construction and Maintenance Contracts/Projects in Zambia. Opinions were obtained from various players in the Road Sector. The responses are as shown in the graph in Figure 22 below:

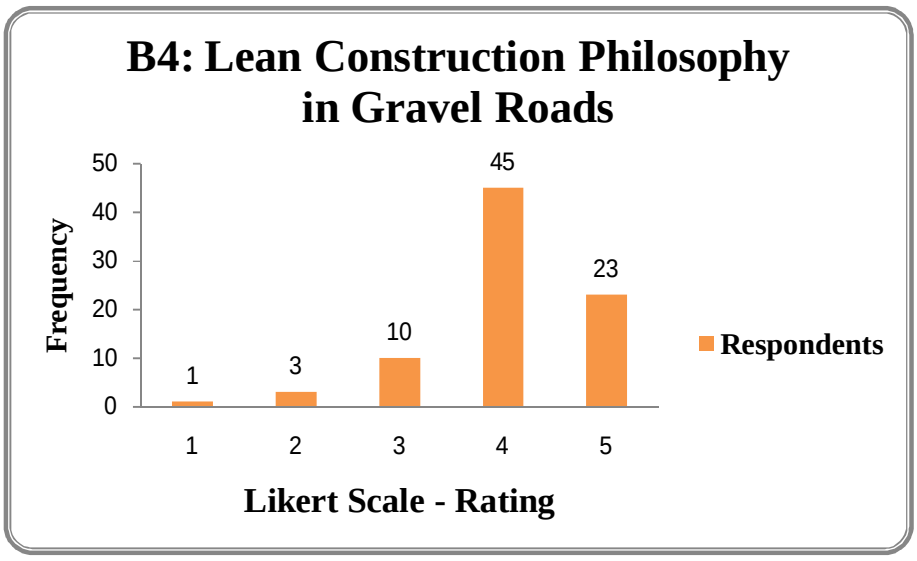

Figure 22: Lean Construction in Gravel Roads

As can be seen from the responses obtained shown in Figure 22, 82 respondents provided responses. Out of these 28% (23) 'strongly agreed' that Lean Construction Philosophy was new in Gravel Road Construction and Maintenance contracts, 55% (45) indicated that they 'greed' with the above statement, 12%(10) held the neutral position, while 4% (3) 'disagreed' with the statement and only 1% (1) of the respondents, 'strongly disagreed' that Lean Construction was a new theory in Construction and Maintenance of gravel roads.

The analysis of Likert statement B4, indicated weighted Mean of 4.04, which was rounded to Likert scale rating of 4, the Mode being also of the Likert scale rating 4 and the Weighted Standard deviation of 0.81. This indicates that 68% responses fall between 3.24 and 4.86 of the weighted mean. According to the analysis shown above, Respondents indicated consensus of response at 79.9% with dissension in response of 20.1 %. This shows high consensus consistency in response with low dissension in response. It was therefore, held that most respondents interviewed considered Lean Construction as a new theory in the Contracts/Projects dealing with gravel roads in Zambia. This revealed that Gravel Road Contracts have not integrated the intricate principles that Lean Construction philosophies brought about.

4.3.5 Question – B5: Lean Thinking Philosophy could enhance the quality of Gravel Road Contracts and Projects and Management in Zambia

This Likert statement was generated so as to obtain views from conveniently or purposively selected stakeholders involved with the Construction and Maintenance of gravel roads, whether Lean Thinking Philosophy would enhance quality in various aspects. This again was to establish whether the Road Sector stakeholders could appreciate the benefits derived from Lean Thinking philosophies with regard to quality and value improvement. This was meant to provide a balance in responses and hence, remove the inherent external and internal biasness. The following graph displays the responses as received from Research respondents that were contacted on the issue.

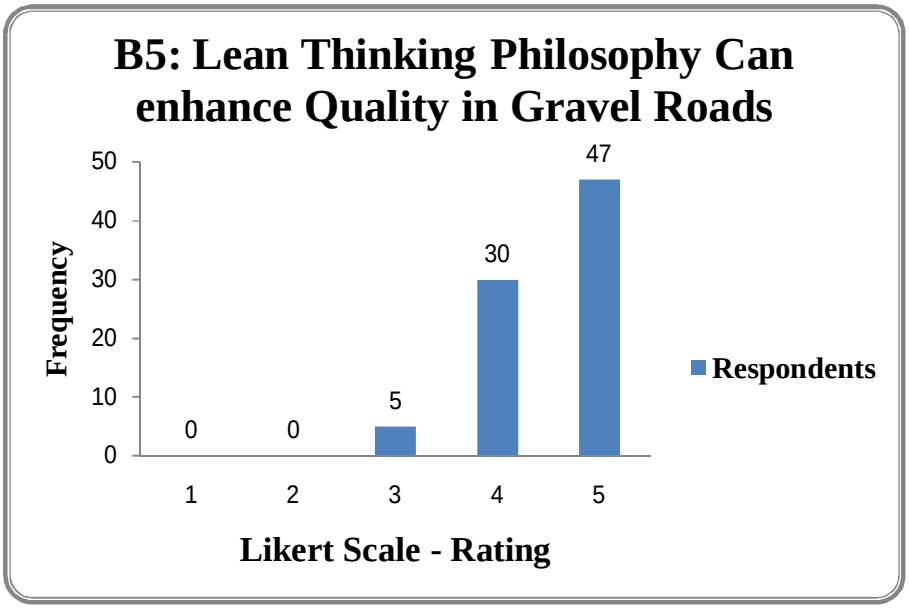

Figure 23: Lean Thinking Philosophy can enhance Quality of Gravel Roads

From the graph shown above (Figure 23), out of the 82 respondents, 57% (47) 'Strongly agreed' that Lean Thinking Philosophy could enhance the quality of gravel road Contracts in Zambia, 37% (37) of the respondents captured also 'Agreed' with the statement, while 6% (5) remained 'Neutral' of the issue of quality enhancement as a result of applying Lean Thinking. There were no respondents who either 'Disagreed' or 'Strongly disagreed' with the Likert statement.

Further, the analysis of Likert statement B5 responses indicated weighted Mean of 4.51, which was closer to Likert scale rating of 5, the Mode being also of the Likert scale rating 5 and the Weighted Standard deviation of 0.61. This indicates that 68% responses, fall within the band of 3.90 and 5.12 of the weighted mean. According to the analysis shown above, Respondents indicated consensus of response at 85.5% with dissension in response of 13.5 %. This shows high consensus consistency in responses with slightly low dissension in response.

Nevertheless, considering the 57% of respondents 'Strongly agreed' with the statement, at Respondent consensus level of 85.5%, it can be deduced that Lean Thinking Philosophy could enhance the quality of Contracts for Gravel Road Construction and Maintenance in Zambia.

4.3.6 Likert Statement – B6: Road Contractors need more knowledge in the Lean Thinking Principles for Gravel Road quality enhancement in terms of Serviceability and Sustainability in Zambia

This Likert statement was aimed at gauging and establishing whether there was need for Road Contractors to gain more knowledge in Lean Thinking Theory if they were to fully apply its principles in the Construction and Maintenance of gravel roads. The main reason behind this was that for Gravel Roads Contractors to appreciate Lean Thinking Theory they needed more enlightenment in that area. The Stakeholders responses have been presented in the following graph on the next page:

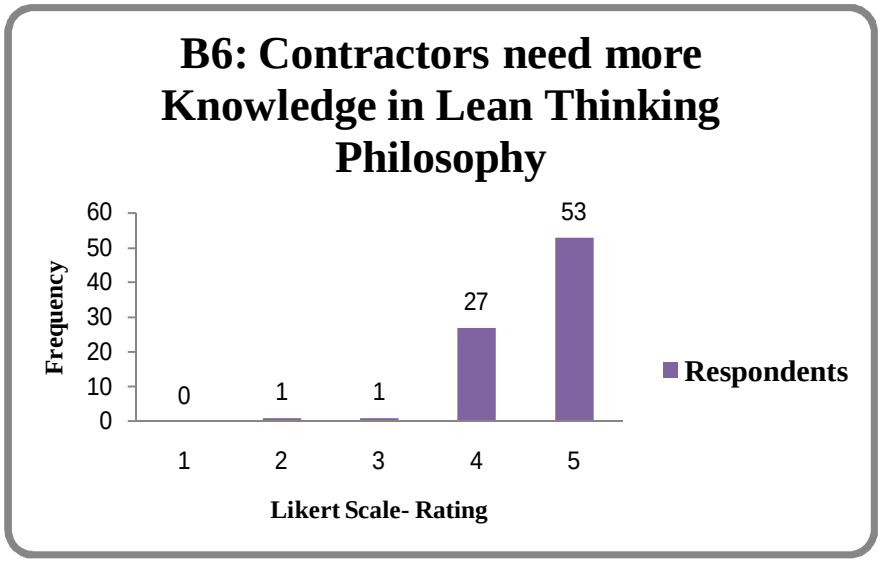

Figure 24: Contractors need more knowledge in Lean Thinking

Of the total of 82 responses received as shown in Figure 24, 65% (53), 'Strongly agreed' that Road Contractors needed much knowledge in Lean Thinking Philosophy to improve gravel roads in terms of Serviceability and Sustainability in Zambia, 33% (27) Respondents 'Agreed' with the statement, 1% (1) of the responses gathered were 'Neutral' and 'disagreed' with the statement respectively. No respondent indicated that he or she had 'Strongly disagreed' with the statement that Road Contractors needed more knowledge in Lean Thinking Philosophy.

The analysis of Likert statement B6 responses indicated weighted Mean of 4.61, which was closer to Likert scale rating of 5, the Mode being also of the Likert scale rating 5 and the Weighted Standard deviation of 0.58. This indicates that 68% responses, fall between 4.03 and 5.18 of the weighted mean. According to the analysis shown above, Respondents indicated consensus of response at 87.4% with dissension in response of 12.6 %. This shows high consensus of consistency in response with relatively low dissension in responses. The fact that 65% respondents 'Strongly agreed' with the Likert statement at 87.4% consensus just confirms that it could be true Road Contractors desired to be enlightened in the area of Lean Thinking philosophies if they were to effectively gain benefits there from for good quality and enhanced value gravel roads in Zambia.

4.3.7 Section C: Value Management (VM) in the Construction and Maintenance of Gravel Roads

It was therefore, necessary when undertaking this research to very well understand the value of gravel roads as perceived by the Road users. Questions and Statements meant to measure opinions of stakeholders were therefore, developed as follows;

4.3.8 Question – C1: To what extent are you familiar with Value Management (VM) phisophies?

The question was specifically developed and included in the Research Questionnaire so as to gauge opinions and perceptions of Stakeholders about their level of knowledge in Value Management philosophies. This was meant to understand and appreciate how much sensitisation with regard to Road Sector Stakeholders had been done in the area of Value Management. The most important thing was to investigate the extent or level of VM knowledge appreciation. Like in the case of Lean Thinking, the responses obtained from research respondents are presented in the following pie chart below:

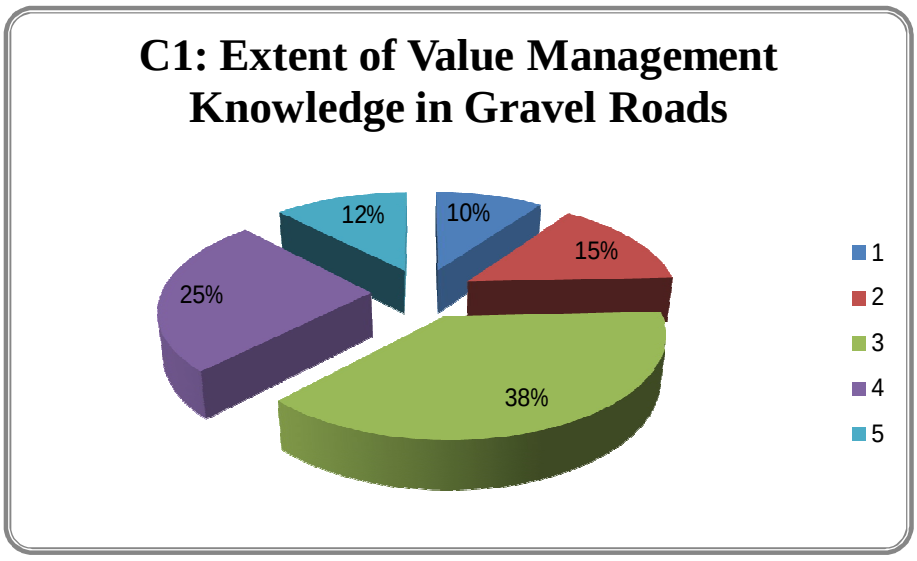

Figure 25: Extent of Value Management Knowledge

Out of the total of 82 respondents captured for this question as shown in Figure 25, 38%(31), indicated 'Medium', extent of knowledge in Value Management. 25% (21) said they had 'high' level of Knowledge in VM, 15% (12) indicated that they had 'low' level of knowledge in Value Management, 12%(10) stated that their knowledge was 'very high' and 10% (8) had perceived themselves to have 'very low' knowledge in Value Management .

The analysis of Likert Question C1 responses indicated weighted Mean of 3.16, which was closer to Likert scale ratings of 3, the Mode being also of the Likert scale rating 3 and the

Weighted Standard deviation of 1.12. This implies that 68% responses fall between 2.04 and 4.28 of the weighted mean. According to the analysis shown above, Respondents indicated consensus of response at 64.5% with dissension in response of 34.5 %. This shows relatively high consensus consistency in response, with reasonable dissension in responses. However, this researcher had apprehension accepting these views presented by the respondents as the facts on the ground as there appears to be some element of them [Study respondents] being too conservative on the issue as they appeared not to accept the fact that they had little knowledge in Value Management. Their responses could have been influenced by their ego to protect the intrinsic status that they felt possessed, hence reserved the true opinions (Personal impressions). It could be true that they did not very well understand the dimension for which the statement was structured hence the hedging tendency observed. Whatever, the case the fact that respondents chose to remain neutral, spoke volumes on their perceived ignorance about Value Management philosophy.

4.3.9 Question – C2: Value Management can be described as a new Philosophy in Gravel Road Construction in Zambia

This was a follow up to the previous question under this section whose main aim was to try and understand the appreciation on Value Management in Construction. It was also particularly meant to establish whether the Value Management Philosophy (VMT) was new to most stakeholders in the Road sector. The responses to the Likert Scale are reflected in the following pie chart:

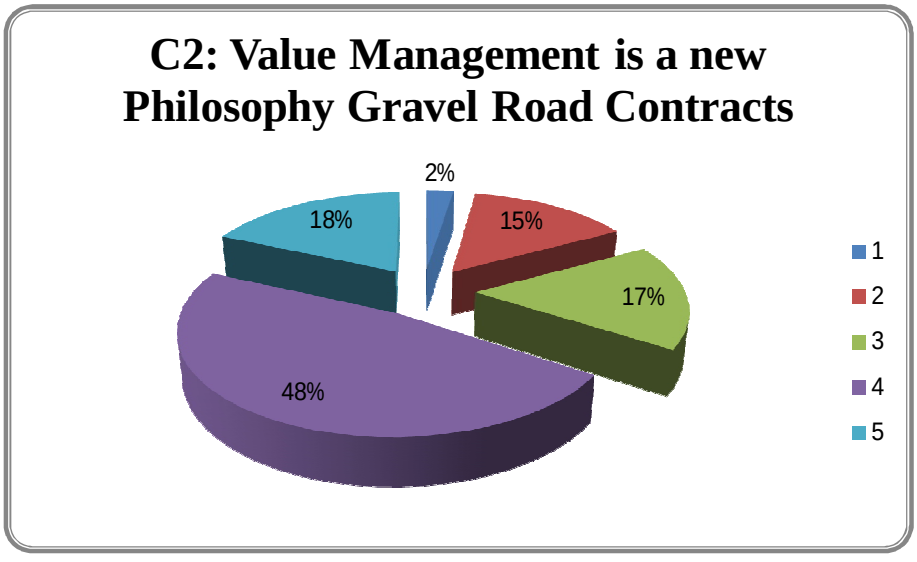

Figure 26: Value Management is a new philosophy is Gravel Roads

Figure 26, shows that there were 82 respondents and only 18% (15) 'Strongly agreed' that Value Management was a new theory in Contracts for gravel roads, 48% (39) stated that they 'Agreed' with the Likert statement, 17% (14) held the 'Neutral' position with the notion that VM theory was new in Gravel road Contracts. 18% (12) respondents 'Disagreed 'with the statement and only 2% (2) 'Strongly agreed' with the statement that Value Management was a new philosophy in Gravel road Contracts. To a larger extent the position taken by most respondents was that it could be true that Value Management was a new philosophy for gravel roads in Zambia.

The analysis of Likert Statement C2 responses indicated weighted Mean of 3.65, which was closer to Likert scale ratings of 4, the Mode being also of the Likert scale rating 4 and the Weighted Standard deviation of 1.02. This indicates that 68% responses fall within the band 2.62 and 4.66 of the weighted mean. According to the analysis shown above, Respondents indicated consensus of response of 72.1% with dissension in response of 27.9 %. This shows relatively high consensus consistency in response, with reasonable dissension in responses. This study established that most respondents felt that Value Management was a new philosophy in the Construction and Maintenance of gravel roads in Zambia.

4.3.10 Likert Statement – C3: Value Management could enhance Gravel Road Contracts and Projects in Zambia (including the current OPRC Contracts being implemented)

This Likert Statement was developed to dispel the apprehension that Stakeholders may be holding with regard to the benefits of Value Management and how this would enhance the quality and value of Gravel Road Contracts. The attitudes and opinions of the Stakeholders involved in the gravel road Construction and Maintenance projects or contracts. In order to avoid being biased with the findings and conclusions, the research respondents were drawn from a cross section of various Road Sector practitioners. The pie chart [Figure 27] shows the responses obtained from Research respondents namely Client institutions, Consultants, Trainers and Contractors:

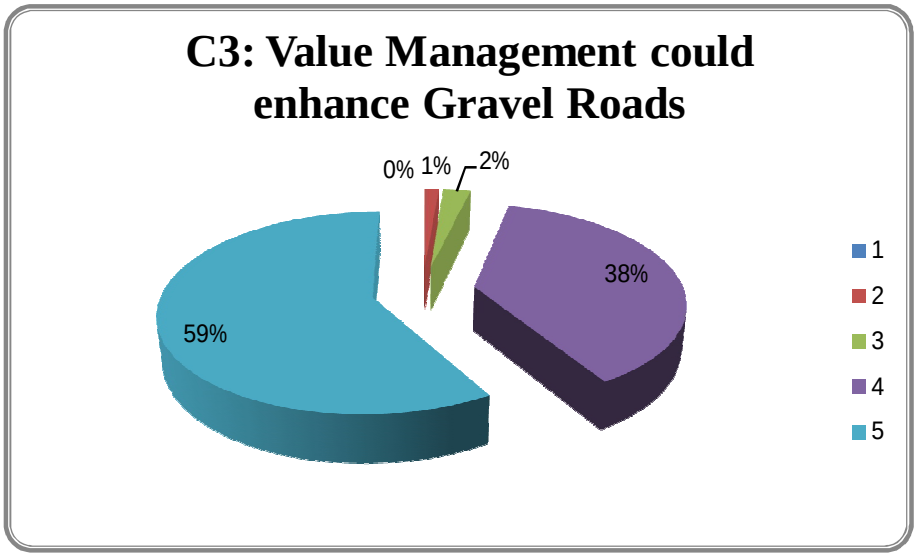

Figure 27: Enhancement of Gravel Road Contracts through Value Management

Of the 82 respondents shown in Figure 27, 59%(48) had 'Strongly agreed' that Value Management could enhance Contracts of Gravel Roads in Zambia, while 38%(31) of the respondents 'Agreed', with the statement and 2% (2) were 'Neutral' on the notion, and 1% (1) of the respondents 'Disagreed'. There was no one who refuted the assertion that Value Management could enhance Contracts of Gravel Roads. This can therefore, confirm that Value Management could enhance Gravel Road Construction and Maintenance Contracts.

The analysis of Likert Statement C3 responses indicated weighted Mean of 4.54, which was about the Likert scale ratings of 5, the Mode being also of the Likert scale rating of 5 and the Weighted Standard deviation of 0.6. This adduces that 68% responses fall between 3.92 and 5.14 of the weighted mean. According to the analysis shown above, Respondents indicated consensus of response at 86.6% with dissension in response of 13.4 %. This shows very high consensus consistency in response, with slightly low dissension in responses. The study revealed that there was no doubt that Value Management could shape and improve the Gravel Road Construction and Maintenance Contracts in Zambia.

4.3.11 Likert Statement – C4: The Scope/Design of works in Road Contracts is determined by the Client and Donors/Funders

Currently Conventional Road Contracts which depend on the execution of Bill of Quantities (BoQ), are being used in gravel roads. The design and scope of the works are mainly developed by the Client without input of the beneficiaries, the Road users. Harris, McCaffer and Edum-Fotwe (*op.cit.pp.151-237*), explained that some Countries like 'Zambia', Clients, or their advisers, prefer to deal with Contractors with a common document for pricing in the

form of bill of Quantities (BOQ). This entails that the Client or Financier will develop the scope and design requirements for the Contract. Value Management encourages parties to critically think through together and thereby develop a Contract of work scope of good and appreciable consensus. To confirm these assertion stakeholders were invited to state their views. The pie chart below displays the results obtained from the field survey:

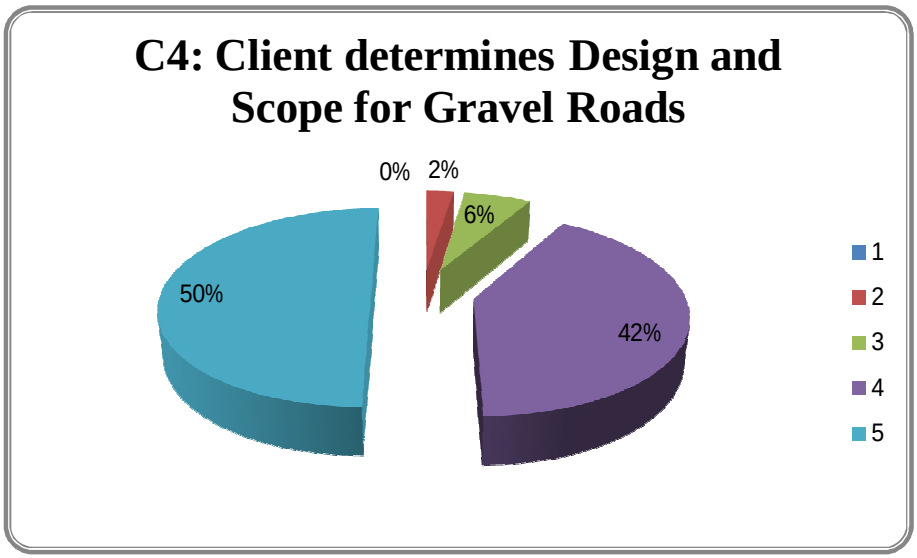

Figure 28: Determination of Design and Scope for Gravel roads

There were 82 responses on this Statement. Figure 28 shows that 50% (41) of respondents 'Strongly agreed' with the notion that the design and scope of gravel road works were determined by the Client, 42% (32) respondents 'Agreed' with the statement, 6% (5) were moderately 'Neutral', on the issue of perceived value, Only 2% (2) 'Disagreed' with the statement and no one of the respondents 'Strongly disagreed' with the indication that design and scope for Gravel roads in Zambia was solely decided by Clients and Donors/Funders.

The analysis of Likert Statement C4 responses indicated weighted Mean of 4.39, which was slightly above Likert scale ratings of 4, the Mode being also of the Likert scale rating 5 and the Weighted Standard deviation of 0.71. This indicates that 68% of the responses fall between 3.68 and 5.10 of the weighted mean. According to the analysis shown above, Respondents indicated consensus of response at 83.8% with dissension in response of 16.2 %. This shows substantially high consensus consistency in responses, with low dissension in responses. This therefore confirms that the Client and Donors were the Ones determining the design and scope of Gravel Roads for the current forms of road contracts contrary to Value Management attributes.

4.3.12 Likert Statement – C5: Perceived Value of Gravel Road Contracts (Unpaved) is determined by the Client and Donors/Funders

This statement was developed to investigate the issue of Value determination with regard to Stakeholder involvement and collaboration. The essence is to establish whether the current scenario of Gravel Road Contracts, gave room for Stakeholder involvement through the Participatory Learning Action (PLA) as advanced by Value Management principles. The responses are displayed in the following pie chart below:

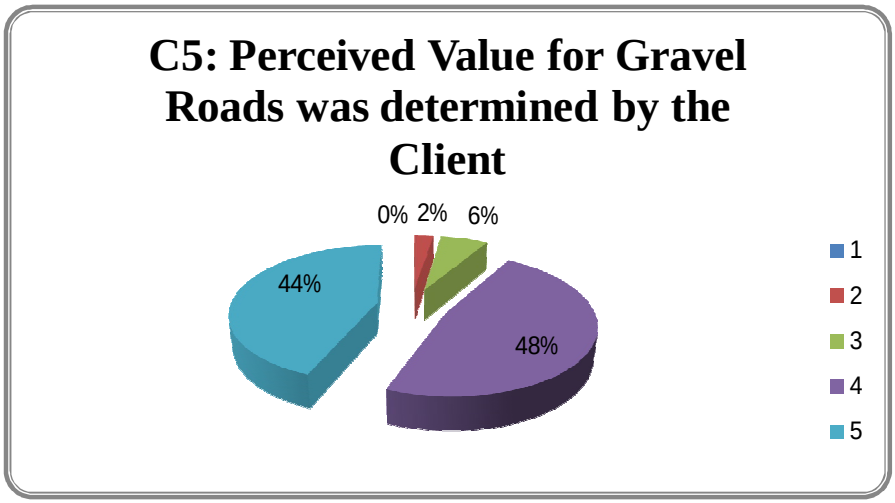

Figure 29: Determination of Perceived Value by the Client

Figure 29, shows that there were 82 responses, of these 44% (36) indicated to have 'Strongly agreed' with the assertion that Perceived value was determined by the Client and Donors, 48% (39) 'Agreed' with the statement, 6%(5) were 'Neutral' on the Likert statement, 2%(2) 'Disagreed' with the notion and no one among the respondents 'Strongly disagreed'.

The analysis of Likert Statement C5, responses indicated weighted Mean of 4.32, which was also slightly above Likert scale ratings of 4, the Mode being also of the Likert scale rating of 4 and the Weighted Standard deviation of 0.69 or 0.70 almost the same to the Value in Likert Statement C4 responses. This shows that 68% of the responses fall between 3.62 and 5.02 of the weighted mean. According to the analysis shown above, Respondents indicated consensus of response at 83.8% with dissension in response of 16.2 %. This like in the previous case, shows remarkable high consensus consistency in responses, with low dissension in responses. This also indicated an impression that Perceived value for Gravel Roads was currently in Zambia, determined by the Client or Donor/Funder.

4.3.13 Likert Statement – C6 Value Management Theory is not well perceived and therefore not applied in Gravel Road Contracts in Zambia, including the current OPRC Contracts

This Likert statement C6 was developed and meant to establish the Stakeholders' perceptions of the Value Management Theory with regard to its employment in the Construction and Maintenance of gravel roads in Zambia. The following pie chart below gives an elaborate view on the respondents' responses obtained:

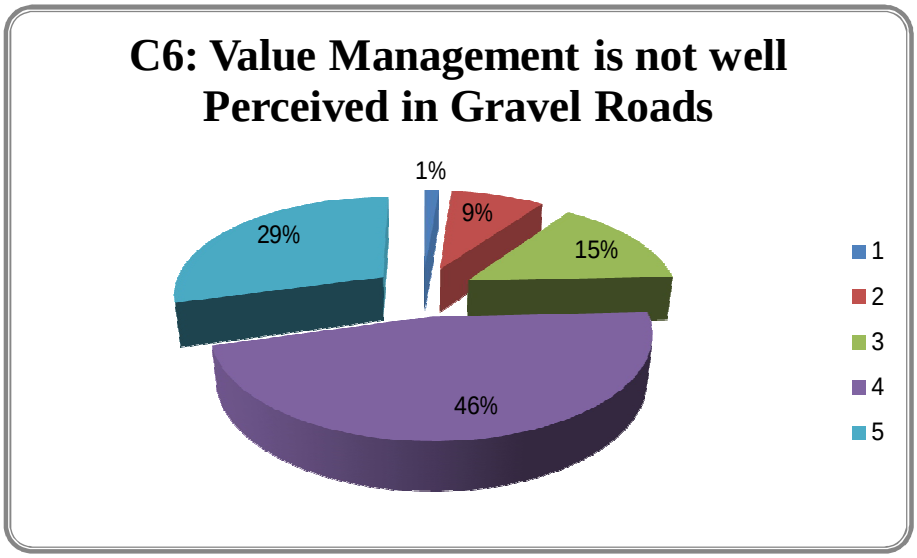

Figure 30: Perception of Value Management in Gravel Roads

The respondents to this question were 82 is as indicated in Figure 30, shown above and of these, 29%(24) of the respondents 'Strongly Agreed' that the Value philosophy was not well perceived, 46%(38) of the responses received indicated that they 'Agreed', with the statement and 15%(12) remained 'Neutral', while 9%(7) and 1%(1) of the respondents 'Disagreed' and 'Strongly disagreed' respectively.

The analysis of Likert Statement C6 responses indicated weighted Mean of 3.92, which was almost Likert scale ratings of 4, the Mode being also of the Likert scale rating of 4 and the Weighted Standard deviation of 0.94. This indicates that 68% of the responses fall between 2.99 and 4.88 of the weighted mean. According to the analysis shown above, Respondents indicated consensus of response at 76.1% with dissension in response of 23.1 %. This like in the previous case, shows high consensus consistency in responses, with low dissension in responses. This also indicated an impression that Value Management was not well perceived by Gravel Roads developers and practitioners in Zambia.

4.3.14 Section D: Output Performance Based Road Contracts (Gravel Roads)

According to Zietlow (2007), the traditional or Conventional Contracting of Road Construction and Maintenance is based on the amount of work measured as executed and paid on the basis of agreed rates. On the contrary, Output Performance Based Road Contracts (OPRC) allows the Contractor to manage the Contract through meeting certain set conditions or criteria to ensure compliance. In OPRC type of Contracts the system defines the Value and Quality of the product that the Contractor must definitely endeavour to meet. Even if these types of Contracts transfer more risk from the Client to the Contractor, they however apportion more freedoms to the Contractor to decide the destiny and chat a way forward. The Contractor is more involved from the conceptual, design, planning and implementation stages. It was however, necessary to obtain views from the road users and local People so as to establish how the Zambian Road Sector practitioners appreciated this strategy.

4.3.14.1 Statement – D1: Gravel Roads are an important part of the Zambian Road Network in terms of Connectivity and Economic growth

The statement was developed to investigate and ascertain respondents' opinions on the importance of gravel roads in Zambian road network and economic development. This was also meant to establish a case on why the research in the '*Strategic Application of Lean Thinking and Value Management principles in gravel roads in Zambia'* was being conducted. The Likert scale method of rating was again used and respondents were to 'Strongly Disagree', 'Disagree', remain 'Neutral', 'Agree', or 'Strongly Agree' with the statement. The results obtained are displayed in a bar chart on the next page as follows:

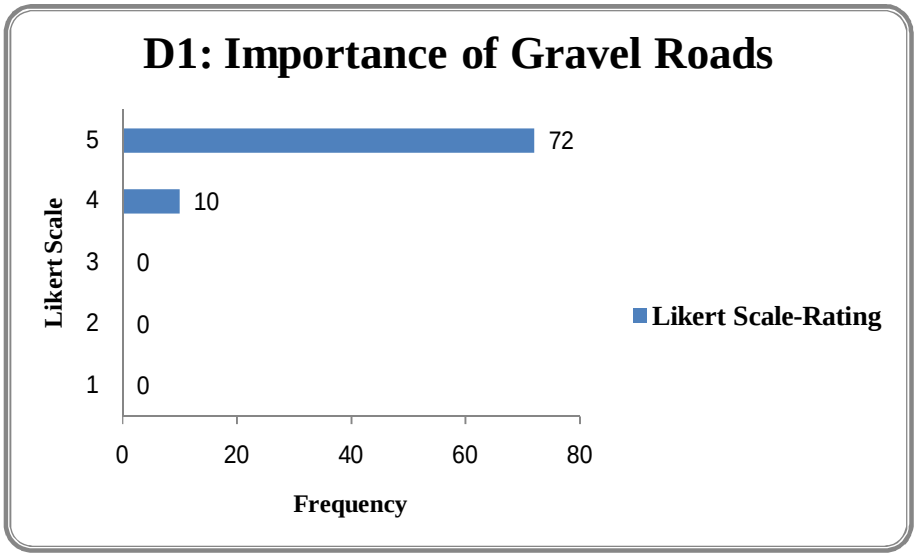

Figure 31: Importance of Gravel Roads in Zambia

Figure 31, shows that the total number of respondents to this statement was 82, and no one 'strongly disagreed', 'disagreed' or remained 'neutral' with the statement. However, those who 'agreed' and 'strongly agreed' with the statement were 10 (12%), and 72 (88%) respectively. The respondents felt that gravel roads were important for the Zambian economy and community connectivity.

The analysis of Likert Statement D1 responses indicated weighted Mean of 4.87, which was almost Likert scale ratings of 5, the Mode being also of the Likert scale rating of 5 and the Weighted Standard deviation of 0.32. This represents that 68% of the responses are within the band 4.55 and 5.20 of the weighted mean. According to the analysis shown above, Respondents indicated consensus of response at 93.3% with dissension in response of 6.7 %. This shows higher consensus consistency in responses, with very low dissension in responses. This also suggested that most stakeholders perceived Gravel Roads important driver of Zambian economy and community connectivity.

4.3.14.2 <u>Statement</u> – D2: How would you describe the quality of most Gravel Roads without maintenance for a period of 2 years or more after construction in Zambia?

The statement aimed at establishing from the respondents on the quality of gravel roads in Zambia without maintenance after two years of their construction. This was meant to underscore the importance of maintenance through long term strategic Contracts. The results are presented in a bar chart on the next page as follows:

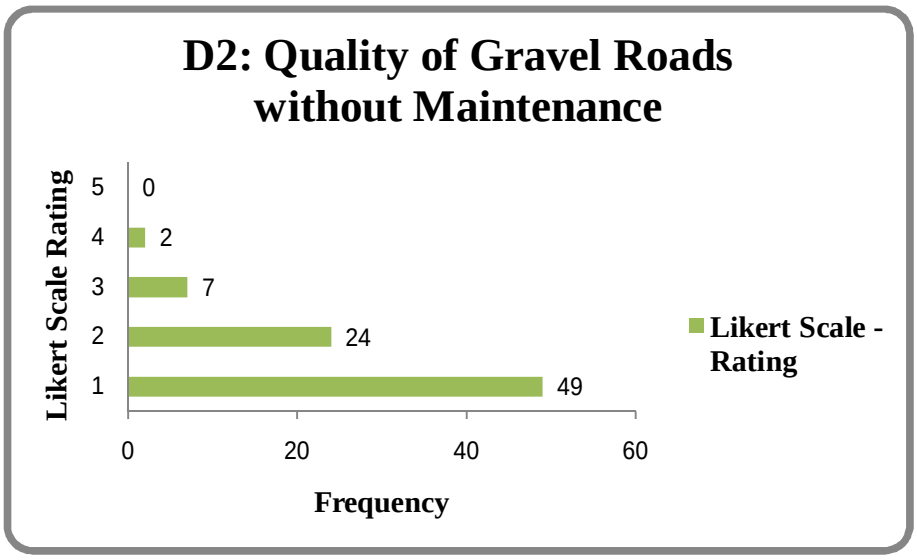

Figure 32: Quality of Gravel roads without Maintenance

Figure 32, shows that out of the 82 respondents to this statement, 49 (60%) indicated that the quality of gravel roads was 'Very poor', without maintenance after two years of construction. 24 (29%) felt that the quality of gravel roads was 'Poor', 7 (8.5%) said that the quality of gravel roads was 'Fair', while 2 (2.5%) perceived the quality of gravel roads was 'Good' and no one indicated that the quality was 'Very good'. Considering the responses obtained it could be deduced that most Gravel roads were of poor quality if no maintenance was carried out after two years of Rehabilitation or Construction with increased level of traffic and inclement weather.

The analysis of Likert Statement D2 responses indicated weighted Mean of 1.54, which was almost Likert scale ratings of 2, the Mode being also of the Likert scale rating of 1 and the Weighted Standard deviation of 0.75. This indicates that 68% of the responses fall between 0.78 and 2.28 of the weighted mean. According to the analysis shown above, Respondents indicated consensus of response at 51.1% with dissension in response of 48.1 %. This shows almost the same level of consensus consistency and dissension in responses. This also indicated that most stakeholders felt that gravel roads in Zambia were generally of poor quality without maintenance.

4.3.14.3 <u>Statement</u> – D3: Gravel Roads are difficult to Sustain and are susceptible to deterioration without maintenance

The statement was used to establish or find out whether research respondents from the Zambian road sector perceived sustenance of gravels roads difficult without maintenance. The results are presented on the next page as follows:

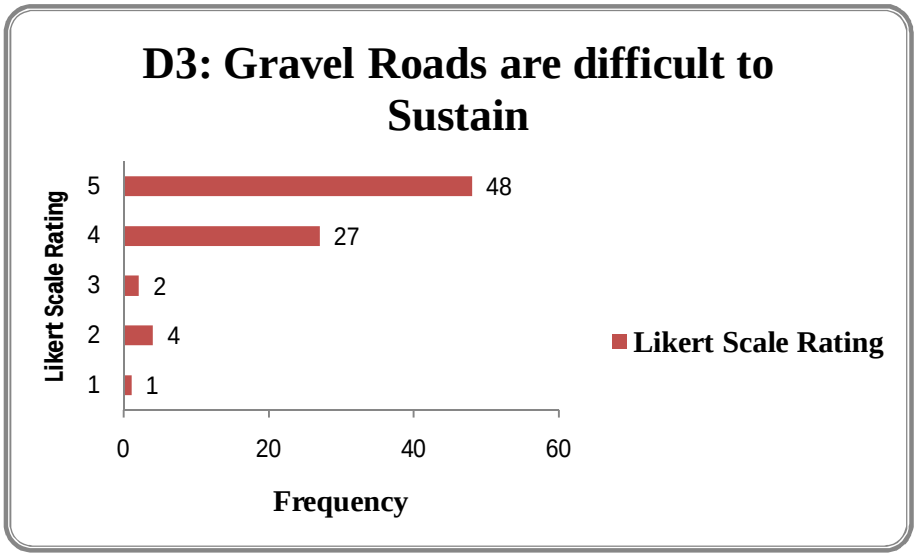

Figure 33: Gravel Roads are difficult to sustain

There were 82 respondents to this statement as shown in Figure 33, 1 (1%) of these 'Strongly disagreed', 4 (5%) 'Disagreed', 2 (2.5%) were 'Neutral', 27 (33%) 'Agreed' and 48 (58.5%) 'Strongly agreed'. The responses obtained suggested that most Gravel roads were difficult to sustain without strategic maintenance (Routine and Periodic road Maintenance).

The analysis of Likert Statement D3 responses indicated weighted Mean of 4.42, which was almost Likert scale ratings of 4, the Mode being also of the Likert scale rating of 5 and the Weighted Standard deviation of 0.85. This shows that 68% of the responses fall between 3.57 and 5.28 of the weighted mean. According to the analysis shown above, Respondents indicated consensus of response at 80.7% with dissension in response of 19.3 %. This shows higher consensus consistency in responses, with very low dissension in responses. This also indicated that most stakeholders were in agreement with each other and held the opinion that Gravel Roads were difficult to sustain without maintenance.

4.3.14.4 Statement – D4: Gravel Roads are not suited for Short term or One off Road Contracts (Conventional Road Contracts).

In trying to compare the effectiveness of the two types of Contracts (Conventional and OPRCs) for the Construction and Maintenance of gravel roads, respondents were consulted through the above Likert statement. The results obtained are presented on the next page as follows:

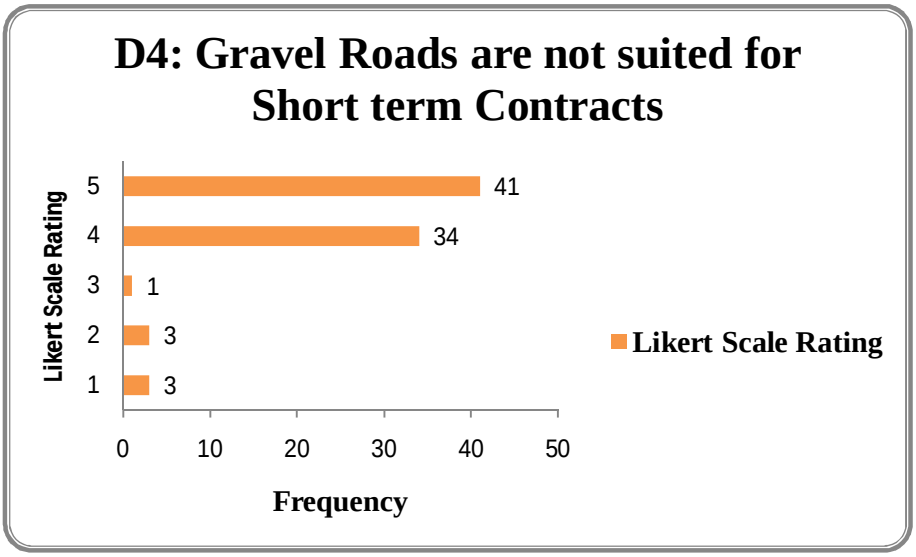

Figure 34: Gravel Roads are not suited for Short term Contracts

Of the total 82 respondents to this statement shown in Figure 34, 3 (4%) strongly disagreed, 3 (4%) disagreed, 1 (1%) were neutral, 34 (42%) agreed and 41 (50%) strongly agreed. From these results, it shows that about 92% of total respondents agreed with the assertion that Short term (Traditional or Conventional Road Contracts) were not suitable for the construction and maintenance of Gravel roads. Combining those who were strongly agreed and those who agreed, it can be depicted that the current Contracts used in gravel roads were not preferred and suited for gravel roads in Zambia.

The analysis of Likert Statement D4 responses indicated weighted Mean of 4.31, which was almost Likert scale ratings of 4, the Mode being also of the Likert scale rating of 5 and the Weighted Standard deviation of 0.95. This indicates that 68% of the responses fall between 3.35 and 5.25 of the weighted mean. According to the analysis shown above, Respondents indicated consensus of response at 78% with dissension in response of 22%. This shows high consensus consistency in responses, with relatively low dissension in responses. This also showed that most stakeholders perceived Gravel Roads not suited for Short term Contracts.

4.3.14.5 <u>Statement</u> – D5: Long term Road Contracts or Output Performance Based Road Contracts (OPRCS) are suitable for good quality and sustainable Gravel Roads in Zambia.

Further, to appreciate the potency of the two types of Contracts (Conventional and OPRCs) for the Construction and Maintenance of Gravel roads, respondents were consulted through the above Likert statement. The results obtained are displayed as follows on the next page:

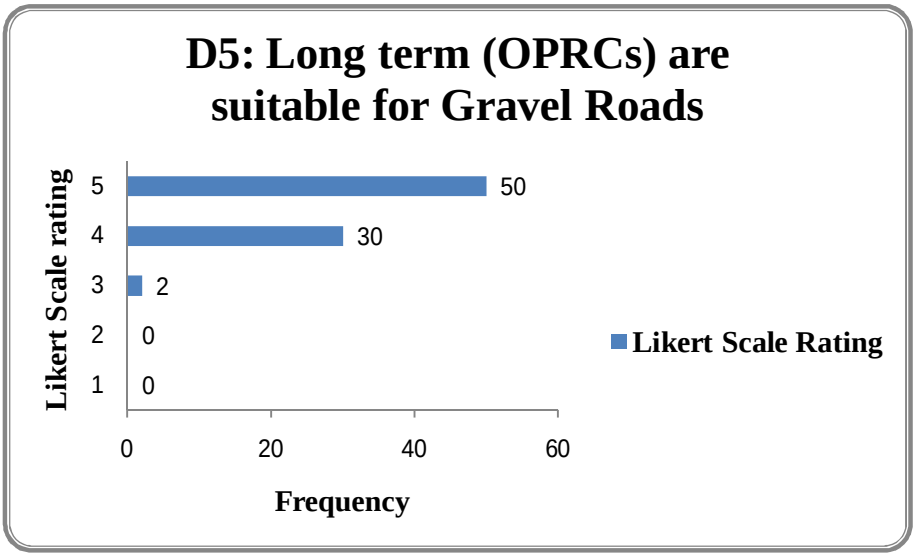

Figure 35: Long term Contracts (OPRCs) are suitable for Gravel Roads

Of the total 82 research respondents to this statement shown in Figure 35, no respondent either strongly disagreed or disagreed with the statement. However, 2 (2.5%) were neutral, 30 (36.5%) agreed and 50 (61%) strongly agreed. From these results, it shows that about 97.5% respondents were in agreement with the thought that long term Road Contracts (OPRCs) were suitable for the Construction and Maintenance of gravel roads in Zambia.

The analysis of Likert Statement D5 responses indicated weighted Mean of 4.59, which was almost Likert scale ratings of 5, the Mode being also of the Likert scale rating of 5 and the Weighted Standard deviation of 0.54. This represents that 68% of the responses fall between 4.04 and 5.12 of the weighted mean. According to the analysis shown above, Respondents indicated consensus of response at 88.2% with dissension in response of 11.8 %. This shows higher consensus consistency in responses, with very low dissension in responses. This also indicated that most respondents felt that OPRCs would be suitable for Construction and Maintenance of Gravel Roads in Zambia.

4.3.14.6 <u>Statement</u> – D6: From the experience with the projects you are implementing, OPRCS operate on the Lean Thinking and Value Management philosophies

Respondents were requested to state their opinions on whether they felt or agreed with the statement that OPRCs operated on Lean Thinking and Value Management philosophies. This was meant to appreciate how the attributes of LT and VM had helped to shape the Output Performance Based Road Contracts (OPRCs) could have improved Road Contracts strategies

through the adoption of and adaption to OPRCs. The results obtained are presented in Figure 36 as follows:

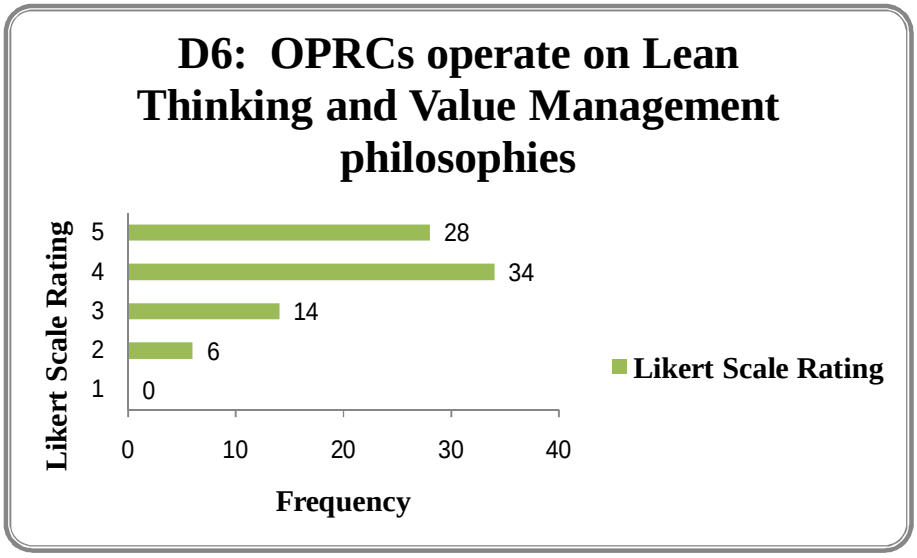

Figure 36: OPRCs operate on the Lean Thinking and Value Management philosophies

Of the total 82 respondents to this statement shown in Figure 36, no research subject strongly disagreed, 6 (7%) disagreed, 14 (17%) were neutral, 34 (42%) agreed and 28 (34%) strongly agreed. From the results obtained, it shows that many (76%) respondents were in agreement with the statement that OPRCs operated from the Lean Thinking and Value Management philosophies. The results suggested that OPRCs were very effective compared with Conventional or Traditional Contracts due to the perceived attributes of Lean Thinking and Value Management principles incorporated in the said intervention strategies.

The analysis of Likert Statement D6 responses indicated weighted Mean of 4.02, which was almost Likert scale ratings of 4, the Mode being also of the Likert scale rating of 4 and the Weighted Standard deviation of 0.90. This shows that 68% of the responses fall between 3.12 and 4.92 of the weighted mean. According to the analysis shown above, Respondents indicated consensus of response at 77.7% with dissension in response of 22.3 %. This shows high consensus consistency in responses, with relatively low dissension in responses. From the above results, a deduction could be drawn that OPRCs operated on Lean Thinking and Value Management philosophies as indicated by most research subjects.

4.3.14.7 <u>Statement</u> – D7: Strategic application of LT and VM Philosophies can enhance the quality and life span of Gravel Roads and improve their quality in terms of Serviceability and Sustainability in Zambia

In order to arrive at tangible deductions on whether strategic application of LT and VM philosophies enhanced the quality and life span of unpaved (gravel) roads, in terms of serviceability and sustainability, respondents were consulted. The results obtained are as shown in Figure 37 below:

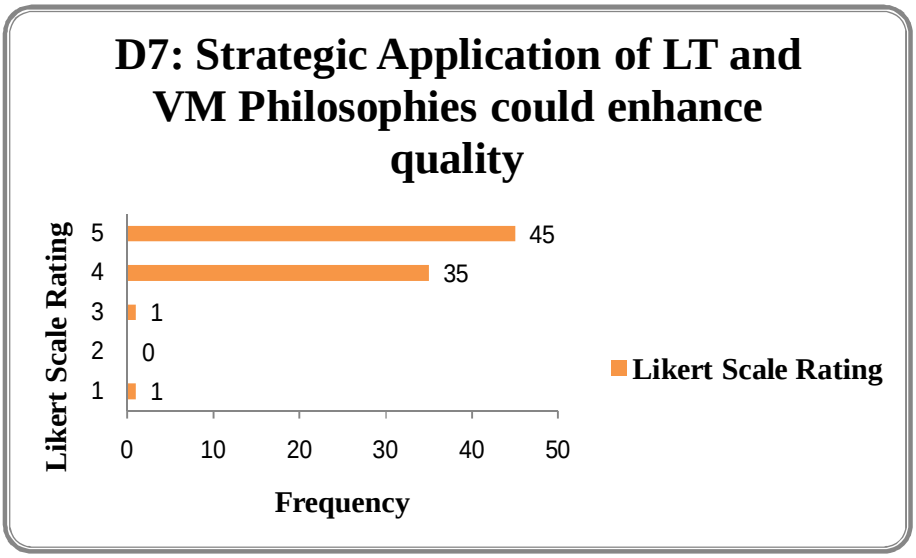

Figure 37: Strategic LT and VM Philosophies can enhance quality of Gravel Roads

Of the total 82 respondents to this statement shown in Figure 37, 1 (1%) strongly disagreed, while no respondent disagreed, 1 (1%) were neutral, 35 (43%) agreed and 45 (55%) strongly agreed. From these results, it shows that many (98%) respondents either agreed or strongly agreed with presumption that strategic application of Lean Thinking and Value Management could enhance the quality of gravel roads in Zambia.

The analysis of Likert Statement D7 responses indicated weighted Mean of 4.5, which was almost Likert scale ratings of 5, the Mode being also of the Likert scale rating of 5 and the Weighted Standard deviation of 0.65. This indicates that 68% of the responses fall between 3.85 and 5.15 of the weighted mean. According to the analysis shown above, Respondents indicated consensus of response at 85.6% with dissension in response of 14.4 %. This shows higher consensus consistency in responses, with very low dissension in responses. This also indicated that most stakeholders supported the notion that Strategic application of Lean Thinking and Value Management philosophies could enhance the quality of gravel roads in terms of serviceability and sustainability in Zambia.

4.3.15 Section E: Collaboration in Gravel Road Construction and Maintenance (Planning, Design and Implementation stages)

To understand the Lean Thinking and Value Management from the Collaboration of Stakeholders point of view in the road construction industry in Zambia, it was important to review generally the levels of interaction and collaboration currently being used. This area was investigated by looking at various issues surrounding gravel road Construction and Maintenance as follows;

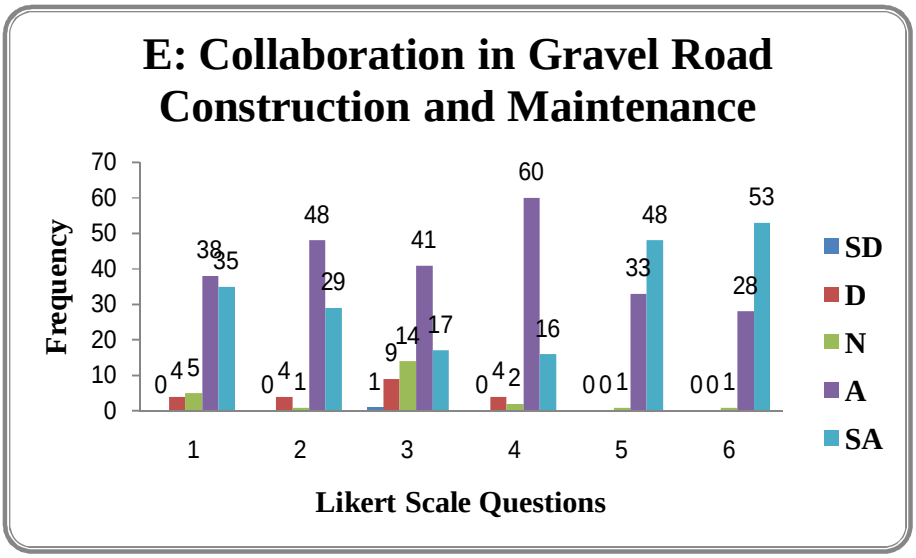

Figure 38: Collaboration in Gravel Road Construction and Maintenance

4.3.15.1 <u>Statement</u> – E1: There is no much Collaboration among Client, Consultant and Contractor at Project Planning, Design and Implementation stages

This statement was used to get the respondents opinions on the level of collaboration among Stakeholders in the Zambian Road Industry. The results of responses are illustrated in Figure 38 shown above.

The respondents were 82 in total, of those 35 (43%) indicated that they 'Strongly agreed', with the Statement, 38 (46%) of the respondents 'Agreed', that there was no collaboration among the stakeholders of 5 (6%) remained 'Neutral', 4 (5%) of the respondents 'Disagreed' that there was no much collaboration in the Road Sector and no one 'Strongly disagreed' with the notion that there was no much collaboration. In view of the above results, there is a strong indication the Stakeholders in the Construction and Maintenance of Gravel roads did not have much collaboration at all.

The analysis of Likert Statement E1 responses indicated weighted Mean of 4.27, which was almost Likert scale ratings of 4, the Mode being also of the Likert scale rating of 4 and the Weighted Standard deviation of 0.78. This states that 68% of the responses fall between 3.48 and 5.05 of the weighted mean. According to the analysis shown above, Respondents indicated consensus of response at 81.7% with dissension in response of 18.3 %. This shows higher consensus consistency in responses, with very low dissension in responses. This also showed that most stakeholders supported the notion that there was lack of real collaboration among stakeholders dealing with gravel roads.

4.3.15.2 Statement – E2: Most Gravel Road Contracts fail to meet Value to Customer perspective, hence they incur cost and time overruns due to change in Work Scope resulting in Variations Orders

According to Mohammand et al, 2010, there are many reasons that are responsible for Variation orders in Road Construction Contracts. Variation orders may occur due to change in site conditions, increase in work scope by the Client, errors in Contract documents during the design phase, additional and reduction of work quantities, poor communication and collaboration among the parties. The above statement aims at establishing whether most unpaved (gravel) roads Contracts fail to meet Value to customer perspectives and hence experience Variation orders which ultimately result in time and cost overruns.

There were 82 Respondents in total and out of these, 29 (35%) stated that they 'Strongly agreed', with the statement, 48 (59%) 'Agreed' that Value to customer perspective could not be realized hence the Variation orders, only 1 (1%) respondent remained 'Neutral', 4 (5%) research respondents 'Disagreed' with the statement and none of the respondents consulted or interviewed 'Strongly disagreed' that most gravel road contracts experienced Variation orders. The opinions gathered indicated that Value to customer perspectives could sometimes not be met in gravel road contracts as a result of Variation orders.

The analysis of Likert Statement E2 responses indicated weighted Mean of 4.24, which was almost Likert scale ratings of 4, the Mode being also of the Likert scale rating of 4 and the Weighted Standard deviation of 0.71. This indicates that 68% of the responses fall between 3.54 and 4.95 of the weighted mean. According to the analysis shown above, Respondents indicated high consensus of response at 83.3% with slightly low variability in response of 16.7 %. This shows higher consensus consistency in responses, with very low variation in responses. The results adduced that many respondents had the opinion that Variation orders were experienced in gravel roads contracts due to lack of collaboration.

4.3.15.3 Statement – E3: Most Gravel Road Contracts fail to meet Value to Customer perspective due to unclear or vague definition of road product value by Client and Donors/Funders

Failures to meet value to customer perspective are as a result of unclear or vague definition of road product value due to errors developed at project planning or design phase *(ibid).* To establish the truth about this thought again 82 respondents were interviewed and their opinions are as shown in the graph as shown in figure 38.

Of the 82 responses received, 17 (21%) 'Strongly agreed', with the assertion, 41 (50%) 'Agreed', that it was true road product value to customer perspective was sometimes not realised due to unclear or vague design definition, 14 (17%) indicated that they were 'Neutral' with the statement, 9 (11%) 'Disagreed' and only one 'Strongly disagreed' with the opinion that road product value was not realised due to unclear or vague definition at design stage. Combining respondents who 'strongly agreed' and those who merely 'Agreed' with the statement it can be concluded that vague and unclear definition of road product value was the reason for not meeting Customer perceived value in the Construction and Maintenance of gravel roads.

The analysis of Likert Statement E3 responses indicated weighted Mean of 3.78, which was almost Likert scale ratings of 4, the Mode being also of the Likert scale rating of 4 and the Weighted Standard deviation of 0.94. This means that 68% of the responses fall between 2.84 and 4.72 of the weighted mean. According to the analysis shown above, Respondents indicated consensus of response at 75.2% with dissension in response of 24.8 %. This shows higher consensus consistency in responses, with relatively low dissension in responses. From the data collected respondents developed the opinion that there is unclear and vague definition of project or road product value at planning and design stages.

4.3.15.4 Statement – E4: The Function of Gravel Roads could sometimes be over emphasized by the Client and Donor/Funder which may not very well be understood by the Contractor due to lack of real Collaboration at Project Planning and Design stages

The needs of the Client may sometimes change in the course of design and implementation phases. If the owner or developer is not very certain of the road product value, perceptions may be different to expectations of the Contractor. In case of gravel roads, some clients may have an impression that these roads may offer the same benefits as those obtained from paved ones. This normally occurs due to non collaborative efforts among stakeholders or parties. Mohammad, N. (2010), reasoned that Customer perceived needs may change along the way

due to change in technology or misrepresentation of facts from the design point of view amongst various parties. Respondents were interviewed on the issue of suspected lack of real collaboration at project design as the major contributor of misunderstandings. Below are the opinions of respondents;

There were 82 respondents recorded and out these, 16 (20%) stated that 'Strongly agreed' with the statement, 60 (73%), of the respondent 'Agreed', that real collaboration was lacking among the stakeholders in road sector, 2 (2%) of the research subjects held a 'Neutral' position on the statement that real collaboration lacked, 4 (5%) of the respondents 'disagreed' but no one 'strongly disagreed' out of the stakeholders consulted. It can therefore, be deduced that there was lack of real collaboration among road stakeholders including those involved with gravel roads.

The analysis of Likert Statement E4 responses indicated weighted Mean of 4.07, which was almost Likert scale ratings of 4, the Mode being also of the Likert scale rating of 4 and the Weighted Standard deviation of 0.64. This indicates that 68% of the responses fall between 3.43 and 4.71 of the weighted mean. According to the analysis shown above, Respondents indicated consensus of response at 84.3% with dissension in response of 15.7 %. This shows higher consensus consistency in responses, with very low dissension in responses. This also indicated that most stakeholders supported the notion that there was lack of real collaboration among road stakeholders including those involved with gravel roads in Zambia.

4.3.15.5 <u>Statement</u> – E5: Understanding Lean Thinking and Value Management principles may lead to improvement of meaningful Collaboration for the Gravel Road Project team (Client/Donor, Consultant and Contractor)

Respondents were asked to state their opinions on the suggestion that understanding of Lean Thinking and Value Management would culminate into improved collaboration among parties. The opinions gathered are as presented in figure 44 and discussed in the comments below:

Again 82 responses were received, out of these 48 (58%) 'Strongly agreed' that there was no doubt that understanding of Lean Thinking and Value Management principles would lead to improvement in collaboration among stakeholders, 33 (41%) of those consulted also 'Agreed' with the statement, only 1 (1%) respondent held a 'Neutral' position on the issue. No one either 'disagreed' or 'strongly disagreed' with the statement. It can be observed from these

results, that Lean Thinking and Value Management would improve collaboration among parties in the road sector in Zambia.

The analysis of Likert Statement E5 responses indicated weighted Mean of 4.57, which was almost Likert scale ratings of 5, the Mode being also of the Likert scale rating of 5 and the Weighted Standard deviation of 0.52. This adduces that 68% of the responses fall between 4.05 and 5.09 of the weighted mean. According to the analysis shown above, Respondents indicated consensus of response at 88.7% with dissension in response of 11.3 %. This shows higher consensus consistency in responses, with very low dissension in responses. The results of the data analysis revealed that most respondents felt that Lean Thinking and Value Management would improve collaboration among parties in the road sector in Zambia.

4.3.15.6 Statement – E6: Collaboration is a Lean Thinking and Value Management tool which when used correctly may lead to Construction and Maintenance of Gravel Roads of good quality to meet Customer needs

The research also delved on the issue of establishing whether collaboration through use of Lean Thinking and Value Management tools would lead to improvement of quality of gravel roads to meet Customer needs when used correctly. Below are the opinions of respondents;

There were 82 responses recorded, 53 (65%) of the research subjects indicated to have 'Strongly agreed' with the statement, 23 (28%) of the respondents 'Agreed' that real Collaboration would lead to improved gravel road quality. Only 1 (1%) of the respondents remained 'Neutral'. There were no respondents who either 'disagreed' or 'strongly agreed' with the assertion that real collaboration would improve road product value. It can therefore, be deduced that real collaboration would lead to improvement of the quality of gravel roads in Zambia.The analysis of Likert Statement E6 responses indicated weighted Mean of 4.63, which was almost Likert scale ratings of 5, the Mode being also of the Likert scale rating of 5 and the Weighted Standard deviation of 0.51. This states that 68% of the responses fall between 4.12 and 5.14 of the weighted mean. According to the analysis shown above, Respondents indicated consensus of response at 89.1% with dissension in response of 10.1 %. This shows higher consensus consistency in responses, with very low dissension in responses. This also indicated that most stakeholders supported the notion that real collaboration would lead to improvement of the quality of gravel roads in Zambia.

4.4 DATA ANALYSIS for Unstructured Questions- Section F

In trying to get more free will opinions and perceptions on the Lean Thinking and Value Management in the Construction and Maintenance of gravel roads, open ended or

unstructured questions were also used to interview Stakeholders. As already mentioned the target group were the following:

- Client Institutions;
- Consultants;
- Contractors; and
- Training and Regulatory Institutions.

Three questions around the areas of the quality of gravel roads, the appreciation and effectiveness of Output Performance Road Contracts (OPRCs) and reasons for improving value and quality of gravel roads in Zambia were developed to aid the investigation. The responses received are displayed as follows:

4.4.1Discussion of the results

The investigation was about getting the opinions on the relevance and importance of Lean Thinking and Value Management principles when applied in the Output Performance Road Contracts for gravel roads in Zambia. The essence of the study was to establish importance of gravel roads as catalyst to drive and improve the Zambian economy through rural community connectivity. Respondents involved in gravel road construction and maintenance in Zambia, were requested to state their unrestricted opinions. On question F1 of Section F, out of 82 respondents 79% indicated that 'Lack of Maintenance' was the reason for poor quality gravel roads in Zambia, 18% felt that 'Other' reasons such as poor priotisation were responsible and 3% of the respondents remained 'Neutral' on the issue. On question F2 of Section F, 93% of the respondents said 'Yes' to the suggestion that OPRCs would improve the quality of gravel roads in Zambia if adopted and only 7% held a neutral position on the assertion. Lastly, on question F3 of Section F, 83% of the respondents felt that OPRCs would bring about 'Sustainable Road Maintenance', 8.5% forwarded 'other' reasons and another 8.5% were 'neutral' on the matter, as displayed in table: 11 on the next page.

4.4.2 Validity and Reliability of Data and Information

Since the target sample comprised two types of respondents, such as those that were perceived to be to the Clients' side (Clients and Training & Regulators) and those viewed to be from Contractors' side (Constructor/Contractor and Consultants), validity of opinions was of prime importance. This is why some structured questions were used so to have respondents' responses within the study domain (OPRC sites). The issues of Reliability and Validity were carefully considered through proper construction of questionnaires and

interview questions so that they met minimum requirements. The use of Triangulation enhanced data and information validity and reliability. The validation of data and information was further complimented by the fact that most of the respondents were involved in OPRCs, which Zambia was currently implementing. The data collected in the study were deemed reliable as most of it was obtained from respondents deployed on active OPRCs (Miller, M.J, n.d). Most of the respondents included in the sample for the study, were involved the Construction and Maintenance of gravel roads. The respondents would have either been involved in OPRCs at planning or implementation stages. Others like those drawn from the National Council for Construction (NCC), came into contact with the OPRCs as they went about with regulatory assignments of Contractors on the road construction and maintenance sites. The researcher ensured that collection of data from respondents were done with due diligence. This is the reason why the case study was adopted for this study as the main strategy which could easily be replicated due to its suitability for exploratory research.

4.4.2.1 Section F- General Comments and Perceptions on OPRCs

As stated in sub section 4.4.1, this was also the section of the questionnaires through one to one interviews and was designed to allow respondents to answer unstructured questions for them to freely give their preferred responses. The responses are as shown in table 11 on the next page:

Table 11: Lean Thinking and Value Management in OPRCs for gravel roads (perceptions)

Code	Question	Sustainable Maintenance	Lack of Maintenance	Yes	No	Other	Neutral	Total	Comments
F1	*Why do you think most gravel roads are of poor quality in Zambia?*	0	**65**	0	0	15	2	**82**	**Lack of Maintenance**
F2	*OPRCs offer long term Road maintenance intervention; do you envisage that the quality of gravel roads would improve if these were adopted?*	0	0	**76**	0	0	6	**82**	**Yes**
F3	*Why would quality improve as result of adopting OPRCs?*	**68**	0	0	0	7	7	**82**	**Sustainable Maintenance**

'Flow if you can and pull if you must' (Liker, 2004)

CHAPTER FIVE

DISCUSSION OF RESULTS OF THE OPRC CASE STUDIES

5.1 INTRODUCTION

As earlier alluded to in sub section 1.5 (Scope and location of the study), the Case Studies were conducted on the OPRCs located in Chipata, Katete, Chipata, Lundazi, Chongwe and Choma districts of Zambia. At the time of this study, these Contracts were being implemented by the Road Development Agency (RDA) in conjunction with the National Coordinating Office (NCO) of the Ministry of Agriculture and Livestock (MAL). The researcher established that RDA had been implementing the OPRCs under the Rural Road Improvement Facility (RRIF) which was a sub project of the Agriculture Development Support Project (ADSP) falling under the MAL. The study noted that project's main objective was to improve the construction and maintenance of gravel and rural roads in agricultural potential areas, with a view to bring about commercialisation of smallholder farmers in those areas, thereby enhancing food security and foster improvement of standard of living per household. The OPRCs which commenced in the year 2009, were expected to take a period of five (5) years, the system which ensures that roads are always kept in a serviceable condition. This study is therefore, a precursor for consideration as to whether the OPRCs could be viable option for the construction and maintenance of gravel roads, most of which are currently in a state of disrepair and requiring immediate attention. In the Country's Case-study report, Public Private Infrastructure Advisory Facility [PPIAF], (2009: p.127), it was stated that:

> *In 2006 performance contracts were introduced on over 3 000 km of gravel District Roads with funding assistance from the European Union. The District Roads had been neglected for many years as the main thrust of road investments in Zambia had gone into bringing the paved roads into maintainable condition. As a result connections between district centres had become increasingly problematic, with many roads becoming impassable during the rains". These Output Performance Road Contracts (OPRCs) are the first generation proper for gravel roads in Zambia although some*

Figure 39: Location of Zambia on the African Map-OPRCs *(Adapted from RDA, Report, 2010)*

performance road maintenance contracts were first implemented as early as 1993 using small scale Contractors.

Zambia was the first country in the region to adopt a second generation Road Fund in 1993, and since 2002 had an agency structure with separate agencies responsible for funding, road management and road safety each reporting to different ministries. The Road Fund now receives about USD 160 million per year from road user charges and a levy on fuel for road maintenance. One of the main challenges facing the Agency is disbursing maintenance funds efficiently and effectively over the network".

In 2007 more performance-contracts were prepared for maintenance of over 1 000 km of feeder roads under a World Bank financed project for Agricultural Development. These contracts are due to be awarded in 2008. Much care has been taken to define the initial works in these contracts. Design responsibility is only passed to Contractors for clearance of simple backlog maintenance which has been combined with maintenance services in the performance-based part of the contracts. Everything else, including earthworks and additional structures needed to bring roads up to required standards, is specified in a traditional way in bills of quantity and on drawings (ibid).

It was established through this study that these were considered to be the first and second generation Output Performance Road Contracts (OPRCs) on gravel roads in Zambia. The first generation OPRCs were faced with challenges, this could be because *"Lean Thinking"* and *"Value Management"* philosophies were not applied, therefore failed to bear much fruit (RDA, 2009). As a way of rekindling strategic maintenance of gravel roads in Zambia, which was lost through the years of post independence and after the shift from Force Account to Contracting, the Road Development Agency had been implementing Output Performance Based Road Contracts (OPRCs) since 2005. The study noted that initially between 1993 and 1998, the Performance Based Roads Contracts (PBCs) were used in the maintenance of the paved roads in Zambia. The work scope mainly involved off carriageway operations (Vegetation control and maintenance of drainage structures). Small Scale Contractors were employed on this arrangement, managed by the then Roads Department Training School (RTS), now called National Construction School (NCS), under the auspices of the newly constituted National Construction Council (NCC) (PPIAF, 2009). This generation of Performance Based Contracts (PBCs) was forerunner to the Output Performance Based Road Contracts (OPRCs) that were conceived in 2005 and finally consummated in 2006. About 3000 Km of gravel roads were placed on the Output Performance Based Contracts (OPRCs) with the funding coming from the European Union (EU) on the pilot basis. This is due to the fact that most District roads (Feeder roads) had not received any maintenance attention, a situation which led to their deterioration and degradation to states of no value for money. A

total of Ten (10) Contracts were awarded using World Bank (WB) sample binding document which had commonly been referred to in Zambia as first generation Output Performance Based Road Contracts (OPRCs) - (See Figure 5). Unfortunately due to lack of experience and apprehension on the principles and characteristics of OPRCs, by the Contractors selected, not much benefits were realized. Most of these Contracts failed to achieve the intended objectives and goals, being among others, providing sustainable road maintenance that sooner or later would culminate into having roads that could offer the Zambian citizenry, services and connectivity described as those giving value for money and worthy the salt. During the implementation phase, it was difficult to achieve the results due to poor bids coming from contractors because of bad pricing. The lessons were that more preparations were required compared with those considered for Conventional or Traditional Road Contracts *(ibid)-(See Figures 40 & 41).*

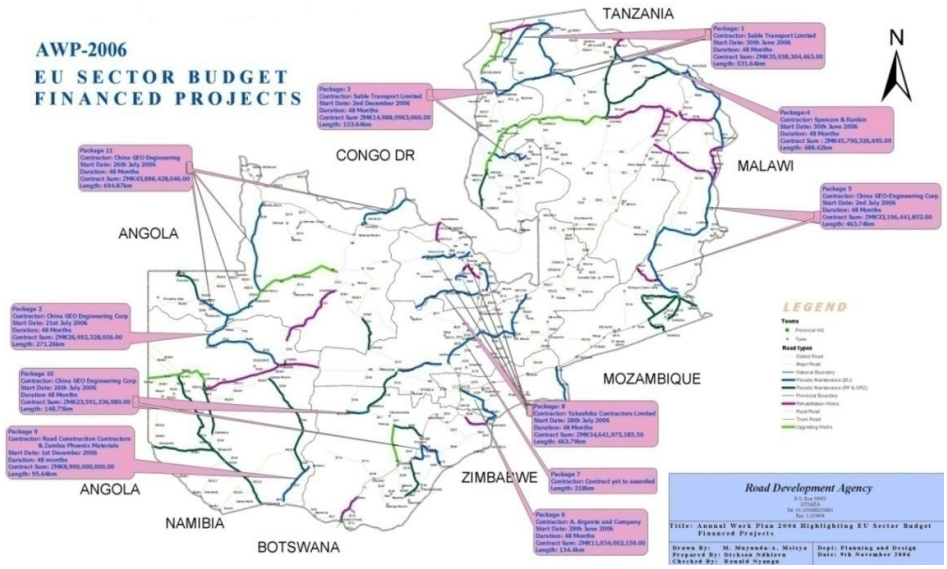

Figure 40: 1st Generation OPRCs Project locations on the Zambian Map *(Adapted from RDA, Report, 2010)*

Figure 41: 1st Generation OPRC Contracts failed due to poor preparations and Financing *(Lundazi-Chama Road, 2006- Adapted from RDA, Report)*

The study discovered that in view of the lessons learnt from the 1st generation OPRCs, the RDA in liaison with the then Ministry of Agriculture and Cooperatives (MACO), now known as the Ministry of Agriculture and Livestock (MAL), initiated Output Performance Based Road Contracts (OPRCs) programme of maintaining rural roads. The Agricultural Development Support Programme (ADSP) funded by the World Bank (WB), aimed at improving the conditions of the agriculture potential areas in order to easy transportation difficulties so as to access markets for goods and services. Under this programme, a component known as Rural Road(s) Investment Fund [RRIF], was used to finance the OPRC contracts in three provinces of Zambia, namely; Southern, Lusaka and Eastern. During the period between the year 2008 and 2009, Five (5) districts selected to serve as pilot model, were Choma, Chongwe, Katete, Chipata and Lundazi. The programme had grouped these districts into two packages, namely Choma and Chongwe as package 1 and Ketete, Chipata and Lundazi as package 2. The Choma, Chongwe and Katete districts were funded by the World Bank (WB) under the RRIF programme. The two other districts, Chipata and Lundazi were financed through the European Union (EU) provisions (RDA, 2nd Quarterly Report, 2008). These Output Performance Based Road Contracts (OPRCs) which in essence came into effect in the year 2009 and were expected to come to an end in 2014, covering a period

of five (5) years and targeted a road network of 1000Km. The 2nd generation OPRCs were awarded to one Contractor or firm, while the design and supervision were awarded to two Engineering Consulting firms.

Figure 42: Stakeholders monitoring and evaluating progress of 2nd Generation OPRC contracts perceived to be designed on Lean Thinking and Value Management philosophies *(D361 Road in Choma, 2011)*

The Choma and Chongwe were under one package and were supervised by UWP Consulting Engineers. The Katete, Chipata and Lundazi roads composed another package and were designed, supervised and managed by ASCO Consulting Engineers (See Figures 40, 41 & 42).These OPRCs are perceived to operate on the value for money basis as they encourage full involvement of the Contractors in the design and implementation stages of the Contracts. The model nevertheless, promotes collaboration among the parties, which makes the Client involvement effective and with less hurdles to achieve the desired results of having roads that support the farming and other local communities. These types of Contracts offer a lot of relief to the Client as they move most of the risky burdens to the Contractor. However, underlying these principles, are the greater benefits that Contractors receive in terms of deciding their destiny. The incentives that they offer to the Contractors cannot by any means be compared to those derived from Conventional or Traditional contracts.

Figure 43: 2nd Generation OPRC Contracts were successful due to good preparation and financing *(D361 Road in Choma, 2010)*

Figure 43 above shows the contrast in the preparedness between 1st and 2nd generation OPRCs in terms of resource mobilization as result of lessons learnt along the way. The fact that Contractors are encouraged under these contract regimes to develop designs, work scopes (BOQ) and prepare bids is the reason why most parties, namely the Clients and Contractors favour or support the Output Performance Based Road Contracts (OPRCs). These Contracts if properly determined and examined may be said to conform to the principles of *"Lean Thinking"* and *"Value Management"* which have emphasis on value for money. The Contracts are propagated in the order of promoting value, through value addition activities and waste reduction in the work flow processes.

This study endeavoured to carry out case-studies using the Output Performance Based Contracts (OPRCs), being implemented by the Zambian Government through the RDA in order to assess levels of conformity to *"Lean Thinking"* and *"Value Management"* philosophies. The roads were sampled from the five (5) districts implementing OPRCs in the agricultural potential areas on the pilot basis. The observations made and results obtained from these case-studies would serve as a platform for this study to draw informed conclusions on the benefits and shortcomings of the OPRC strategies perceived to follow *"Lean Thinking"* and *"Value Management"* philosophies.

In order to have variety of comparisons and draw lessons from the achievements gained from OPRCs, some roads Rehabilitated and Maintained through conventional contracts within the same period as those under OPRCs (2009 to 2014) were also captured and observed in the case-studies. Among the roads selected for observation are the Spinal road in Kafue National Park (KNP) and Monze –Niko – Locaniver National Park in Southern province executed under Conventional or Traditional contracts financed from the Nordic Development Fund (NDF) facility of the Nordic Countries and the Zambian Government respectively *(ibid).* Other roads observed which were rehabilitated and maintained through Conventional road contracts are Zimba – Ngwezi-Nyawa, Zimba-Luesi-Ruyala and Katimba – Bbombo – Siatontola also in Southern province. These roads were rehabilitated and maintained on a co-financing arrangement involving the Germany and Zambian Governments through KFW and GRZ funds. Deteriorated gravel road (Choma - Open prison farms) which has now become impassable also formed part of the roads observed under the case – studies (See figure 3).

5.1.1 Output and Performance Based Road Contracts (OPRCs) – The Strategy

As stated in sub section 1.5, five (5) districts were selected as pilot OPRC project sites by the Ministry of Agriculture and Cooperatives (MACO) then, now the Ministry of Agriculture and Livestock (MAL) working in collaboration with the Road Development Agency (RDA). The World Bank (WB)-IDA[54] and European Union (EU) co-financed the project, although the Bank contributed the largest chunk. The Bank funded the OPRC contracts located in Choma, Chongwe and Katete while the EU financed the Chipata and Lundazi projects *(RDA, 2nd Quarter, Report, op. cit.)- (See Figure 44).* The 2nd generation Contracts earnestly commenced in the year 2009 after being cleared by the financing institutions and were expected to last for five (5) years. This meant that these Contracts were to continue until the year 2014. The fact that they were long term contracts, the selected

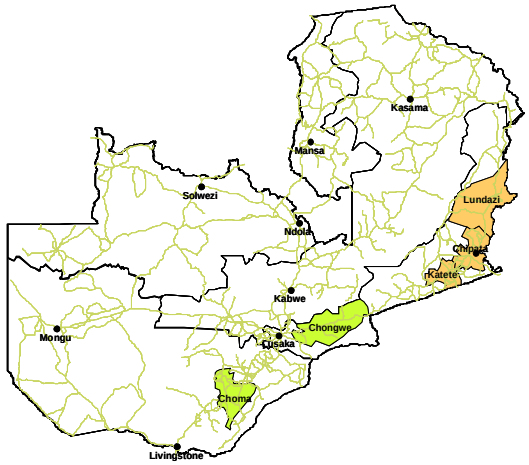

Figure 44: 2nd Generation OPRCs Project Locations on the Zambian Map *(Adapted from RDA, Report, 2011)*

[54] IDA: International Development Agency, an organization for disbursement of funds for developmental projects through or on behalf the World Bank (WB)

gravel roads were to receive uninterrupted maintenance attention and hence keeping them in serviceable states and offer value to customer perspective. The benefits as a result of this arrangement, would be enormous to the expected road users.

5.2 RESULTS and Findings of the Case - Studies on OPRCs for Gravel roads Interviews

The following are the results obtained from case studies conducted on the OPRCs. The study established that the scope of works was grafted in two phases namely; the improvement and maintenance stages. Contractors were expected to make informed decisions on what needed to be carried out under these two scenarios. The nature of these Contracts are said to have followed principles of *'Lean Thinking'* and *'Value Management'* as is reflected in Figures 45 & 46. This could be because the Contracts strategies allowed some form of collaboration and consultation among the parties and placed greater emphasis on value for money for the services emanating from these OPRC Contracts. The other typical feature associated with these OPRC Contracts was that Contractors were paid on the 'Output –Performance' basis. This meant that the Contractors would be paid by unit rate method for Output through the execution of all the works specified in the Bill of Quantities (BOQs) during the Improvement or Rehabilitation stages. Thereafter, the Contractor would then be paid on the basis of meeting road performance by complying with specified service levels through the monthly Lump sum payment method. The motivation for the Client to support these types of Contracts was that there would be less monitoring required, hence registering much financial savings. To the Contractors the benefits accrued through these forms of Contracts were enormous. Among the returns

Figure 45: D361 road before the OPRC ***(Adapted from RDA, Report, 2008)***

Figure 46: A World Bank Official congratulating the Contractor on achieving performance or road service levels compliance ***(Macha road (U20) in Choma)***

realised by the Contractors were that they are to remain in employment for a long period of time and would be paid for minimally ensuring that the roads meet would the road users desired performance service levels (Performance indicators).

The study also established that for these pioneer OPRC contracts, four (4) service levels were applied namely:

- Road accessibility;
- Travel speed (Minimum of 40Km/h to 60 Km/h);
- Road Surface riding quality (Patching of potholes/deformations, depression/rutting and corrugation removal etc); and
- Enhanced durability (Drainage maintenance, Vegetation control, Road level, Road width, Shoulder levels, etc) *(ibid)*.

Through this study it was established that OPRC contracts were said to be operated on the Pull or demand and not pushed to deliver value to customer perspective (See Figures 46, 47, 48 & 49, considering their underpinning principles).

Figure 45: Author/Researcher at the beginning of road D361 at Pemba

Figure 46: D361 road in Choma after improvement through OPRC, 2009

Figure 47: Traffic volume and loads have increased on D354 road in Choma

5.2.1 Case-Study 1: Observations on OPRCs and other Gravel Roads in Southern Province

In Southern province, Choma district was selected and a number of rural or feeder roads were picked for improvement and maintenance under this programme. Among the roads observed

in the case study were the D361 and RD622, U20 and D354 (See figures 45, 46 & 47). Most of these roads led to agriculture potential areas and were at the time of selection in deteriorated state until the implementation of the OPRC Contracts under RRIF of ADSP programme. The state of these roads made it difficult for the farmers to access farming implements and later the markets for their produce, as shown in figure 50. The situation led to the reduction of farming activities in the affected local communities. Further, the food security at household level reduced tremendously and the levels of poverty were said to have reached alarming levels in the affected areas as a result. However, these roads that were rehabilitated and maintained from the year 2009 to date [2014] had turned around this seemingly gloomy picture in these areas. The local communities interviewed confirmed in this study that the realised good gravel roads in the OPRC project areas have eased transportation of local people, goods and services. Consequently, they had boosted economic activities due to the scaling up of farming activities in the communities, thereby reducing poverty levels at household level. The good quality gravel roads had also made accessibility of social services such as schools and health facilities by the local communities easier. However, most local people consulted seemed not to firmly appreciate the value of good quality gravel roads (See figure 47). They felt limited with the benefits accrued from these gravel roads compared to those obtained from tarmac (paved) roads. The bottom line is that the Lean Thinking and Value Management principles were not being fully applied in these OPRC contracts for the users to determine or perceive value as being obtained from these gravel roads which could be at the moment rated as excellent. What was of essence was to involve communities in project stages through collaborative and consultative approach or Participatory Planning Approach (PPA). Lean Thinking and Value Management demanded that expected beneficiaries should be well informed for them to meaningfully appreciate the product value. The culture diversity of Stakeholders needed also to be considered in order to avoid cultural barriers and shocks when disseminating information to the local communities. According to Bovee and Thill (2010), the interaction of culture and communication is so pervasive that separating the two was virtually or almost impossible. It is to be noted that the way one communicates through use of various means such as languages and gestures

Figure 48: Easy movement of farm produce is a new norm on OPRC roads

determines how one is perceived by others. In Lean Thinking and Value Management, ethnicity and cultural alignment of various stakeholders involved with OPRC contracts and other projects are worthy of consideration for effective communication and collaboration. This etiquette seemed to have been missed in the formulating, planning and implementation of the current OPRC contracts, referred to as the 2nd generation OPRC contracts in Zambia.

5.2.1.1 Observations and Findings on the OPRCs and other Gravel Roads in Southern Province

The case studies were conducted on the OPRC project roads in Southern province and which are mainly concentrated in Choma. Observations and interviews were made from the year 2009 to 2014. Roads D361 and D354 were regularly inspected and they made up most of the consensus obtained in the study. The Monze- Niko road, Zimba-Nyawa and Zimba-Ruja roads which were rehabilitated using conventional or traditional contracts between the year 2009 and 2010 were also observed for control and comparison with OPRCs purposes. These roads were funded from the KFW of Germany and GRZ. Visual inspections of the roads were conducted to determine the changing trends in terms of road quality and realised value over time. Special attention was paid to the four performance criterion or service levels stated earlier, being Road accessibility, travel speed, Road Riding quality and durability *(ibid)*. The open structured interviews were conducted among the road users using the gravel roads under OPRC Contracts. The target group for the case study interviews involved the Contractors, Consultants, Road users and the general public and local communities. It should however be mentioned that apart from those who owned or regularly used cars as mode of transportation, most local people interviewed seem not to understand or appreciate the benefits or value of gravel roads in their communities. The following are some of the observations made and findings obtained from the study. The data and information were received from selected road users who were interviewed randomly, on the first come, willingness and availability basis.

Figure 49: Diverted traffic from Monze-Niko road to D361 OPRC road in Choma

Observations and Findings – Choma package

- Most OPRC roads had remained accessible since the year 2009 compared to the roads rehabilitated through Conventional Contracts[55].
- Travel speeds had increased for most of these OPRC roads which in some cases, Vehicles were observed to move at average speeds as higher as 100Km/h and some were observed to go beyond this recorded average speed, a situation deemed dangerous by most road users interviewed. The road users were as a result agitating for speed reduction humps to prevent Road Traffic Accidents (RTA) on these roads.
- Although the Stakeholders (Client, Contractor, Consultant and the Funders) objected to this request, due to the reasons that a number of traffic signs have been erected to warn the users to deter any impending dangers on the road sections, the local communities and road users alike disputed, saying that drivers tended to over look all these embedded road safety features.
- However it, was established during the study that at least five (5) Road Traffic Accidents (RTAs) had been recorded on these OPRC roads due to their good serviceable states which in some cases had resulted in the losses of life, livestock and property.
- Another concern raised by the road users, was that of dust emission due to over speeding by most drivers. This was responsible for polluting air and causing damage to adjacent properties and vegetation such as decolourisation of properties [real estate] and stomata blockage in tree and crop leaves [retarding plants growth].
- The road users urged this author to inform the responsible authorities to seriously look at ways of striking a balance so that good quality gravel roads were granted, at the same time surrounding properties [real estate] and vegetation preserved.
- The Contractor assigned to these OPRC contracts had continued to carry out periodic and routine maintenance[56] to meet the specified service levels in order to escape the effects of penalty sanctions for non performance [not fit for purpose].
- The Client, RDA, had minimised its involvement in the implementation of these contracts since Contractor took full responsibility through the incentives of the Contract Strategy, thus realising some financial savings and reduced risks.

[55] *Conventional Road Contracts: Traditional form of contracts which utilizes Bill of Quantities to execute works and paid through unit rates*

[56] *Periodic and Routine Maintenance: Types of maintenance strategies used in the management of roads. Periodic maintenance happens intermittently say after 3-5 years while Route Maintenance takes place regularly say on the Season cycles.*

- Stakeholders interactively met once in every calendar month to discuss various concerns such as project progress and challenges.
- Since funds had been provided and reserved by the World Bank (WB), through the National Roads Fund Agency (NRFA) which managed the disbursements, there were no major notable financial bottlenecks and challenges.

Figure 50: Chongwe to Chalimbana road before OPRC, 2009 ***(Adapted from RDA, Report, 2010)***

- The Contractor was paid on time as and when the payment claims were approved with minimal delays due to the process of funds transfers, which had to be recouped by NRFA from Washington D.C. in U.S.A, at the Bank headquarters.
- The Contractor cited this arrangement as a minor setback which otherwise could easily be managed through strategic planning of project cash flows.
- The Monze-Niko road which was also rehabilitated in 2009 through traditional form of contracts had ever since badly deteriorated making it difficult for traffic to use it. This had led to the traffic travelling to Namwala from Monze to take a longer route through D361 road branching off at Pemba.
- Traffic volumes had increased on both D361 and D354 roads of Choma compared to the registered drastic reduction of traffic on the Monze-Niko road and the KFW/GRZ funded roads. (See figure 51).
- Most drivers interviewed preferred that roads were regularly maintained to offer perceived quality and prolong life of the improved gravel roads through OPRC contracts in Southern province. (Lean Thinking and Value Management philosophies)
- However other drivers did not consider these roads to have improved in quality of service as they preferred tarred roads and this meant that with such attitudes Government efforts might not be appreciated as perceived value was being determined from the top (RDA) and pushed to the bottom (Road user). This was not

following Lean Thinking and Value Management philosophies, which promoted pulling of perceived value from the Customer-bottom – up[57] planning.

- On the contrary, other road users suggested that the improved gravel roads through OPRC contracts should not be paved, as doing so would bring about great miseries in the affected communities. They were apprehensive and sceptical with the feelings of other road users who preferred these gravel roads tarred. This was due to envisaged catastrophic increase in Road Traffic Accidents (RTAs) due to carelessness and over speeding by some drivers.

Figure 51: Chongwe – Chalimbana road after improvement through OPRC

5.2.2 Case-Study 2: Observations on OPRCs and other Gravel Roads in Lusaka Province

The roads identified to be rehabilitated under the Output and Performance Based Road Contracts (OPRCs) in Lusaka province, were located in Chongwe district (See figures 52 & 53). Like the roads in Southern province, the selected roads in Chongwe district were financed under the Rural Road Improvement Facility (RRIF) of the Agriculture Development Support Programme (ADSP) of the Ministry of Agriculture and Livestock (MAL). The programme budget line was through a loan obtained from the World Bank (WB). As earlier stated, the main objective of the programme was to improve rural roads (gravel) in agricultural potential areas, for

Figure 52: A road in Katete before OPRC ***(Source: Adapted from RDA, Report, 2009)***

[57] *Bottom-up planning: Planning which allows inputs to flow from the lower levels to the higher levels of the supply chain. From the Consumer or Customer to the Supplier or Client and could also be from the Subordinate to the Superior respectively.*

ease transportation of farming implements and products. The Contract in Chongwe district was being implemented by the same Contractor with design and supervision management by the same Consultant for Choma OPRC roads *(Op cit, RDA, 2008)*.

5.2.2.1 Observations and Findings on the OPRCs and other Gravel Roads in Lusaka Province

Unlike the OPRC project in Choma which had allowed for a number of gravel roads to first be improved to be maintained before being placed on a maintenance scheme (Maintenance Management Unit[58]). Most roads selected for improvement in Chongwe were recommended for maintenance only. However, due to the long spell of time between feasibility or identification and the Contract awarding stages, a lot of these roads had deteriorated beyond reasonable service levels (See figures 54 & 55). This therefore called for an intervention similar to the one recommended for the Choma package or better still, stepped up going by the anticipated high traffic volume levels registered due to their proximity status with the city [Lusaka]. It was also established in this study that the late start of the civil works on this package, limited the realisation of substantial benefits compared to the Choma package.

Figure 53: Extraction of construction materials an antidote for gravel roads

Observations and Findings – Chongwe package

Most road users interviewed in this study had expressed mixed feelings on the Chongwe package. Others felt that the programme initially started well but later drifted as the works stalled without achieving tangible results (See figure 53). The delay in the award of the contract led to the change of the work scope which later needed additional funding through Variation Orders. Some of the observations made during the study and data gathered from road users were listed below:

- The roads had improved in the initial stages of the project but later deteriorated due to suspension of works to allow time for the Variation Orders' adjudication as a result of noticeable change in scope of works.

[58] *Maintenance Management Unit: A Maintenance strategy for OPRC Contracts that is used to maintain roads after being improved to serviceable levels.*

- Due to the fact that all the packages (contracts) were awarded to literally one Contractor, the implementation of certain packages such as Chongwe suffered setbacks as operations progress seemed to be skewed to other projects like Choma and Katete.
- The roads in Chongwe, being closer to Lusaka, needed a more comprehensive and proactive approach which required regular attention due to high traffic volumes and loads.
- The Contractor seemed to have lacked capacity in terms of Personnel and Equipment due to being over stretched. The Stakeholders felt that as a way of enhancing Lean Thinking and Value management principles, OPRC contracts needed to be distributed to many Contractors of matched capacity. The current arrangement did not inspire value delivery as the Contractor appeared to be incapacitated due to high work load.
- With the newly launched Link Zambia 8000Km, most of the roads on Chongwe OPRC package had been recommended for upgrading to bituminous standards.

Figure 54: A road in Katete after improvement with OPRC

5.2.3 Case-Study 3: Observations on OPRCs and other Gravel Roads in Eastern Province

This study observed that in Eastern province, only the roads in the Katete package of the OPRC programme proved successful and without much hurdles. Although there was relatively substantial progress recorded for the Chipata package, in Chapangali and Chiparamba areas, this was however short lived as the European Union (EU) suspended funding. This withdrawal of financial support by EU, affected the Lundazi package the study established (See figures 54, 55 & 56). The effects were so devastating that the Contractor lost most of what had been completed and in progress works. This to say the least, did not reflect good Lean Thinking and Value Management approaches as the works needed to be redone when financing was later restored, which was a form of waste. On the hand, it only created the resentment of the methodology and attracted negative public opinion, especially that these were being implemented on the pilot basis with the aim of lobbying support from stakeholders [Practitioners and end users].

Nevertheless, the achievements in Katete area were remarkable with continued funding from the World Bank.

5.2.3.1 Observations and Findings on the OPRCs and other Gravel Roads in Eastern Province

The study also noted that Katete package proved successful with some notable shortcomings. There were some savings recorded on some roads in this package although additional funds were needed especially for the drainage structure improvements which appeared to have been under estimated. This scenario was the same for the Chipata and Lundazi packages despite their suspension of works. It was also established during the study that Contractors were not given ample time to understand the OPRC concept so that they could develop bids that were reasonable and sustainable. It seemed like Contractors priced the bid as for traditional contracts, hence the difficulties incurred during the implementation stage [Business as usual].

Observations and Findings – Katete, Chipata and Lundazi packages

- Stakeholders and road users appreciated the achievements recorded under the OPRC Contracts for the Katete package as the project objectives seemed to have been met.
- Travel speeds increased leading to reduction in journey times and Vehicle Operation Costs (VOCs)[59] as a result of the improved and maintained roads.
- There was remarkable rejuvenation of economic activities on the roads rehabilitated under the Chipata package. New markets for trading in commodities between Zambia and the neighbouring Malawi evolved, as a result of good quality gravel roads.
- Improvement in general connectivity, accessibility to social facilities, movement of people goods and services.
- The under estimating of contracts [low bid prices] was a major concern for many road users interviewed, especially that many drainage structures were left unattended. Many Stakeholders felt that collaboration and consultative process to encourage local people's participation was if any limited. This did not reflect the attributes of Lean Thinking and Value Management philosophies.
- Overly, many Stakeholders consulted and interviewed felt that the OPRCs as a means of managing gravel roads was the right way to go for Zambia as the strategy assured maintenance of roads especially that the Contractor would be available to the project to attend to emerging defects for a long time, [say five (5) years].

[59] *VOCs: Vehicle Operation Costs are costs resulting from Vehicle wear and tear as result poor state of roads which are variable.*

- The suspension of Chipata and Lundazi packages on the seemingly flimsy excuses of lack of funds was regrettable and was the main reason why most gravel roads were in deteriorated states in Zambia. This confirmed that Lean Thinking and Value Management philosophies were to some extent not fully understood and applied in these 2nd generation OPRC Contracts.
- On the negative note, other local people interviewed in the study felt that gravel roads caused degradation of the environment due to continuous extraction of construction materials for gravel road Construction and Maintenance (See figure 55). They also competed with the local people in land, leading to reduction in the available arable land hence retarding economic growth or improvement in the affected areas. This would in the long run affect local communities due to increased poverty levels at household levels (ASCO, 2009 and Muya, 2010).
- Some local people interviewed favoured Construction of tarred roads on which materials would be borrowed from the environment once, but to last for a long time before such a need arose again, thereby giving chance to local people to utilize land economically. Although some sentiments were valid, this researcher had difficulties to appreciate the merits of such assertions or apprehensions.

Figure 55: Spinal Road before Rehabilitation in KNP: the consequences of lack of Sustainable Road Maintenance System-A sign of non application of Lean Thinking and Value Management Philosophies

5.2.4 Case-Study 4: Observations on Gravel Roads from Conventional Contracts point of view in Central and Southern Provinces

In order to make reliable comparisons on the benefits and challenges associated with Output Performance Based Road Contracts and Conventional or traditional road Contracts, this study included two gravel roads which were rehabilitated under Conventional Road Contracts. These roads were the Spinal Road and Monze-Niko/Kalomo – Kabanga located in Central and Southern provinces respectively. The roads were a link to local communities and to the famous Kafue National Park. The works were commissioned in 2008 and earnestly commenced in 2009. The works on these road Contracts were funded by Nordic Development Fund (NDF) and the Government of the Republic of Zambia (GRZ) respectively. These Road Contracts started almost at the same time as the Output and Performance Based Road Contracts (OPRCs) so as to lay unbiased platform for inference of results *(op. cit. RDA, 2008)*. The reason for making comparison was to draw informed conclusions on which type of Contracts ensured sustainability of gravel roads to offer value for money to road users. This also gave this researcher an opportunity to assess from the two types of contracts, the Short term and Long term contracts, which ones were most suitable for gravel roads in line with the research questions in Section D. This also served as a way of assessing from which of the two types of contracts applied some form of Lean Thinking and Value Management philosophies in its operations.

Figure 56: Works in Progress on Spinal Road

5.2.4.1 Observations and Findings obtained from the Spinal Road Contract

The works on Spinal road Contract which were to commence in 2010 were delayed to start due to lengthy procurement procedural arrangements by the Funder (NDF), Funding Agency (NRFA) and the

Figure 57: Researcher inspecting improvement works on Spinal Road

implementing Agency (RDA). In September, 2011 the works formally started for the Spinal road. The scope of works involved installation of drainage structures and road spot gravelling [60]*(op. cit. RDA, 2008)*. Although, it appeared like an experienced Contractor was awarded the Contract, this researcher established that the implementation phase was marred with various challenges. The Contract period was Fifteen (15) months and with extended time of Four (4) months. The Contract was planned to have Twelve (12) months for defect liability period (DLP)[61] after substantial completion. It was substantially completed in June, 2013 and now running into the defect liability period phase (See figures 57-63). The following were the Observations, Findings and data collected from Stakeholders during the study on Spinal road;

Figure 58: Rehabilitated Spinal Road in KNP

Observations and Findings-Spinal road

- It was confirmed by the Contractor for Spinal road that gravel roads were currently not receiving periodic and routine maintenance in Zambia.
- This turn of events had led to the deterioration of gravel roads, which in some cases had made most roads impassable (see figure 55).
- Gravel roads under the former Roads Department regime, were maintained (graded) three times in a year, making it possible for them to remain in good condition.
- Grader and other operators were well trained during the time of Roads Department as a result gravel roads were well maintained.
- The spinal road Contract even if it

Figure 59: Senior Civil Engineering Consultant checking flooded Causeway

[60] *Spot gravelling: Refers to application of selected gravelly material to the formed unpaved road on selected sections.*
[61] *DLP: Defect Liability Period, the time allowed for correction of defects resulting from workmanship in a Conventional Road Contract.*

was completed, it faced a lot of challenges among them delayed payments and work scope variations.

Figure 60: Washed out Spinal Road during 2012-2013 Rainy Season

- Design for this Contract did not capture most of the defects on the ground which led to a lot of challenges during the implementation. The design team did not visit the entire road length as it was inaccessible at the time, thereby making it difficult for the parties to arrive at the design that addressed the Customer or Client needs (see figure 57).
- The Contractor observed that the road design was without its input and most of concerns presented to Client at bidding stage were not incorporated.
- Due to poor designs, the Contractor under estimated the cost of executing works, which caused them lose substantial amount of money as the Client demanded that a road product which would fit for the purpose be delivered in the specified contract period.

Figure 61: Flooded and Soft Spots on Spinal Road due to 2012-2013 rains

- The delay in starting works meant that the Contract which was to experience One (1) rain season would end up going through Two (2) rain seasons (figures 61, 62 and 63).
- This meant that the Contractor had to attend to defects which came as result of the adverse weather conditions which were not covered in the Contract
- The cost for attending to defects resulting from the Two (2) rain seasons (2010-2012 and 2012-2013) was met by the Contractor without receiving additional cost compensation from the Client.

- The unexpected rainfall during the 2012 to 2013 rainy season caused substantial damage to the rehabilitated sections of the Spinal road, hardly a year after (See figures 62 and 63). The Contractor was forced to carry out repair works at own cost, even when the cause of defects could be termed as "Force majeure"[62], *inter alia*.
- The high intensity of rainfall during the 2012 to 2013 rainy season washed out and over flooded some installed drainage structures, causing the Contractor undertake repair works and the Consultant ordering some changes in design, so as to come up with Structures that would cope with the future higher rainfall patterns.
- Alteration of designs by the Consultant with the approval of the Client made it difficult for the Contractor to effectively plan and refocus.
- The Contract which was planned to be completed in Fifteen (15) months, took Twenty (20 months) in instead. This meant that the Contractor had to be tied to this assignment for a period of three (3) years until the defect liability period ended. This was a conventional Contract which expected to operate on a short term basis but it over stretched and the increased cost solely bone by the Contractor.
- It was also established that as a result of these lapses, the Contractor declared a dispute with the Client demanding to be compensated on a number of claims.
- The Consultant and Client found some of the claims by the Contractor erroneous and without merit, though he had insisted and prepared to fight it up to the arbitration.
- There was strained relationship with acrimony between the Contractor and the Consultant as a result, leading to poor collaboration during the implementation stage.
- The Contract arrangement was burdensome to the Contractor as it did not encourage the principle of equity of parties it was observed.
- The payments to the Contractor on works done were delayed as the requests for funds needed to go as far as Finland, the Country where the funds for projects were sourced from (NDF). This payment arrangement caused a lot of cash flow problems and placed the

Figure 62: Deteriorated Monze – Niko Road after rehabilitation in 2010

[62] *Force Majeure: Defects or damage as result of unforeseen circumstances or events, the act of God.*

Contractor in a very awkward situation, as the Contract was expected by the Client (RDA) to run normally and be completed on schedule.

- Since the works were located in the Kafue National Park (KNP), there was a great risk due to the danger paused by vicious wild animals such the big cats. The Stakeholders, such as ZAWA did assist the Contractor in ensuring that security was provided to workers. They were however, asking the Contractor to pay commercial rates for any form of escort ZAWA provided to the workers. The Contractor resorted to risking lives of his employees by entering the National Game Park for road works unaccompanied by ZAWA officials (Game Scouts). This simply revealed that there was no real collaboration and consultation among the Stakeholders at planning and design stages.

Figure 63: Rock out crops on Monze – Niko road

- Lean Thinking and Value Management principles seemed not to be applied in this Contract and it proved to be costly to the Client, Consultant and Contractor.

5.2.4.2 Observations and Findings obtained from the Monze-Niko/Kalomo-Kabanga Road Contract

The RDA in 2008 awarded a Contract for the rehabilitation of the Monze-Niko/Kalomo/Kabanga road. Works involved Road formation, Drainage Structures improvement and regravelling. The road is a major Link to the Kafue Flats (Lochinvar) of Kafue National Park (KNP) *(op. cit, RDA, 2008.* After improvement of this Road, there was remarked reduction in journey time due to increased average

Figure 64: A cyclist using the middle part of Monze-Niko Road as Vehicles use the sides

travel speed. Travelling to the Kafue National Park and Namwala was with minimal difficulties (See figures 64 - 66). However, this study established the following after site visits made in 2012 and 2013.

- The road users confirmed that the road had improved after it was rehabilitated, although this only lasted for a short period.
- After the defect liability period ended in 2011, the road deteriorated and became impassable in some sections and this was worse in the rain season.
- Road users confirmed that most traffic originating from Monze to Namwala, opted to use the D361 road in Pemba which was in good condition as a result of the OPRC programme.
- This researcher gathered that the road had not received any Periodic or Routine Maintenance since it was rehabilitated between the year 2009 and 2010.
- Even if most users felt that a tarmac road would be effective and sustainable in serving their transportation needs, they lamented that regular maintenance would give the road another lease of life.
- The Public Passenger Transporters (Taxi and Bus drivers) complained of the higher Vehicle Operation Costs (VOCs) due to the bad state of the road and this was the reason why they opted to go through Pemba when travelling to Namwala even if it was a longer route.
- Local people complained of transport difficulties to move goods and services as many operators shunned the road.
- They informed this researcher that it was a hassle for Transporters to force their way on the road in order to move farming inputs and products.
- Agriculture had adversely been affected as a result and many local people have given up on farming as an economic activity in the area.

Figure 65: Deteriorated Nyawa road in Zimba

5.2.4.3 Observations and Findings obtained from the KFW and GRZ funded roads Contracts

The other roads visited for the purpose of this study were those rehabilitated through the KFW and GRZ funding in Southern province. Even if the roads eased movement of people, goods and services immediately after they were improved, they have also deteriorated causing road users, great difficulties and discomfort. The roads have lost substantial amount of gravel and rock out crops are dangerously exposed. Like in the case of Monze-Niko road, the road users on these areas are experiencing higher vehicle operation costs as result of the poor state of these roads.

Figure 66: Large stones exposed on Ruyala road in Zimba

Observations and Findings – KFW and GRZ funded roads

- The roads were said to be fair but needed to be worked or maintained due to rock out crops.
- Drainage structures are damaged and these are inaccessible in the rainy season. They needed to be repaired.
- Some road users suggested that gravel roads needed to be graded (maintained) at least Three (3) times a year to ensure that they remained in serviceable state.
- Following the philosophies of Lean Thinking and Value Management, regular or routine maintenance was a way of ensuring continuous improvement so that the product would always be available to the Customer.

Figure 67: Narrowed and Overgrown Ruyala Road

- Another reason why the rehabilitated roads got damaged so quickly, was due to diverted and attracted traffic that needed to access good roads than those in deteriorated states in their vicinity.
- Due to lack of information on the benefits of good gravel roads, most road users preferred tarred [paved] roads.

Figure 68: Corrugations on Ruyala road in Zimba

5.2.5 Case-Study 5: Observations from Consultants on OPRCs and Conventional Road Contracts

Consultant Engineering firms supervising the 2nd generation OPRC in Choma, Chongwe, Katete, Chipata and Lundazi were also interviewed so to obtain their opinions and perceptions on the application of Lean Thinking and Value Management philosophies in gravel roads in Zambia. This was meant to verify and draw comparisons between the views of road users and the Contractors. Other Consultants that were not engaged in any Output and Performance Based Road Contracts (OPRCs) assignments but were perceived to be familiar with the system were consulted too. The following below are the observations made and findings obtained from the study;

Observations and Findings – Consultants [UWP and ASCO]

- There was general consensus that gravel roads in Zambia required OPRCs for them to attain serviceability at all times. OPRCs strategy was the best way to go because gravel roads are susceptible to deterioration.
- It was noted that longer defect liability period would assist much than the current arrangement. Although there was apprehension that increasing defect liability period for Conventional Road Contracts would make things unbearable for the already struggling Contractors. This would also be the reason why OPRCs should be recommended for adoption in Zambia with much incorporation of Lean Thinking and Value Management philosophies in the work processes.
- Lean Thinking and Value Management philosophies are not well perceived and therefore currently not effectively applied in Zambia.

- The current OPRCs were initiated on inadequate designs which led to unnecessary Variation Orders (VOs). Road designs should also be collaborated and of integrated approach by various stakeholders from conceptual to implementation stages of projects.
- The Contractor inputs in designs at the initial stages were necessary for perceived value awareness and design ownership, thereby reducing or avoiding unnecessary claims and disputes during the implementation phase.
- The local people in Communities where gravel roads are to be Constructed or Maintained need to be involved in the selection process of which roads will be of much priority in the event that there was limitation on the available funds in the budget. The local people being direct beneficiaries or users would be well placed to know which roads were of most importance compared with others in the affected areas. The current OPRCs did not effectively encourage local stakeholder participation at planning and design stages, later alone at implementation stage. The danger is that local people would not have full ownership of the improved roads facilities since they may not appreciate the processes involved and level of investment ploughed into the exercise.
- Initially the Contractor (s) engaged on the current OPRCs did not fully appreciate or understand their nature and attributes. With the passage of time, valuable lessons have been learnt for better future encounters. (Contractors and Consultants alike need more knowledge in OPRCs, Lean Thinking and Value Management).
- OPRCs if implemented to Lean thinking and Value Management philosophies, may reduce degree of deterioration and hence ensuring better road service levels to users.
- The current 2nd OPRCs are performing well but are not without challenges and shortcomings being pioneer models.
- Work scope for drainage structures were under estimated for all the packages under the current OPRCs. Insufficient funds had made it difficult for most of the damaged structures to be repaired. This is as a result of lack of credible and real collaboration and value management among the stakeholders, which led to having poor and inadequate designs.
- The Client should pay aptly Interim Payment Certificates (IPCs) to ensure adequate, stable and steady cash flows to support project needs and ensure continuous flow

and improvement (Kaizen)[63] in line with Lean Thinking and Value Management philosophies.

- Parties should ensure that there is serious consideration on achieving accurate costing for the OPRC contracts with the availability of contingence fund window, to serve as budget safeguards to address unforeseen and overlooked needs.
- It was established without doubt that OPRC strategy was a new concept and not all stakeholders are aware of its principles in Zambia. However, Contractors involved in the 2nd generation OPRCs were emerging as champions in managing them.
- Contractors are now able to draw a line between Rehabilitation (Improvement works) and Maintenance through the use the Maintenance Management Unit vehicle.
- Most Consultant Engineers observed that there was need to include more penalty measures or clauses in the OPRC Contracts that would be evoked to punish Contractors failing to meet specified performance criteria. The current OPRCs which had emphasized on travel speeds as means of gauging performance did not inspire improvement in road product perceived value.
- In their current form the 2nd OPRC generation contracts lacked clauses that compel the Contractors redo badly performed works. The emphasis was more on "Performance" than "Output" criterion. To align these Contracts to Lean Thinking and Value Management philosophies the "Output" component of this contracts should be refocused in order to add more value to the road product at improvement phase before initiating maintenance of road facilities.
- It was noted from Consultants that currently some OPRC contracts being implemented by RDA, were not meeting service levels due to lack of funds from committed budgets.
- There must be consideration for funds to cater for emergences that may occur from unforeseen circumstances, such as 'Force Majeure'.
- There was need to provide a portion of contingency funds in the OPRC contracts to be used in addressing defects that come as a result of force majeure, unlike the current OPRCs being implemented by RDA with the support of the World Bank (WB) funding.
- Most Consultant Engineers observed that to curb the current situation where gravel roads remained in bad state of disrepair in Zambia, promotion of Output and

[63] *Kaizen: This is a Japanese word which continuous improvement through use of Lean Thinking and Value Management principles in order to meet Customer perceived value or need.*

Performance - Based Road Contracts (OPRCs) was the only way to ensure that road facilities were preserved as well as granting their better connectivity and serviceability to road users.

- It only makes economically sensible that most of the gravel roads in Zambia could perform better if OPRC contracts were used in maintaining them to survive the time between now and when the opportunity for them to be upgraded to bituminous standards was feasible.
- Much as it was the desire of many stakeholders that most gravel roads should be upgraded to bituminous standards in Zambia, the reality cannot be overlooked. There are a lot of roads on the Zambian road network (about 80%) of gravel standards. Government might not have ready financial resources to have all these backlog of gravel roads to be immediately improved to paved standard.
- The increase in the number of roads attaining paved status out of the Zambian road network (Link Zambia 8000) also means that there would be great strain on the Zambian annual budgets to ensure that these roads were well maintained. This would in return work against the Government policy of wanting to have many gravel roads improved to all weather bituminous or paved standards.
- Consequently and naturally some roads would as a matter of fact remain in their current gravel surfaced conditions, with the only hope for them to survive through the OPRC strategies, if not they risk to drift into oblivion and cause the country to backpedal on its attained achievements in the road sector.
- The other concern is that new settlements are bound to be developed or established in Zambia. It is common knowledge that except on few cases most roads would start as gravel until when they have met economic viability that they are upgraded to paved standards. It is the time when they are being assessed for economic benefits on envisaged demand of investment, that Output and Performance Based Road Contracts would be critically and appropriately positioned for the Country.

5.3 THE OPRC MODEL –Gravel Road Construction and Maintenance in Zambia

The Case studies conducted on the 2nd generation OPRCs on Construction and Maintenance in Zambia in this study, suggest Model that need developed for adoption for future projects. Before delving on the proposed OPRC Model, it necessary that OPRCs and Convention Contracts are compared to reveal attributes of Lean Thinking and Value Management philosophies and wastes associated with Traditional Contracts. A review of typical Project

Lifecycle (5 Phases), namely, Strategy, Feasibility, Definition, Execution and Commissioning/Handover needs to be examined in terms wastes (Burke, 2013). The OPRC Project phases for gravel road Construction and Maintenance in Zambia will thus be interrogated so as to expose associated wastes and how they could be reduced through "Strategic Lean Thinking and Value Management philosophies".

5.3.1 OPRCs and Conventional Road Contracts-Comparisons

The Case studies' observations have highlighted features of Conventional Contracts and OPRCs. The Conventional Contracts utilize Bill of Quantities and Contract specifications to satisfy Customer perceived quality and value. This is based on the amount of work done and measured and is paid for on agreed unit rates of different work items. By contrast OPRCs define minimum road conditions [Performance service levels] that are to be met by the Contractor to satisfy the Road User perceived needs (Zietlow, 2007). OPRCs therefore, uses the pull system to deliver Customer perceive quality and value. Womack and Jones (2003), asserts that pull system is a principle of the Lean Thinking and Value Management philosophies which aims at delivering value at the customer pull. The table 12 below compares Conventional contracts and OPRCs to reveal perceived wastes in the project phases:

Table 12: Conventional contracts and OPRCs for gravel roads - Comparisons

PROJECT PHASES	CONVENTIONAL CONTRACTS [a]	OPRCs [b] LT & VM	OUTCOMES	COMMENTS Pull/Push
Strategy	The Client strategic fit, sets out what needs and intended benefits through "Top-Bottom" and "Feedback" Planning.	The Stakeholders [Clients, Contractors, Consultants and Road Users] feed into the strategy through "Bottom – Top" and "Feed-forward" Planning.	**[a]** The Client determines what to be done. **[b]** Users feed into the Clients plan. **[a]** Done swiftly. **[b]** Takes time.	**[a]** Waste as this is Push system. **[b]** Value as this is a Pull system. **[a]** Waste as it is not exhaustive. **[b]** Value as this Pull system.
Feasibility	The Client sends out its staff [Engineers] to conduct gravel road conditions surveys.	Stakeholders are involved in the conducting of road conditions surveys.	**[a]** Data collected sometimes is devoid of Road User inputs.	**[a]** Waste as this is Push system, it does not pull from the User.

			[b] Inclusive approach – PRA.	**[b]** Value as this is Pull system.
Definition	Client develops the BOQs and Specifications. Client proposes time (Contract duration) from BOQs and Costs [Quality, Quantity & Time].	Contractor determines the Quantity of Work which the Client approves. He also proposes Time and Quality to User needs. (The Users are consulted.	**[a]** Client determines inputs alone. **[b]** Stakeholders determine inputs together. (Collaboration and Consultation are the Key drivers).	**[a]** Waste as a lot of Variation Orders and Time overruns emerge. **[b]** Value as Variations and Time overruns are minimized.
Execution	Short term with DLP and much involved of the Client. The Conventional Contracts treat Gravel road construction and maintenance as if they are for paved roads.	Long term with DLP as part of Contract period and reduced Client involvement. The constructed gravel roads are maintained.	**[a]** Lack of sustainability of gravel roads service/performance **[b]** Sustainable performance of gravel roads and User satisfaction.	**[a]** Waste as gravel roads deteriorate after first rain season **[b]** Value as there is maintenance.
Commission	Client pushes Contractor to complete.	Contractor is motivated to complete within OPRC time frame	**[a]** Reactive approach **[b]** proactive approach	**[a]** Waste as this is Push system **[b]** Value as this Pull system

5.3.2 OPRCs - Lean Thinking and Value Management Model

The Study proposes the OPRCs Model that would assist in making the "Strategic Lean Thinking and Value Management philosophies" effective in the Construction and Maintenance of gravel roads in Zambia. The suggested model anchored on the attributes of Collaboration and Consultation of the Lean Thinking and Value Management philosophies. This uses Participatory Review Action or Participatory Learning Appraisal (PRA or PLA) as proposed by Mulwa (2008). The OPRCs Model was generated from Case study results. Zietlow (2007, p.4) gives the following main reasons as the drivers for implementing OPRCs:

- Reduction of Maintenance costs application of more effective and efficient technologies and work procedures;

- Provide transparency for road users, road administrations and contractors with regard to the conditions of roads to be maintained;
- Improve control and enforcement of quality standards; and
- Improve overall road conditions and road user satisfaction.

The above stated reasons for promotion of the implementing of Output Performance – Based Contracts (OPRCs) indicate Lean Thinking and Value Management philosophies the main drivers. This is because they follow the order of the pull systems [LT & VM] through use of the attributes of real Collaboration and Consultation. The OPRCs Model [Two Pillars] for the Construction and Maintenance of gravel roads in Zambia is set out in Figure below:

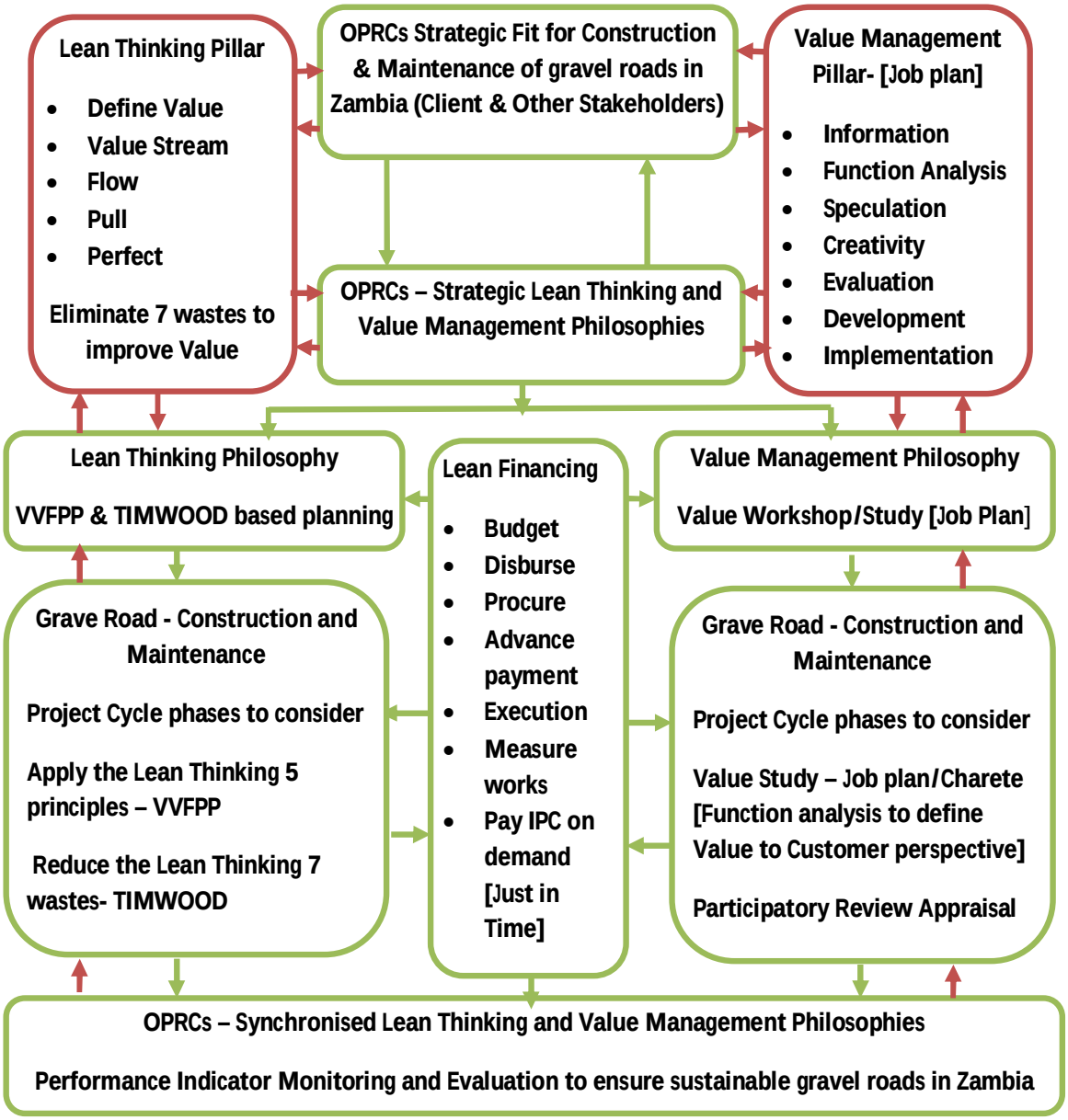

Figure 69: OPRCs Model – Lean Thinking and Value Management philosophies

5.4 CONCLUSION-Findings and Presentation

After thoroughly conducting the data analysis, the study revealed from the research questions that most stakeholders had the following opinions;

- The parties or stakeholders in the Zambian Road Construction industry have little or no knowledge about the *Lean Thinking* and *Value Management* philosophies, hence, the philosophies/principles are currently not applied in Gravel Road Construction and Maintenance projects.
- *Lean Thinking* and *Value Management* disciplines are not well appreciated by most Road Contractors engaged for Construction and Maintenance of gravel roads, that they required much knowledge in this area for best results in delivering or offering services that would satisfy the needs of road users.
- OPRCs are based on *Lean Thinking* and *Value Management* principles which need enhancement to improve quality of gravel road Construction and Maintenance projects in Zambia (i.e. through case study on the World Bank funded OPRCs).
- Strategic application of *Lean Thinking* and *Value Management* principles can lead to improvement of quality of gravel road Construction and Maintenance projects in Zambia (i.e. Project life cycle stages).

Most of the perceptions and opinions received from the Stakeholders indicated that *'Lean Thinking'* and *'Value Management'* were new philosophies in Zambia. It was also noted that due to lack of knowledge in *'Lean Thinking'* and *'Value Management'*, gravel roads were not well maintained. Most stakeholders none the less, appreciated the benefits that could be drawn from the principles of *'Lean Thinking'* and *'Value Management'* as key drivers to good gravel roads in Zambia. This notwithstanding the fact that Value philosophies, have been in existence in North America [USA and Canada] since the 1940s as Value Engineering (VE) which operated under the name Society for American Value Engineers (SAVE). The UK Value Engineering Association (VEA) was established in 1966 but later in 1972 changed its name to the Institute of Value Management (IVM). Australia and Hong Kong [Asia] established Value Management hybrid body from the SAVE and IVM called Institute of Value Management for Australia and Hong Kong (IVMAHK/AHKIVM) (Kelly, Male and Graham, 2004: p.11). This therefore, dispelled the notion that Value Engineering (VE) and Value Management (VM) are new phenomena in the world as held by most research respondents. The assertion however, could not be understated as it clearly demonstrated that Lean and Value

Management theories have not to a greater extent been grasped by most stakeholders in Zambia. This study is therefore an ice breaker in these value enhancing management disciplines with the belief that they would be well and elaborately inculcated in most stakeholders involved with gravel roads to be fully adopted as value enablers or drivers.

The data analysis revealed that gravel roads were important in terms of economic growth and connectivity of most agriculture potential rural and out laying or far flung areas in Zambia. It was also brought to the attention of this researcher, that gravel roads form the larger part of the Zambian road network and are in deteriorated state (RDA, Annual Reports, 2008-2010). Further, gravel roads are not receiving strategic road maintenance (Routine and Periodic Maintenance) and this is why they were in poor conditions. On the issue of suitable mode of Construction and Maintenance contracts to be employed in gravel roads in Zambia, the research data analysis revealed that the Conventional or Traditional (Short term) were not suitable. Long term road Contracts such as the Output and Performance Based Road Contracts (OPRCs) like the ones being implemented by the Road Development Agency on a pilot basis could be most preferred form of contracts for the Construction and Maintenance of gravel roads in Zambia. This according to the perceptions of most Stakeholders in the road sector interviewed indicated that *'Lean Thinking'* and '*Value Management*' philosophies were the pillars of Output and Performance Based Road Contracts as they ensured delivering Value to Customer perspective. It was also established that Value and Quality of gravel roads were determined by the Clients and Funders. Most designs implemented by the Road Development Agency did not receive input of the other Stakeholders such as Contractors and Consultants as observed from this study. This was as result of poor or no real collaboration at planning and design stages among all the Stakeholders in the road sector. For gravel roads to be brought to better serviceable levels, *'Lean Thinking'* and *'Value management'* philosophies should be adopted and be properly applied in the Output and Performance Based Road Contracts in Zambia. Finally, having given a discourse of the research findings and results in Chapters Four and Five, the last Chapter is presented as a Thesis epilogue. The major strides or discoveries made in this study are included in Chapter Six, which also consists of the major research conclusions and recommendations. It also forms the summary episode of this study, for which it becomes uniquely indispensable to the whole research process.

'The Right process will produce the Right results' (Liker, 2004).

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

This chapter gives the conclusions and recommendations of the study. Based on the data used and results collated in this study, it was found that Lean Thinking and Value Management philosophies were not fully comprehended and therefore, not well incorporated in the work flow processes in the construction and maintenance of gravel roads in Zambia. Currently, stakeholders in the road sector lacked meaningful and real collaboration in the planning and designing of Contracts for construction and maintenance of gravel roads in Zambia. This was according to most respondents, the reason why most Contracts were perceived to be poorly drafted and hence exhibited numerous flaws such as vague specifications and inadequate project budget provisions. Most Contracts used in the construction and maintenance of gravel roads failed to be executed within the initial approved project completion time, the study revealed. For projects to be completed, Variation Orders (VOs) had to be granted by the Client, culminating into extended project time and blotted budgets, hence making it costly for Government and the Cooperating partners [Funders]. Further, the following were observed;

Firstly, most Stakeholders/Respondents reached out to, in this study, expressed and confessed to the notion that Lean Thinking and Value Management were new philosophies to them and the world at large. They also indicated that most organisations were just learning these philosophies and therefore most stakeholders had if anything, very little or limited knowledge in the disciplines of Lean Thinking and Value Management. Some respondents such as Engineers argued that the basics of strategic Lean Thinking and Value Management were not alien in Construction as the knowledge gained from Project Management techniques could offer the same mitigation as obtained from LT and VM philosophies. Although this view could not be totally misplaced or dispelled, it nonetheless, missed the intricate factor that Lean Thinking and Value Management principles were not discrete tools of management but a combination of many disciplines which were in the emergent stages, always kept mutating and improving. To assess perceptions on Strategic LT and VM philosophies as applied in Construction and Maintenance of gravel roads, the target group [sample] had to be an inclusive one so as to avoid biasness in the responses that were to be obtained. Hence, Clients, Consultants, Contractors, Trainers and Regulatory bodies and other stakeholders in the road construction industry in Zambia, were the key respondents in this study.

Secondly, the study looked at the philosophies of Lean Thinking and Value Management with the view of incorporating them in the enhancement of the construction and maintenance of gravel roads in Zambia. When investigating and exploring Lean and Value Management, it was necessary to consider four cardinal factors in the area of Construction Project Management in general. Some Four disciplines Construction Project management and Business management namely; Lean Thinking, Value Management, Output and Performance Based Road Contracts (OPRCs) and Collaboration formed the main basis of questionnaire development for the study. This is with the premise that Gravel Road Construction projects in Zambia have been realised through use of Contracts such as admeasured; by use of Bills of Quantities (BOQs), the Lump sum, Cost plus, etc. Despite all the attempts made to improve the system, the Road Construction Industry has failed to get the best value for money through the use of conventional type of Contracts. The Study Literature review, revealed that the reason for this failure according to Womack and Jones (2003), 'is that it was hard to define and realise value, partly because most Producers (Contractors) want to make what they are already making and partly because Customers only know some variant of what they are already getting'. The study established that Lean Thinking and Value Management would therefore, be a great catalyst to better Road Construction and Maintenance project delivery for which the Zambian Construction industry and end users would stand to benefit from.

After analysing data obtained from the research question area under Section B, it was observed that most respondents held the opinion that the knowledge and practices of *"Lean thinking"* and "*Value Management*" philosophies were not well established and perceived by the parties or stakeholders in the Zambian Road Construction industry, namely, the promoters or owners, the financiers or funders, the Trainers and Regulators, the Designers or Consultants and the Contractors.

Another thing considered to be important issue, was to look at the research question area under Section C. As presented and adduced in Chapter Four, to a larger extent, the position taken by most respondents was that it could be true that Value Management was a new philosophy for gravel roads in Zambia and therefore, not being taught fully incorporated in the training curricula. The other question area under Section D investigated by the study was that, to do with Output and Performance Based Road Contracts in the gravel road construction and maintenance in Zambia. It could be depicted that, the current Contracts used in gravel roads were not preferred and suitable for gravel roads in Zambia. Almost all respondents had the opinion that Output and Performance Based Road Contracts (OPRCs)

were most suited for gravel roads going by the revelation of data analysis and results of the study. There was therefore, need to have OPRCs incorporated in gravel road management.

Another issue thought of worth of importance to consider in the study, is the general collaboration among stakeholders in road construction industry in Zambia covered under the question area Section E. From the results obtained after data analysis for question area Section E, it could be deduced that there was lack of real collaboration among road stakeholders including those involved with gravel roads. This study revealed that real Collaboration was lacking among stakeholders and this could be one of the reasons why most gravel roads were in poor conditions in Zambia. It could not be over emphasised that, there was need to enhance Collaboration strategies amongst stakeholders for the gravel road construction and maintenance contracts in Zambia. The study also considered the area of general management of gravel roads in Zambia through research question area Section F. After the analysis of the data the results indicated that a high number of the respondents interviewed, held a view that gravel roads required strategic maintenance [OPRC] so that they could remain in serviceable state to provide a better service to the road users in Zambia.

As already observed in the data analysis, most of the perceptions and opinions received from the Stakeholders indicated that Lean Thinking and Value Management were new philosophies in Zambia. It was also noted that, due to lack of knowledge in Lean Thinking and Value Management philosophies, gravel roads were not well maintained. Most respondents appreciated the benefits that could be drawn from the philosophies of Lean Thinking and Value Management as key drivers to good quality gravel roads in Zambia. The data analysis revealed that gravel roads were important in terms of economic growth and connectivity of most agriculture potential rural and out laying or far flung areas in Zambia. It was also established in the study, that gravel roads form the larger part of the Zambian road network and are currently in deteriorated state (RDA, Annual Reports, 2008-2010). This study further revealed that Output and Performance Based Road Contracts, were favoured by most respondents to be suitable for the maintenance of gravel roads in Zambia.

6.2 Main conclusions

The study established that there is a good number of Stakeholders in the road sector in Zambia, who are not very conversant with *"Lean Thinking and Value Management philosophies"*. This could explain the reason why these philosophies are not being strategically applied in the construction and maintenance of gravel roads in Zambia. The

respondents held a view that *"Lean Thinking and Value Management philosophies"* were very important drivers to enhancing value and quality delivery of gravel roads in Zambia. They however, also pointed out the fact that *"Lean Thinking and Value Management philosophies"* were relatively new in Zambia and therefore were not well perceived by most Stakeholders in the Road sector. It was upheld by most respondents in the study that "Lean Thinking and Value Management philosophies", if strategically applied and adopted, would improve the methods of construction and maintenance of gravel roads. This would also ensure that Value to customer perspective for gravel roads was delivered and the strategies sustained. The study observed that Output Performance Based Contracts (OPRCs) are based on Lean Thinking and Value Management philosophies which should be enhanced so as to deliver Customer perceived value to road users. The current OPRCs even if they recorded some remarkable results in as far as the value and quality of gravel roads in Zambia are concerned, most of the stakeholders involved lacked much knowledge in Lean Thinking and Value Management philosophies that could have otherwise enhanced the processes output. It was also acceptable to most stakeholders included in the study that, much dissemination of knowledge in the areas of strategic Lean Thinking and Value Management philosophies were necessary to all Stakeholders involved with the construction and maintenance of gravel roads in Zambia. It was also established in this study that the Training Institutions should take up the initiative of incorporating LT and VM philosophies into their curricula and programmes. Doing so would not only enlighten but also equip the learners who would later be after graduation, involved in the construction and maintenance projects for gravel roads. Collaborative planning that involved all Stakeholders should be encouraged throughout the Whole Life Project Cycle phases (Inception to implementation through to commissioning phases). This would improve planning for gravel roads in Zambia as this would enhance bottom up planning, an etiquette feature of Lean Thinking and Value Management philosophies. Much as upgrading of gravel roads to bituminous standards was a welcome initiative, as this would improve and further spur economic growth and development, the study however, noted that this should not be at the expense of abandoning high value gravel roads. It was established that gravel roads are as equally important as paved roads in terms of economic benefits, although most of them are currently in deteriorated states due to poor or deferred maintenance the reason why OPRCs were to be promoted in Zambia. Further, it was also established by this study that Output Performance Road Contracts for gravels roads in Zambia would only enhance benefits when stakeholders take on board the Lean and Value philosophies in their various preparatory programmes. Clients should at all costs avoid

pushing road products to road users but should endeavour to pull from the customer demand. This is with the view that the Customers are in a position to know what they need even if they may not on the onset define their perceived product value. With some real collaboration and consultation with the Producers, they will certainly be enlightened and are able to properly define the product value that would satisfy their needs before delivery. This would be the case with the construction and maintenance of gravel roads in Zambia. It was found out in the study that the Customer according to the Lean Thinking and Value Management philosophies, is not only limited to the Road users but could also be Contractors, Clients and Consultants depending on the needs at hand in the work flow processes. This study is therefore, a foundation for solving most problems facing gravel roads in Zambia.

6.2.1 Findings and Inferences

In summary conclusions, through this study '*Strategic Lean Thinking and Value Management for the Construction and Maintenance of Gravel Roads in Zambia',* a number of issues were raised and observed for which some of the findings and inferences are listed as follows;

- Most stakeholders were of the opinion that Lean Thinking and Value Management philosophies were new for most Countries in the world including Zambia.
- Lean Thinking and Value Management philosophies are relatively new for most Organisations in Zambia and therefore not effectively used in the Construction and Maintenance of gravel roads, including the Output and Performance - Based Road Contracts (OPRCs).
- It was argued by most respondents that most Contractors did not very well appreciate the Lean Thinking and Value Management philosophies. However, there was overwhelming consensus that much knowledge was needed to be provided to most Contractors if they were to construct and maintain gravel roads that delivered value to customer perspective.
- Other respondents felt that Lean Thinking and Value Management philosophies could have been applied in most road projects through project management philosophies though not effectively.
- The study discovered that OPRCs were anchored on *Lean Thinking* and *Value Management* philosophies which needed enhancement to improve quality of Gravel Road Construction and Maintenance projects in Zambia. The current OPRCs were not performing as anticipated due to poor application of Lean Thinking and Value Management philosophies in the projects value chain or steam. From the "Lean

Construction standpoint Value dynamism is the governing principle for product delivery to Customer".

- Some study respondents did not absolutely agree with the assertion that strategic *Lean Thinking* and *Value Management* philosophies could alone lead to improvement of quality of Gravel Road Construction and Maintenance projects in Zambia. They strongly believed that there were a lot of factors at play, which might be responsible for poor Construction and Maintenance of Gravel roads Contracts; among them poor project financing through delayed payments by the Client (e.g. RDA and NRFA). The OPRCs Model considers the Lean Financing as the central driver on which LT and VM depends.
- The study observed that most respondents felt that there was no meaningful or real collaboration at planning and design stages among the stakeholders in the road sector. Perceived value and quality were considered a preserve for the Clients, Donors and Regulating Agencies. Top to bottom planning, was used leading to drafting Contracts that lacked valuable inputs or contributions from the Contractors, Consultants and end users.
- The study observed that Local communities were mostly not involved in the selection of roads to be improved and therefore, they [locals] felt left out and their involvement in the managing and safeguarding rehabilitated gravel roads would be of no consequence as they were not part to project formulation in the initial stages and hence lacked ownership.
- Most stakeholders affirmed the belief that gravel roads were among the most important public assets and that they [gravel roads] were key drivers in Zambia's eventual development in terms of the economic growth and connectivity of agricultural potential rural communities.
- Other findings in this study were that currently, most respondents felt that Training Institutions did not fully and clearly incorporated effectively Lean Thinking and Value Management philosophies in their Management curriculum and as such Engineers and other road practitioners lacked appreciable knowledge in such areas, the reason why gravel roads were not being given appropriate maintenance strategies [OPRCs].
- The study established that the current short term or conventional road contracts being used in the construction and maintenance of gravel roads, lacked merit and were not appropriate for the kind of roads. It was overwhelmingly accepted that the Output performance Road Contracts (OPRCs), which are long term, (5 to 10 years) were most suited for gravel roads and should be enhanced and adopted as the right means of construction and maintenance of such types of roads.

- The case studies conducted, revealed that roads improved and maintained through Output and Performance - Based Road Contracts, remained in good condition for a long period of time compared to roads improved at the same time using traditional or conventional road contracts. This is the reason why in some cases traffic volumes and flow increased.
- The Output and Performance - Based Road Contracts (OPRCs) being implemented in Zambia, somehow failed to realise and deliver best value for road users (Customer) due to the fact that their efficacy were not well appreciated. Contractors were excited to have contracts that were long term but never on the onset appreciated the associated risks.
- This study also discovered that most road users did not fully appreciate value driven from good gravel roads; they instead recommended or preferred to have them tarred than maintaining their status quo [gravel standards].
- Another reason for resenting gravel roads was that local communities felt economically, physiologically and psychologically affected or threatened in that they abhorred competition in terms of extraction of construction materials leading to depletion of land which was a valuable asset to support their economic activities through agriculture. Bituminous surfaced roads would therefore, be opted as their life spans were longer than gravel roads hence the interval or frequency of extracting material would be minimal.
- This notion was compounded by the latest Government public policy which encouraged upgrading of gravel roads to bituminous standards through the programmes such as “Link Zambia 8000”, “L400” and “Pave Zambia 2000” (RDA, 2012).
- The study also revealed that paved roads were favoured by most local communities (road users) interviewed in that they [locals] perceived increased number of vehicles flowing into their community as a result (developed, generated and attracted traffic), situation which might lead to a reduction in the cost of transport as many Public Bus Operators (PBO) would venture to conduct transport business in such areas and thereby suffer the effects of competition, causing them to reduce bus fares in order to gain competitive advantage over their business rivals (Scarborough, 2011, pp.106 -107).
- Other respondents (Commercial Farmers) however, favoured gravel roads for the different reasons to the one given above, they felt that if gravel roads were upgraded to paved standards there would be a higher influx of vehicles which might lead to noise pollution of the environment which could cause distress to the livestock and negatively affect production levels on their Farm lands and Ranches.

- For OPRCs to be effective, gravel roads earmarked for maintenance should firstly be improved or rehabilitated to serviceable standards. Sound preparations should be put in place before road project implementation. Poor or rushed up designs will only result into catastrophic consequences and OPRCs would hardly realise desired benefits.
- Paved roads are seen to be a form of development which to the local people was translated into improved social status of local communities (Burningham and Sankevick, 2005). This could be one of the causes for gravel roads resentment by most road users.
- The other intricate factor is that of health and safety which became compromised as a result of good gravel roads due to over speeding by some irresponsible or uninformed road users (drivers), leading to dust emissions and high rates of Road Traffic Accidents (RTAs). Gravel roads are abhorred, mostly due to the problem of dust emissions.
- High levels of vandalism was also observed in this study, since most of the gravel roads are located in rural and outlying areas, without formal institutions to ensure security of people and property, through law enforcements (Zambia Police Service). Road traffic signs installed or erected as road accident mitigating measures were with impunity vandalised or stolen, leading to a horrendous situation.
- Another factor that was noted was that of attitude among the local communities which did not promote responsible behaviour to safeguard public property. Champions are required to effect a paradigm shift or provide change management. There is need to mobilise and encourage local communities to ensure that ownership of public properties or assets become an acceptable norm and way of life for most them through strategic LT and VM.
- Training of local people was lacking in the current methods of constructing and maintaining gravel roads as Contractors recruited people outside the local community, leading to making the locals agitated and therefore deliberately or genuinely failing to appreciate the benefits. Lean Thinking and Value Management philosophies encourage growing leaders within the Organisation and Project locality to provoke ownership among workers and stakeholders internally. This strategy is supported by Lean Thinking principles No. 9, 10, 11 and 12 of Toyota Production System (TPS);

  > *Grow your Leaders who thoroughly understand the work, Live the philosophy and Teach to others", "Develop exceptional people and teams who follow your Company's philosophy", Respect your extended Network of Partners and Suppliers by challenging them and helping them improve" and "Go and see for yourself to Thoroughly understand the situation – "Genchi Genbutsu[64] (op.cit, 2004).*

[64] *Genchi Genbutsu: Japanese term which encouraging observation of work or production flow without preconceptions and with a blank mind. Repeat "why" five times to every matter (Liker, 2004).*

- Client exhibited delayed payment of Interim Payment Claims (Certificates) tendencies and misplacing or poor paper trail of important contract documents. Some members of Staff lacked knowledge in the Output and Performance - Based Road Contracts (OPRCs) currently. This is not in any way fitting with an appreciated principle No. 3 of Lean Thinking, from Toyota Production System (TPS), *"Kanban, Use 'Pull' Systems to Avoid Overproduction and delays" (op. cit. 2004).*
- The current forms of Contracts were not fairly implemented as penalty clauses in accordance with General Conditions Contract (GCC), could mainly only be evoked from the Clients' side. The Contractors currently employed by RDA under 2nd generation OPRC Contracts were naive to evoke penalty clauses if the event that Client defaulted. This is due to their vulnerable position of fearing to be blacklisted if they did otherwise.
- Output Performance - Based Road Contracts (OPRCs) encourage long term investment hence discouraging Capital flight. Since they are carried out over a long period of time (Say 5 years and over), this may encourage local participation as foreign Companies may see this strategy as a drain on their operational capital as they would be compelled to establish themselves well enough locally for them to participate in these type of Contracts.
- Where there is local participation [local companies], it could as well mean that these might spur economic development as investment returns could be reinvested within the Country and avoid externalisation of funds as is the case at the moment from some foreign companies involved in the Construction and Maintenance of Gravel Roads in Zambia.
- The study noted that OPRCs are difficult to sustain & requires champions for success.

6.2.2 Required interventions

- As most Stakeholders in the road sector (Construction and Maintenance of gravel roads) felt that Lean Thinking and Value Management philosophies were new and hence not well perceived, it is important to enlighten them of the LT and VM philosophies with the main aim of incorporating them in various road projects in Zambia. According to Womack and Jones, (2003, p.10-17), the term "Lean Thinking" is believed to have first been coined in the early 1990s. Although the philosophy is still in the infancy, it is definitely not new in the Project and Business disciplines, [1940s Lean production].

- Although most Respondents (Stakeholders) interviewed in this study felt that they had good perception of Lean Thinking and Value Management philosophies, it was clear from the findings that a good number lacked knowledge in these philosophies. There is need therefore, for much popularising of the strategic Lean Thinking and Value Management philosophies and sensitization of various Stakeholders involved with the Construction and Maintenance of gravel roads in Zambia. The issue of enhancing value to customer perspective need not to be overemphasized, hence Stakeholders should be informed on how Value in road projects could be added or created in order to largely satisfy the end users. The OPRC Model for gravels presented under section 5.3.2 attest to this opinion.
- It should also be noted that "Lean Thinking and Value Management" are not ends in themselves or destinations; they are a journey that could only be realised through ingredients of Stakeholders right mindsets and behaviour, processes and products/services deliveries or realisations (Liker, 2004, p.41). For gravel roads to attain serviceable levels or states in Zambia, Stakeholders involved, should have ample and effective knowledge in formulating Value, mapping up Value stream, defining Value or product flow, operate on the pull systems through customer demand and applying the continuous improvement etiquette in order to achieve product perfection (Womack and Jones, 2003,pp.14-98). Judiciously following the above, will ensure that Lean Thinking and Value Management philosophies would effectively be utilised in the improvement of gravel roads in Zambia.
- Since most respondents contacted in the study indicated that OPRCs could be based on *Lean Thinking* and *Value Management* philosophies, it was important to intensify the exercise of sensitizing and training Stakeholders, so that they could fully appreciate the intricacies of LT and VM philosophies and how these philosophies could be of benefit in the Construction and Maintenance of gravel roads in Zambia. This would be a mammoth task but since it requires change in the perceptions of many Stakeholders, champions are needed to advance such road project management and decision changes. Herold and Fedor (2008, p.43) indicated that Change Management would definitely call for resonant Leadership:

  > *Leading implies change, change implies leadership! In oft –heard distinction between managing and leading, made popular by Harvard Professor Abraham Zaleznik, smooth running of day –to-day affairs, through the design and enforcement of organisational systems, processes, and procedures, is seen to be domain of Managers. Setting directions enlisting people's help in moving towards a new goal, and being willing and able to alter human and economic relationships represents the work of leaders.*

The Stakeholders concerned with the construction and maintenance of gravel roads in Zambia, should if they needed to succeed in applying Strategic Lean Thinking and Value Management philosophies, be change or transformational leaders themselves. It should be underscored here that gravel roads have for a long time in Zambia, been managed through Conventional Contracts, thus changing to OPRCs that depended on the Lean Thinking and Value Management philosophies to operate, would call for a paradigm shift and a major change championed by magnificent transformational leaders or change agents.

- As most Stakeholders indicated that gravel roads were important to the economic growth and connectivity of Zambia's far flung or rural areas, it was necessary that efforts that were aimed at improving construction and maintenance strategies were stepped up. In a nutshell "Strategic Lean Thinking and Value Management philosophies" would serve as precursor to re-orient or re-engineer project management processes with the key aims of achieving road value that is fit for purpose and to the satisfaction of intended road users. As this study also observed beyond reasonable doubt that, "gravel roads are among the most important public assets for most Countries and therefore, their improvements would bring immediate and sometimes dramatic or drastic benefits to road users through appreciable improved access to social amenities. Road users could with gravel roads in their good states, through strategic road maintenance easily access social amenities such as hospitals, schools, markets; improved driver and passenger comfort, speed, and safety, and lower Vehicle Operating Costs (VOCs) (Burningham and Stankevick, 2005). According to this study the notion held by some respondents that paved roads were most preferred in terms of economic benefits compared with that realised from gravel roads, should be treated with much caution or if anything utterly dispelled. Road users and Stakeholders should in their quest to enjoy benefits from the Zambian road network, be assisted to appreciate value commensurate with Customer needs. They should be made to understand that both paved and gravel roads had an important place in the Zambian economic development and rural connectivity. To put it bluntly, they are both drivers of development at various levels and therefore, the two strategies of road construction and maintenance must be at all costs supported and encouraged by well meaning citizens and stakeholders as they are not in conflict, but complimentary to each other in terms of road user perceived value.
- For sustainability in the construction and maintenance of gravel roads in Zambia, real collaboration must be explored, natured, infused and encouraged among stakeholders.

This should start with the sharing of information at planning, design and implementation stages of the road projects' whole Life Cycle (WLC)[65]. This could be easily attained if targeted OPRC Contractors like the case with Consultancy and Services Contracts were requested to submit Expression of Interests (EOI) at pre-tender stage. It is necessary that before a bid is deposited to the Client at tender stage, the EOI would without much doubt serve as an input channel that would allow Contractors to make submissions to the client with the aim of improving value delivery. When the bidder is called in for negotiation it will be from "Value Added Participation"[66] (VAP) or Co-creation point of view. In the negotiated approach the Contractor tends to assume the ownership of design and related costs. This is a form of collaboration which should be allowed to take root in the Construction and Maintenance of gravel roads through strategic Lean Thinking and Value Management philosophies (Richard, 2005). For real collaboration and consultation, pre-tender meetings should not only be limited to issues pertaining to pre-tender site visits (Road Condition Surveys)[67], but Stakeholders should also delve into matters of design and financing of the OPRCs projects [OPRCs Model]. Road users and other Stakeholders should when necessary be brought on board to lodge in their contributions at planning and design phases to avoid flaws that might only be discovered at the implementation stage. According to Lean Thinking principle No. 13, *"Make decisions slowly by Consensus, Thoroughly considering all Options; implement rapidly"* real collaboration fits well in this principle as it encourages critical thinking and reflection (Liker, 2004, p.40).

- Womack and Jones (2004,pp.1-17), refers to the process as lowering water level as a way of exposing rocks that are themselves wastes in the work or production process requiring to be eliminated from the beginning so as to ensure smooth project flow. Value Management principles encourage Stakeholders participation to identify project goals and objectives according to the tenets of "Lean Thinking and Value Management philosophies". Participatory Review Action/Appraisal and Participatory Learning Action/Appraisal are, value addition means that promote Stakeholder involvement and collaboration. This approach fits well with Lean Thinking and Value Management principle No. 7, of TPS *"Use visual control so no problems are hidden" (ibid).*

[65] *Project Whole Life Cycle (PWLC); Entirety of project process, from planning to implementation with the aim of enhancing Value to Customer perspective.*

[66] *Value Added Participation; This approach provides for selection of a Contractor team with proven experience in cost estimating, design alternatives, value engineering and management, constructability reviews, and ensuring that Contractor and Subcontractor bidders are qualified and reliable (Richard, 2005).*

[67] *Road Condition Survey (RCS); Informed systems and means of assessing road quality at a particular given time to compare with that of perceived quality or value at design time, with a view to determine corrective measures in cases of quality deficiency and enhancement.*

- The Government policy of upgrading gravel roads to paved or bituminous standards is a welcome initiative and an exploit which actually could be referred to as long overdue. This is because the action will without doubt, improve connectivity between places, reduce travelling time, improve travel speeds and certainly bring about desired driver and passenger comfort. However, even if such strategies would culminate into Zambia having roads of long life spans, the Government would be on the other hand, required to handsomely invest staggering sums of money for such ventures to flourish. Since the investment levels would be higher in order to have most gravel roads upgraded to bituminous standards, it goes therefore, that the cost of maintenance for the same would also rise. Zambia even if at the moment is rated as a middle income Country; it is not freed from or immune to the common challenges of developing or emerging economies. This will on one hand mean that if so many gravel roads were upgraded or improved to paved standards, will call for more resources in terms of funds to be reserved for road maintenance. Since the road network will be mostly of paved roads, efficiency of road serviceability will equally improve and most expectedly leading to improved economic activities in most areas traversed by these roads. The question that needs to be addressed is "Where will the funds for Maintenance of these upgraded roads come from?" It should be noted here that during the post independence era, sometime around the 1960s and 1970s most of the core roads in Zambia were constructed to paved standards (PPIAF, 2009 and RDA, 2007-2012). Unfortunately, due to lack of or deferred road maintenance most of these roads degenerated into states of disrepair and efforts to bring them to maintainable standards proved futile and in essence a nightmare for the Country (Heggie, Chiumya, 2004). Subsequently Zambia was forced to engage into heavy borrowing from big economy Countries and Financial Institutions such as the International Monetary Fund (IMF), the World Bank (WB) to mention but a few. With the passage of time Zambia became hugely indebted and was among the Countries referred to as the Highly Indebted Poor Countries (HIPIC). The burden of maintaining infrastructure took a toll on the Zambian economy and the Country was only saved by the Jubilee year when worthy Countries and Financial Institutions were requested to write off such debts, which they did. This has brought about great lessons for Zambia that if there are no good strategies of managing infrastructure and their development was carried out haphazardly, sooner or later the Country will be forced to heavily borrow and in no time retract from the middle income category to being referred to as Highly Indebted Poor Country (HIPIC) again. The programme of upgrading gravel roads to paved standards, should be done cautiously with

Lean Thinking and Value Management strategies in place if the Country was not to catastrophically drift into worst and unbearable conditions due to heavy and huge road maintenance backlog. If not backed with matched maintenance strategies that are oriented from Strategic Lean Thinking and Value Management philosophies, the Country was better placed if it kept some roads in gravel but of good condition roads through the use of OPRCs. It is therefore, necessary, to ensure that whilst carrying out the highly ambitious programme of upgrading gravel roads to bituminous standards, that overloading of resources is checked and in tandem with the Lean Thinking and Value Management philosophies No. 2 and 4 of TPS *"Create continuous process flow to bring problems to surface" and "Level out the workload (Heinjuka)[68]" (ibid).*

- Presently there seemed to be little or no meaningful collaboration among Stakeholders responsible for the Construction and Maintenance of gravel roads in Zambia. This they [Stakeholders] lamented was the reason why most Contracts experienced Variation Orders (VOs) in terms of additional costs and extended project times. According to the Study results obtained, the lack of real collaboration at planning, design and implementation stages of the road projects, was responsible for the flaws associated with most road contracts at the moment in Zambia. To be cost effective, Stakeholders should be collaborative and consultative at every stage of the project life cycle and bottom –up planning should be encouraged and enhanced. The current scenario where the Clients and Funders determined the course of actions in terms of planning and designs did not encourage use of Lean Thinking and Value Management philosophies [Push system], hence the shortcomings being registered in the project work flow and processes. The current contract formats did not advance Feed-Forward systems of managing information amongst stakeholders, which would ensure pro-activeness than the current re-activeness being witnessed. The systems still used the Feedback system in the dissemination of information, and therefore, were mostly of reactive forms, which unfortunately did not in essence promote real collaboration and consultation among Stakeholders. Collaboration is Lean Thinking and Value Management tool which should be used in enhancing value to Customer perspective in the Construction and Maintenance of gravel roads.
- Since most respondents believed that Output Performance - Based Road Contracts (OPRCs), were more sustainable than the Conventional Road Contracts being currently used in Zambia, it is incumbent on the Stakeholders that Lean Thinking and Value

[68] *Heinjuka; Japanese word meaning leveling of resources technique to deal with constrained situations of time, quantity and quality in the project work flow processes.*

Management philosophies are well incorporated in work process and flow. To realise or enhance Value to customer perspective in the managing of gravel roads in Zambia, it is necessary that LT and VM are strategically applied. This will encourage Stakeholders to look at things seriously and differently, so as to properly and effectively define value and value streams to customer perspective. The TVF- Transformation, Value and Flow theories of Lean Thinking and Value Management philosophies should be enhanced in the OPRCS for gravel roads in Zambia. For the Output Performance - Based Road Contracts (OPRCs) to be effective and beneficial as means of constructing and maintaining gravel roads in Zambia, there must be marched financing regime to avoid payment delays. The current 2nd generation OPRCs although they have fairly performed well but could have at mostly done even much better than now, if the philosophies of Lean Thinking and Value Management were effectively at play.

- It cannot go without stating that for OPRCs to blossom in Zambia, steady and stable financing strategies are necessary drivers. This could be evidenced from the current OPRCs being implemented in Zambia with financing from the World Bank (WB), which fairly thrived as result of steady availability of operation funds. Continuous flow of funds would culminate into OPRCs that are value added and delivery oriented as advanced by the Lean Thinking and Value Management philosophies No. 2 of the TPS, *"Create continuous process flow to bring problems to surface" (ibid).* As a result of this principle, the OPRCs located in Choma, Chongwe and Katete recorded remarkable and positive results. On the contrary, the OPRCs projects for Chipata and Lundazi districts failed lamentably or stalled due to poor financing arrangements from the European Union (EU), who later decided to withdraw or freeze the loan for this course. If Zambia would go ahead as planned to adopt the OPRCs strategies in the Construction and Maintenance gravel roads (RDA, 2009-2011), it should be born in mind that good financing was inevitable for these types of contracts to flourish. Applying Lean Thinking and Value Management philosophies in OPRCs will mean that Zambia needs to apply "Kanban or JIT systems"[69] so as to maintain stable and smooth flow of funds to support the related operations. The Ministry of Finance and National planning should therefore, devise systems or measures that would ensure steady and reliable provision of funds to the

[69] *Kanban and JIT systems; JIT means "Just In Time" is a Lean Thinking system of elimination of waste in the work flow process. Wastage is not just synonymous with inventory alone but time as well. Delayed payment is a waste in form of time. Kanban is a Japanese word which is control system that helps the JIT. It is a system that signals that demand or need is required to be instantly attended to in the work process to satisfy customer value (Jessop and Morrison, 1994, pp.126-136, Liker, 2004, p.108). ("Flow where you can, pull where you must", Liker, 2004, p.108)*

National Road Fund Agency (NRFA)[70]. This will allow the OPRCs to be sustainable and dependable interventions of maintaining gravel roads in Zambia. The success of OPRCs everywhere they have been practiced largely depends on the steady availability and smooth flow of operational funds, which are attributes of Lean Thinking and Value Management philosophies [OPRCs Model]. Laxity in the management of road funds, will nonetheless, only spell doom or danger in the success of OPRCs in Zambia.

- The Client (RDA and LRAs)[71], should improve in the paying systems by ensuring that IPCs were promptly paid in line with Lean Thinking and Value Management philosophies (Kanban, Kaizen[72] and JIT). To effectively manage OPRCs for gravel roads in Zambia, sustainable provision funds is key as suggested by the Model set out in section 5.3.2.
- Government through the Road Development Agency and Local Road Authorities (RDA and LRAs) should strategically implement Output Performance - Based Road Contracts (OPRCs), so as to encourage local company establishment and participation. This would in a way discourage the current scenario where foreign Companies have taken the lead in the construction and maintenance of gravel roads in Zambia, which could be the recipe for much talked about Capital flight or externalization of foreign exchange.

6.3 Recommendations

Given that the "gravel roads account for over 80% distributed as 23% in gravel and 59% as Earth roads of Zambian gazetted Road Network" and most of the rural and outlying areas are linked by these types of roads, it is difficult to gain accessibility especially in the rainy season (RDA, 2008, Chiumya, 2004). According to Chiumya, (2004), the cost of operating in rural Zambia is very high. The study was looking at the road network and the conditions of both Paved and Unpaved roads in Zambia, and also in terms of their economic potential, compared with other Countries in the Sub Saharan region. From the foregoing and observations made through this study, it could be noted that gravel roads are an important factor in Zambia's economic development and rural connectivity. As already been established in the study, gravel roads in their nature suffer greatly from the effects of adverse weather conditions and hardly survive one rainy season. Strategic Maintenance through the adoption of Output and Performance - Based Road Contracts (OPRCs) which are said to operate on the basis of Lean

[70] *NRFA: National Road Fund Agency, an Institution formed through the "Act of Parliament" No 13, of 2002 responsible for the mobilization and disbursement of funds for Construction and Maintenance of gazetted public roads in Zambia (Public Road Act, 2002).*

[71] *RDA and LRAs: Road Development Agency and appointed Local Road Authorities as entities responsible for the Construction and Maintenance of public in order promote economic development in Zambia.*

[72] *Kaizen: Lean Thinking principles as coined by Toyota Production System (TPS) which aims at making continuous improvements in the work and production process.*

Thinking and Value Management philosophies could improve value and quality of gravel roads in Zambia. These types of Contracts could only achieve desired results of delivering customer perceived value if Lean Thinking and Value Management philosophies were effectively incorporated in the road projects from inception to implementation stages. The Zambian Government through the Road Sector Agencies is therefore urged on the incorporation of Strategic Lean Thinking and Value Management philosophies, in the planning, design and implementation of Output Performance - Based Road Contracts (OPRCs) for gravel roads, more especially for the new generation Contracts that are to be rolled up in the near future.

6.4 Main Study Limitations

Although a number of studies have been conducted in the area of Lean Thinking and Value Management, most respondents interviewed in this study were unaware that these philosophies existed and were being practised to enhance value to customer perspective. There are a lot of studies conducted in Lean Thinking, Production and Construction but the Stakeholders involved with the Construction and Maintenance of gravel roads in Zambia, subtly knew that these philosophies were necessary in project and business management. "Lean Thinking also provides a way to making work more satisfying by providing immediate feedback on efforts to convert *"Muda"* into value. And, in striking contrast with the recent crave for processing reengineering, it provides a way to create new work rather than simply destroying jobs in the name of efficiency " (Womack and Jones, 2003,p.15). This presented a challenge when undertaking this study as most Stakeholders needed to understand the basic principles of Lean Thinking and Value Management before they could be engaged with the interview or questionnaire administration. It was clear however, that "typically gravel roads although appreciated in Zambia as drivers to spur economic activities and connectivity of the rural or far flung areas but, were in deteriorated states. It was also noted that most gravel roads were in poor state of disrepair due to lack of or deferred maintenance" (Chiumya, 2004). Again making Stakeholders hold on to the notion that even if paved roads were preferred in terms of quality and economic returns, gravel roads were equally necessary was difficult to comprehend, as this presented its own problems as respondents had their own misgivings on such beliefs. They maintained that for Zambia to develop, gravel roads needed to be upgraded to bituminous standards for sustainability and appreciable economic realisation. This researcher was at pains to convince Stakeholders including members of the academic staff [that were adjudicating the research process] that gravel roads were necessary

in the understanding that it would be almost impossible that Zambia would have the financial capability to achieve such very ambitious programme. The need in having some roads of gravel surfacing is evident in the way that some USA states are reverting to gravel roads due to the maintenance burden on paved roads. According to Tembo (2014), in the April 29, 2010*, issue, Michael Arndt, stated thus:* ***"It's a lot uglier up here than people think," says the highway chief.***

A frequent indicator of development is a country's miles of paved roadways. By this measure, at least one corner of America is in reverse. Stutsman County, N.D., a 2,304-square-mile stretch of sparsely populated plains, maintains 233 miles of asphalt roads. The county road department says it can afford to care for just 48 miles, so it's starting to convert the pavement back to gravel.

The down grading of bituminous roads to gravel standards in USA coupled with other such clarification and evidence of importance of gravel roads in Zambia's national economic development, the learned members of the research adjudication panel reluctantly allowed that this study be conducted to ascertain and establish the challenges faced with gravel roads in Zambia and how the Strategic Lean Thinking and Value Management philosophies would offer solutions to that effect. Another, limitation was in accessing of construction sites and willing respondents, as very few construction companies were prepared to give out information which was considered to be confidential and vital to their business integrity. No company will accept to be labelled as having poor management policies and strategies as this would have bad telling effects in the company's future operations and opportunities as it may be seen to be of bad reputation. Road Construction Stakeholders who formed part of the respondents in this study, were sometimes conservative on some issues, hence could not fully open up. Some responses received remained marred with suspicious lack of truth as they appeared conflicted with the results obtained from previous researches consulted. "Lean Thinking and Value Management philosophies were appreciated in production and manufacturing compared with road constructions and other forms of enterprise" (Liker, 2004). This should be noted that the negative attitudes and resentment that could be exhibited by most respondents that Lean Thinking and Value Management philosophies would not offer much for gravel roads in Zambia, could be explained due to some respondents' inclination of having roads of bituminous standard, as already stated in section 6.2.1.

Because of this, the study is perceived to have suffered immeasurable loss in getting data that could be considered to be with low degree of bias. However, the inferences made from the

findings have been done after considering all these shortcomings and taking necessary care. The other limitation is the choice of road construction sites and location of case study sites where the respondents could be drawn from. Some sites, because of the nature of the projects they were undertaking recorded low number of respondents with matched knowledge in the Construction and Maintenance of gravel roads. This to some extent could have created a problem as some respondents included in the survey displayed lack of knowledge on the issues pertaining to gravel roads in Zambia. They could therefore, have given opinions from mere assumptions and speculation which could either be true or completely wrong or misplaced. Time limitation was also another constraint, as this research needed to be carried out within a specified period, collection of data was therefore, done with such shortcomings in mind. Due to financial constraints and time limitation, it was difficult to visit most of rural areas in Zambia. The research sample was mainly conveniently drawn from Four (4) provinces namely; Southern, Lusaka, Central, and Eastern provinces. However some observations were made on some gravel roads on the Copperbelt and Luapula provinces. The remaining provinces of Northern, Muchinga, Western and North Western were incorporated in the research using visits conducted earlier than the study period. As such it was difficult to collect as much data and information as would have been preferred and considered to be importantly sufficient for a thorough research as this one. Nevertheless, much care was taken to ensure that the data collected somehow conformed to the basic research requirements, although the limitation of time cannot therefore, be overly ignored.

6.5 Further research

The study could further be extended to try and investigate the real problems facing the 'Construction and Maintenance of gravel and paved roads' in Zambia where quality, value and sustenance are of great concern. "The bad state and deterioration rate of most gravel roads present huge challenges to most road users in Zambia. Road users are inconvenienced every day whenever they move on most roads, in terms of long journey times, high vehicle operating costs (VOCs) and lack of driver comfort among other things. It is also worth noting however, the fact that Government has embarked on a very high ambitious programme of upgrading most gravel roads to bituminous standards in Zambia (RDA, 2013), which requires more robust approach. This will mean that in 5 years time, most of gravel roads in Zambia would be of paved standards. The question still lingers, to whether within these seemingly good policies have considered the issues of sustainability. Upgrading gravel roads is not only costly but also a daunting task for ensuring that they continually remain in serviceable state.

The Road Development Agency has also devised or crafted a plan of tolling of core road network in Zambia as a means of revenue generation for maintenance of most roads in Zambia (ibid). It still remains a mammoth task and great challenge to ensure that the Zambian Government through Road Sector Agencies sustains the Construction and Maintenance of roads in general so as to deliver value to customer perspective. To think that some of the roads in Zambia will for some time remain of gravel standards is not a fallacy but a fact. This is because over 80% of roads in Zambia are of gravel standards at the moment and it would, I presume take a while before they are all upgraded to paved standards *(ibid)*. The study "Strategic Lean Thinking and Value Management philosophies in gravel roads in Zambia" has tried to deal with some issues but not conclusively and explicitly due to limitations of time and other related constraining factors as already highlighted. Some of the areas of further study could be Collaboration and Sustainability in the construction and maintenance of gravel roads in Zambia for economic development and enhancement.

The study *"Strategic Lean Thinking and Value Management for gravel Roads in Zambia"*, could have produced even more better results if the mode (research methods) of carrying out the investigation was different. Gravel Road quality and Value issues are difficult to discern and sensitive as some people were in many cases not willing to give details about such issues. This is because most people do not want to acknowledge the fact, that they are ignorant about certain theories such as *"Lean Thinking and Value Management philosophies"*. To yield more dependable results, the next researcher in this subject domain, should opt for company or participative project case studies as the most reliable methods to conduct studies dealing with the Strategic Lean thinking and Value Management philosophies in the Zambian Road construction industry. It is emphasized here that Road construction companies or projects should be identified where the researcher should be attached [internship] to interact freely with various Stakeholders when undertaking such studies. The Case study method would reduce the biasness that this study could have experienced and hence be able to produce more tangible results, for better inference. Otherwise, the study was a worthwhile undertaking and a lot of lessons have as expected evolved and been realised which if well deciphered, understood and adopted would certainly improve the Value and Quality delivery for gravel roads in Zambia to the ultimate benefit of road users and also added value to the body of knowledge in the subject domain.

We must not cease from exploration, and the end of all exploration will be to arrive at where we began and to know the place for the first time, to alas our marvel (T.S. Elliot, Lonnie Wilson, 2010).

GLOSSARY AND TERMS

Some terms that have been used in the research of strategic application of *"Lean Thinking/Construction"* and *"Value Management"* principles in Construction and Maintenance of unpaved roads in Zambia are defined as follows;

Admeasured: a form of works which uses quantities set out in the bill of quantities (BOQ) once executed as a Contract accordingly.

Benchmarking: is the method of improving performance in a systematic and logical way, by measuring and comparing performance against other best performers or practitioners.

Best Practice: is the knowledge that underpins measures of excellence, in form of knowledge and skills that could share in a given industry.

Change Management: is a process of making remarkable improvement after strategically making necessary changes and therefore, removing the bottlenecks in the Value stream or work flow process.

Client: this is the promoter or the financier of the project. He/she conceives the idea and engages other to realise that dream.

Collaboration: the art of talking to people to enhance production at minimal cost. The value management process involves collaboration with the team responsible for design and delivering the project, and ideally includes end-users and other stakeholders.

Compliance Service Level: for OPRCs this is set out to the Contractor as Key Performance Inductors for which the quality of work (value) shall be measured.

Construction Management: the process of directing and coordinating construction activities in order to realise or achieve set objectives and goals. This may involve planning and allocation of resources such as labour and materials.

Consultant: normally is the Engineer or Architect engaged to design and manage a project in a given period of time.

Contract: a legal agreement between two or more parties.

Contractor: this is the firm or individual engaged to construct or provide the service as conceived by the Client and designed by the Consultant.

Cost Plus Contract: a form of Contract where the cost of providing a product or service is reimbursed by the Client plus the mark or profit.

Employees: in construction industry, these are those individuals engaged by employers to execute works.

Employers: in construction industry this may include contractors, consultants and all those engaging people to execute works.

Fixed Sum Contract – this is a type of Contract whose contract sum remain constant.

Fixed Sum Contract: this is a type of Contract whose contract sum remain constant.

Health and Safety management: is the practice of ensuring better work environment in terms of environment and safety at work place.

Lean Construction: is the approach of managing production activities to enhance and deliver value to customer perspective, by focusing on those that are value addition and hence remove all forms of waste.

Lean Enterprise: Could be any Entrepreneur endeavour or business concern following the Lean Thinking principles to achieve planned and desired targets.

Lean Production: the approach that focuses on the elimination or reduction of all forms of waste to deliver value to Customer perspective.

Lean Six Sigma: is the philosophy stands for five interconnected phases; *Define, Measure, Analyze, Improve* and *Control* of the product throughout the Total Value Stream (TVS)

Lean Synchronisation: it is both a philosophy and a method of operations planning and control and aims to meet demand instantaneously, with perfect quality and no waste.

Lean Thinking: is a system of production developed through the Toyota Production System (TPS) which aims at reducing waste to enhance value to customer needs.

Motivation: is the driving force behind the way persons act or the way in which people are simulated to act. Involvement in the decision making process in a meaningful way will improve motivation as well as use of incentive schemes.

OPRCs: means Output Performance Based Road Contracts. These are framework contracts which emphasis on performance for delivery of a service to the client and road users.

Partnering: is a management system that is based on a collaborative approach of working.

Perception: is the way in which people interpret the environment or the way in which a person believes or understands the situation.

Procurement: Processes of acquiring works, goods and services through the most appropriate and eligible method of selecting the best team to design and deliver the given products.

Project Management: A "Project" can be defined in various ways, but suffice to say that it is; A unique venture with a beginning and an end, conducted by people to meet established goals, schedule and quality (Buchaanan and Body, 1992).

Risk Management: is a process of assessing and mitigating risks from project inception to completion.

Strategic Management: 'Strategy is the long term direction of an Organisation or business endeavour which implies a more comprehensive view of all work flow processes (Scholes *et.al*. 2010, p.3)'.

Supply Chain Management: this involves integrating the operations of all organisations involved with the delivery of the product or service from inception to the end user.

Sustainable Construction and Management: this is a form of management practice which takes into account of the triple bottom line-Social, Economic and Environmental factors.

Value Addition Activities: processes that reduce waste but enhance customer satisfaction through delivering a product or services.

Value Analysis: as in Value Engineering is the process of assessing functionality of the product to seek ways of attaining the desired value at more relatively cheaper price or lower cost.

Value Engineering: is the method that examines the function of product parts in quest of identifying alternatives which could decrease costs without removing the functions (IVM, 2005).

Value Management: this is a method which aims at identifying the best way to meet the client's needs taking into account, time, cost, quality and risk constraints.

Value Stream: this is a work flow process of value addition to a product or service.

Value: is the Customer need or what the Customer wants in terms of quantity, quality and time, *inter alia*.

Waste 'Muda': anything in the work flow process that adds cost but reduces value as demanded by the customer.

Whole Life Costing: this is a method which considers project or business throughout the entire life from initial capital, costs and returns.

REFERENCES

Abbot, K., Pendlebury, N. and Wardman, K (2013), *Business Law, Cengage Learning AMEA,* Cheriton House, North Way, Andover, Hampshire, SP10 5BE, United Kingdom. ISBN: 978 1 4080 6661 4.

Abdelhamid, T. (2004). *Lean Production Paradigms in Housing Industry*, Research paper, Construction Management Programme, Michigan State University, East Lansing, MI 48824 – 1323, USA.

Abdelhamid, T.S. (2004). *4th Lean Construction Institute Academic Forum*, LCIAC, Michigan State University, USA.

Abdelhamid, T.S. (2004). *The Self-Destruction and Renewal of Lean Construction Theory: A Prediction from Boyd's Theory*, Research paper, Construction Management Programme, Michigan State University, East Lansing, MI 48824 – 1323, USA.

Adams, K.(2000*), Appropriate and Efficient Maintenance of Low Cost Rural Roads: Report II, Assessment of Maintenance Manuals,* DFID, Roughton International, The University of Birmingham and The University of Nottingham, B15 2TT & NG7 2RD, England, UK.

Adamu, S. and Ahmid, R.A. (2012), *Lean Construction Techniques Implementation in Nigeria Construction Industry,* Faculty of Built Environment, Malaysia University of Technology, Canadian Journal on Environmental, Construction and Civil Engineering, Vol. 3, No. 4.

Alarcon, L. (2008), *Lean Construction*, School of Engineering, Catholic University of Chile, Santiago, CHILE, Taylor and Francis, New York, NY 10016, USA. ISBN: 90 5410 648 4.

Alarcon, L.F. and Pavez, I. (2006), *Qualifying People to Support Lean Construction in Contractor Organisations, Proceedings of the 14th Conference of the International Group for Lean Construction*, Lean Construction Institute (LCI), International Group for Lean Construction (IGLC), Pontificia Universidad Católica de Chile, Santiago, CHILE.

Alarcon, L.F. and Sequel, L. (2002), *Developing Incentive Strategies for Implementation of Lean Construction, Proceedings of the 10th Conference of the International Group for Lean Construction*, Lean Construction Institute (LCI), International Group for Lean Construction (IGLC), Pontificia Universidad Católica de Chile, Santiago, CHILE.

Alarcon, L.F., Diethelm, S., Rojo, O. and Calderlon, R. (2008), *Assessing the Impacts of Implementing Lean Construction, Proceedings of the 7th Conference of the International Group for Lean Construction*, Lean Construction Institute (LCI), International Group for Lean Construction (IGLC), Pontificia Universidad Católica de Chile, Santiago, CHILE.

Alexander, R and Wallace, W (2004), *Project Management*, Pearson Education, Edinburgh Business School, Herriot -Watt University, Edinburgh Gate, Harlow, Essex CM20 2JE, United Kingdom, ISBN: 0 273 66140 X

Al-Najja, Z.J., Saco, Z.M. and Al-Azzawi. (2004). *The Impacts of Production Theories on Construction Planning Efficieny*. Emirates Journal for Engineering Research, Regular paper, Department of Civil Engineering, University of Baghdad, Iraq, Building and Construction Department, Roads and Bridges Branch, Technology University, Iraq

Alur, A. (2005), *Participatory Monitoring and Evaluation; Field Experiences*, SDC IC NGO Programme Karnataka Tamil Nadu, Programme Support and Management Unit, 49 3rd Cross, 10th Main, Indiranagar Stage II, Bangalore, 560 038, India.

Al-Yousefi, A.S. (2006), *Value Engineering Benefits in Sustainable Construction*, Research paper, Al-Yousefi Value Engineering (YVE), P.O Box 261366, Riyadh, 11342, Saudi Arabia.

Ansell, M. (2007), *Lean Construction Trial on Highway Maintenance Project, Proceedings of the 15th Conference of the International Group for Lean Construction* (IGLC), PhD paper, Lean Construction Institute, (LCI), Department of Civil and Building Engineering, Loughborough University, LU, UK

ASCO, (2009), *Output and Performance Based Road Contracts in Zambia, Malawi Study Tour Report*, Lusaka, Zambia.

Ashworth, A. (2004), *Cost Studies of Building*, Pearson Education Limited, Edinburgh gate, Harlow, Essex, CM20 2JE, England, UK. ISBN: 978 0 13 145322 7.

Atul V. Sood Advocate (2008), *Procurement of Works and Services under Output and Performance Based Road Contracts (OPRC), Between Opus and PRDB Road Project*, Chandigarh, India.

Avraham, L. (2009), *Combining Lean, Six Sigma, Theory of Constraints to Achieve Breakthrough Performance,* A Velocity paper, Goldratt Institute, Limited Enterprise, 442 Orange Street, New Haven CT 06511, USA

Ballard, G. (1999), *Lean Thinking and Construction Project Management,* Lean Construction Institute, University of California, Berkeley, USA

Ballard, G. (1999), *Positive Vs Negative Iteration in design,* IGLC -8 , Lean Construction Institute, (LCI)

Ballard, G. (2002), *Cycle Time Reduction in Home Building, Proceedings of the 9th Conference of the International Group for Lean Construction* (IGLC), Lean Construction Institute, (LCI), University of California, Berkeley, USA

Ballard, G. (2004), *The Lean Delivery System as a Strategy for Adding Value in Construction Projects*, IGLC, Conference Paper, Lean Construction Institute, (LCI), University of California at Berkeley, Berkeley, CA, USA.

Ballard, G. (2010), *Implementing Lean Construction in Norway*, IGLC, Conference Paper, Lean Construction Institute, (LCI), Oslo, Norway.

Ballard, G. and Arbulu, R, (2004), *Making Prefabrications Lean:* PhD Paper, IGLC, Lean Construction Institute (LCI), University of California, Berkeley, USA

Ballard, G. and Howell, G, (1998), *Implementing Lean Construction: Implementation and Action,* Lean Construction Institute (LCI)

Ballard, G. and Howell, G, (2004), *Competing Construction Management Paradigms:* Lean Construction Journal, Lean Construction Institute (LCI),

Ballard, G. and Howell, G. (1998). *"Shielding Production: Essential Step in Production Control". Journal of Construction Engineering and Project Management*, Vol. 124, No. 1, pp. 11 - 17.

Ballard, G. and Howell, G. A. (1999), *Bringing light to the dark side of Lean Construction: A Response to Stuart Green,* IGLC -7 , Lean Construction Institute, (LCI), University of California, Berkeley, USA

Ballard, G. and Howell, G. A. (1999), *Implementing Lean Construction: Stabilizing Work Flow,* IGLC , Lean Construction Institute, (LCI), Research Article, University of California, Berkeley, CA, 94720, USA

Ballard, G. and Howell, G. A. (1999), *What kind of Production is Construction,* IGLC '98' , Lean Construction Institute, (LCI), University of California, Berkeley, USA

Ballard, G. and Howell, G. A. (2005), *Relational Contracting and Lean Construction,* Lean Construction Journal, Vol. 2, Lean Construction Institute, (LCI), University of California, Berkeley, USA. ISSN: 1555 1369.

Ballard, G. and Koskela, L. (1999), *On Agenda of Design Management Research ,* IGLC '98' , Lean Construction Institute, (LCI), University of California, Berkeley, 4536 Fieldbrook Road, Oakland, CA 94619, USA

Ballard, G. Hammond, J. A. and Nickerson. (2010), *Production Control Principles,* IGLC , Lean Construction Institute, (LCI), Research Article, University of California, Berkeley, CA, 94720, USA

Ballard, G., Harper, N. and Zabelle, T. (2002), *An application of Lean Concepts and Techniques to Precast Concrete Fabrications, Proceedings of the 10th Conference of the International Group for Lean Construction,* Gramado Brazil

Ballard, G., Koskela, L., Howell, G. and Zabelle, T. (2001), *Production System Design in Construction, Proceedings of the 9th Conference of the International Group for Lean Construction* (IGLC), Lean Construction Institute (LCI), Lean Construction Journal, University of California, Berkeley, 4536 Fieldbrook Road, Oakland, CA 94619, USA

Ballard, G.H. (2000), *The Last Planner System of Production Control,* PhD Thesis, School of Civil Engineering, Faculty of Engineering, The University of Birmingham, UK

Bally, P (2008), *Procurement Principles and Management,* Pearson Education Limited, Edinburgh Gate, Harlow, Essex CM20 2JE, England, UK. ISBN: 978 0 273 71379 1

Barnes, D. (2008), *Operations Management: An Introduction Perspective,* Thomson Learning, High Holborn, House, 50-51, Bedford Row, London, UK. ISBN: 978 1 84480 534 1

Bayart, D. (2008). *The Fact-Theory Dialogue in an Industrial Context: The Case Study of Statistical Quality Control.* Centre de recherche en gestion (PREG-CRG), Ecole polytechnique et CNRS Paris, France.

Beardwell, J. and Claydon, T. (2010), *Human Resource Management, A Contemporary approach,* Pearson Education Limited, Edinburgh Gate, Harlow, Essex CM20 2JE, England, UK, ISBN: 978-0-273-72285-4

Bergmiller, G.G. (2006), *Lean Manufacturers Transcendence to Green Manufacturing: Correlating the Diffusion Lean and Green Manufacturing Systems,* Doctoral Thesis, Department of Industrial and Management Systems Engineering, College of Engineering, University of South Florida, USA.

Bertelsen, S. (2002), *Bridging the gaps – Towards a Comprehensive Understanding of Lean Construction, Proceedings of the 10th Conference of the International Group for Lean Construction (IGLC),* The Benchmark Centre for Denmark Construction Sector, Strandgade 27B, 1401, Copenhagen, K. DK, Denmark.

Bertelsen, S. (2002), *Lean Construction in Denmark- A brief overview.* Lean Construction Journal, Lean Construction Institute, (LCI) PhD Paper, The Benchmark Centre for Denmark Construction Sector, Strandgade 27B, 1401, Copenhagen, K. DK, Denmark

Bertelsen, S. (2004), *Lean Construction: where are we and how to proceed?* Lean Construction Journal, Lean Construction Institute, (LCI) PhD Paper, The Benchmark Centre for Denmark Construction Sector, Strandgade 27B, 1401, Copenhagen, K. DK, Denmark

Bertelsen, S. and Koskela, L. (2004), *Construction Beyond Lean: A New Understanding of Construction Management, Proceedings of the 12th Conference of the International Group for Lean Construction (IGLC),* The Benchmark Centre for Denmark Construction Sector, Strandgade 27B, 1401, Copenhagen, K. DK, Denmark.

Bertelsen, S. and Koskela. (2002), *Managing the Aspects of Production in Constructio, Proceedings of the 10th Conference of the International Group for Lean Construction*

(IGLC), PhD Paper, The Benchmark Centre for Denmark Construction Sector, Strandgade 27B, 1401, Copenhagen, K. DK, Denmark.

Bertelsen, S., Henrich, G., Koskela, L. and Rooke, J. (2007), *Construction Physics, Proceedings of the 15th Conference of the International Group for Lean Construction (IGLC)*, The Benchmark Centre for Denmark Construction Sector, Strandgade 27B, 1401, Copenhagen, K. DK, Denmark.

Bertram, D. (2007), *Likert Scales…are the meaning of life*, CPSC 681- Report,

Bhatla, A. (2010), *Implementation of Lean Construction in Indian Institute of Technology (IIT), Guwahati,* PhD Thesis, Department of Civil Engineering, Indian Institute of Technology, Guwahati.

Bjornfort, A. (2006), *An Exploration of Lean Thinking For Multi Storey Timber Housing Construction, Contemporary Swedish Practices and Future Opportunities,* Doctoral Thesis, Department of Civil and Environmental Engineering, Division of Structural Engineering- Timber Structures, Lulea University of Technology, Linkoping University, Institute of Technology, Sweden. ISSN 1402 1544

Blakey, R. (2008), *An Introduction to Lean Construction*, Design and Construction, Touch Briefing, Lean Construction Institute, (LCI), UK.

Boddy, D. and Paton, S. (2011), *Management, an Introduction,* Pearson Education Limited, Edinburgh Gate, Harlow, Essex CM20 2JE, England, UK, ISBN: 978-0-273-73896-1

Bodle, Z., Kane, A. and Marcus, A.J. (2008), *Essentials of Investments*, McGraw Hill Companies, 1221 Avenue of the Americas, New York, NY, 10020 New Jersey, USA. ISBN: 978 007 127346 6, ISBN: 978 007 126324 5.

Bottirov, O. (2011), *Lean Construction in Construction Company,* Dissertation Work, Department of Construction Management, VIA University College, VIAUC.

Bovee, C.L. and Thill, J.V.(2010), *Business Communication Today,* Pearson Education, Prentice Hall, One Lake Street, New Jersey, USA, ISBN 10: 0 13 246458 6

Bowden, J. (2008), *Writing a Report: How to prepare and present really effective reports,* How to Books Limited, Spring Hill House, Spring Hill Road, Begbroke, Oxford OX5 IRX, England, United Kingdom. ISBN: 978 1 84528 293 6.

Brewer, (2007), *Your PHD Thesis, How to plan, draft, revise and edit your thesis*, Studymates, Baskerville Press, Abergele, LL18 9AY, UK, ISBN 13 978-1-84285-070-1.

Brown, J. D. (1999), *What issues affect Likert Scale Formats? (due to measurements scales),* MGS 9920 Prop & Stat Theory 1, University of Hawaii at Manoa, Abstract paper.

Brownsword, R. (2009), *Smith & Thomas: A Casebook on Contract*, Sweet & Maxwell, Thomson Reuters, 100 Avenue Road, London, NW3 3PF, United Kingdom. ISBN: 978 1847 03417 5.

Brushett, S. (2005), *Management and Financing of Road Transport Infrastructure in Africa,* Sub – Saharan Africa Transport Policy Program (SSATP), Africa Region, The World Bank and the United Nations Economic for Africa (UNECA).

Bryceson, D. F. and Bradbury, A. & Bradbury, T. (2006), *Roads to Poverty Reduction, Dissecting Rural Roads, Impact on Mobility in Africa and Asia,* African Studies Centre, Oxford, Transport Research Laboratory, Crowthorne, UK.

Burke, R. (2004), *Project Management: Planning and Control Techniques,* Burke publishing, Trident print, Cape Town, RSA. ISBN: 0 9582391 5 0.

Burningham, S. and Stankevick, N. (2005), *Why Road Maintenance was important and how to get it done,* Transport Notes, Operational guidance, Transport Note No. TRN No. 4, The World Bank, Washington DC, New York, USA.

Buyse, P. and Vandenbussche, T.(2010), *Performance Analysis of Earned Value Management in the Construction Industry,* Master Thesis, Faculty of Economics and Management, Gent University,

Caletka, A.F. (2009), *Managing Construction Projects, Managing Change,* Research paper, Lorman Education Services, Rochester, New York, NY, USA.

Carnall, C. (2007), *Managing Change in Orgnisations*, Pearson Education Limited, Edinburgh Gate, Harlow, Essex CM20 2JE, England, UK,ISBN:978-0-273-70414-0

Carrillo, P.M. and Shelbourn, M.A., (2006), *Managing Knowledge in the Context of Sustainable Construction,* Department of Civil and Building Engineering, Loughborough University, Leicestershire, England, UK.

Chambers, K. D. (2010), *How Toyota Changed the World,* Jaico Publishing House, A-2 Jash chambers, 7-A Sir Phirozshah Mehta Road, Fort Mumbai-400 001. ISBN: 978 81 8495 052 6.

Chapman, C.D., (2005), *Lean, Clean House with 5S,* Quality process, Lean Construction Institute, (LCI)

ChildFund, (n.d), *Participatory Monitoring and Evaluation*, Lusaka, Zambia.

Chitkara, K.K. (2011), *Construction Project Management: Planning, Scheduling and Controlling*, Tata McGraw Hill Education Publishing Private Limited, New Delhi, India, ISBN:13 978 0 07 068075 3, ISBN: 10 0 07 068075 2.

Chiumya, C. (2004), *Banking Sector Reform and Financial Regulation: Its effects on access to financial services by low income households in Zambia,* Development Economics and Public Policy, Working Paper Series, Paper No. 13, Institute for Development Policy and Management, University of Manchester, Harold Hankins Building, Precinct Centre, Oxford Road, Manchester, M13 9QH, UK, ISBN: 1 904143 70 9.

Choudhuri, N.M., (n.d), *Project Management Fundamentals,* ITC, INFOTECH, Business-Friendly solutions, India Limited.

Chris, D., Edmonds, G. and Johannessen, B. (2007), Rural *Road Maintenance, Sustaining the Benefits of Improved Access;* International Labour Organisation, Bangkok, Thailand. ISBN: 978 92 2 119723 2

Clarke, R.H. (1988), *Site Supervision*, Thomas Telford Limited, Thomas Telford House, 1 Heron Quay, London E14 9XF, England, UK. ISBN: 0 7277 0200 9.

Cleves, J.A., and Michel, J.F. (2008). *Lean Project Delivery: A Winning Strategy for Construction and Real Estate Development*, Grant Thornton, National Office, 175 West Jackson Boulevard Chicago, IL 60604, 312.856.0200

Clow, T. and Barda, P. (2002), *Project Strategic Planning: A Prerequisite to Lean Construction, Proceedings of the 10th Conference of the International Group for Lean Construction*, PhD Research paper, School of Civil and Environmental Engineering, UNSW Kensington NSW Australia.

Cole G. (2004), *Management Theory and Practice*, Cengage Learning Services, Cheriton House; North Way, Andover, Hants SP10 5BE England, UK, ISBN:978-84480-095-7

Cole G.A.(2006), *Strategic Management*, Thomson Learning, High Holborn House; 50-51 Bedford Row, London, WCLR 4LR, England, UK, ISBN:13-978-84480-087-2, ISBN:10:1-84480-087-3

Cole, G. A. (2002), *Personnel and Human Resources Management,* Cengage Learning AMEA, Cheriton House, North way, Andover, Hampshire, SP10 5BE UK. ISBN: 978 0 82646 128 5.

Construction Excellence, (2004), *Lean Construction,* Innovation, Best practice, Productivity, LCI, UK.

Construction Excellence, (2004), *Value Management,* Innovation, Best practice, Productivity, LCI, UK.

Construction Users Round Table (CURT), (2004), *Construction Projec Controls: Cost, Schedule and Change Management,* The Owners' Voice to the Construction Industry, Lean Construction Institute (LCI), International Group for Lean Construction (IGLC).

Construction Users Round Table (CURT), (2004), *Construction Project Controls: Cost, Schedule and Change Management,* The Owners Voice to the Construction Industry, 4100 Executive Park Drive, Suite 210, Cincinnati, OH 45241-4023

Construction Users Round Table (CURT), (2007), *Construction Strategy: CURT's Path Toward LEAN Project Delivery,* The Owners' Voice to the Construction Industry, Lean Construction Institute (LCI), International Group for Lean Construction (IGLC).

Cooper, D.R. and Schindler, P.S. (2011), *Business Research Methods*, McGraw Hill Companies, 1221 Avenue of the Americas, New York, NY 10020, USA. ISBN: 978 007 128922 1.

Covey, S. R. (1989), *The Seven Habits of Highly Effective People,* Simon & Schuster, Rosetta Books, LCC, New York, USA. ISBN: 0 671 70683 5.

Covey, S. R. (2005), *The Eighth Habit, From Effectiveness to Greatness,* Free Press, Rosetta Books, LCC, New York, USA.

Da – Silva, F.B. and Cardoso, F.F. (1999), *Applicability of Logistics Management in Lean Construction, A Case Study Approach in Brazilian Building Companies,* Civil Construction Engineering Department, Lean Construction Institute (LCI), International Group for Lean Construction (IGLC), Escola Politécnica, Universidade de São Paulo, Brazil.

Dallas, M., F (2008), *Value and Risk Management, A Guide to Best Practice,* Blackwell Publishing Limited, Garsington Road, Oxford OX4 2DQ, UK. ISBN:978 14051 2069 2.

Daly, D. Tucker, J. T. and Gibson, C. (2004), *Innovations in Performance Based Contracting,* The Southern Area Consortium of Human Resources (SACHS), Academy for Professional Excellence, San Diego State University, School of Social Work, 6505 Alvarado Rd Suite 107, San Diego, CA 92120, USA.

Dawson, C. (2013), *Advanced Research Methods* How to Books, Constable & Robison limited, 55-56 Russell Square, London WCIB 4HP, UK. ISBN: 978 1 8452 8513 5.

De Beer, A. and Rossouw, D. (2012), *Focus on Operational Management: A generic Approach,* Juta and company limited, first floor, Sunclare Building, 21 Dreyer Street, Claremont, 7708, P.O. Box 14373, Lansdowne, 7779, Cape Town, South Africa. ISBN: 978 0 70218 919 7.

De Beer, A.A. (2011), *Business Management for Entrepreneurs,* Juta & Company Limited, , First Floor, Sunclrare Building, 21 Dreyer Street, Claremont, 7708, Cape Town, South Africa ISBN: 978 0 70218 921 0.

Degani, C.M. and Cordoso, F. E. (2002), *Environmental Performance and Lean Construction Concepts: Can We talk about a 'Clean Construction?, Proceedings of the 10th Conference of the International Group for Lean Construction*, Lean Construction Institute, (LCI), Civil Construction Engineering Department, Escola Politecnica, University of Sao Paulo, Brazil.

Dell' Isola, A., P., E., (1997), *Value Engineering: Practical Applications…For Design, Construction, Maintenance and Operations*, Wiley (John Wiley and Sons), Hoboken, New Jersey, USA. ISBN: 978 0 87626 463 5.

Demir, S.T., Bryde, D.J., Fearon, D.J. and Ochieng, E.G. (2012). *Re-Conceptualizing Lean in Construction Environments: 'The Case for "AgiLean" Project Management'* 48th Associated Schools of Construction, (ASC) Annual International Conference Proceedings,

Dess, G.G., Lumpkin, G.T. and Eisner, A.B. (2007), *Strategic Management: Text and Cases*, McGraw Hill/Irwin Companies Inc. 1221 Avenue of Americas, New York, NY, 10020. ISBN: 13 978 0 07 067740 1, ISBN: 10 07 067740 9.

Dessler, G. (2013), *Human Resource Management*, Pearson Education Limited, Edinburgh Gate, Harlow, Essex CM20 2JE, England, UK, ISBN 13 978 0 273 76602 5

Doole, I. and Lowe, R. (2005), *Strategic Marketing Decisions in Global Markets*, Thomson Learning, High Holborn House, 50-51 Bedford Row, London, WC1R 4LR, UK. ISBN: 1 84480 142 X.

Duncan, W.R., (1996), A *Guide to the Project Management Body of Knowledge*, PMI Standards Committee, Project Management Institute (PMI), Four Campus Boulevard, Newton Square, PA 19073 3299, USA. ISBN: 1 880410 12 5

Edvardsson, E. (2010), *Evaluation of Dust Suppressants for gravel roads: Methods Development and efficiency Studies*, Doctoral Thesis, Department of Civil and Engineering, Architectural Royal Institute of Technology, Division of Highway and Railway Engineering, SE – 100 44 Stockholm, Sweden, ISSN 1650 86 X, ISBN 978 91 7415 612 6

Egan John (Sir). (1997), Rethinking Construction, *The Report of Construction Task Force,*UK

Elshahat, M.F. (2006), *Cost Information and Strategic Planning in the Egyptian Private Sector*, Doctoral Thesis, Aim Shams, University of Egypt, Cairo, Egypt, ISBN 10 90 5278 552 X, ISBN 13 978 90 5278 552 3

Estrella, M. and Gaventa, J. (n.d), *Who Counts Reality? Participatory Monitoring and Evaluation: A Literature Review*, IDS Working Paper 70.

Evans, J.R. and Lindsay, W.M. (2011), *The Management and Control of Quality*, South Western, Cengage Learning, Canada, ISBN-13;978-0-538-45260-1 or ISBN-10:0-538-45260-9

Evans, S.T. and Rodgers, P. (2008). *Clarifying Con-Wip Versus Pull System Behaviour Using Simulation, Proceedings of the 2008 Winter Simulation Conference,* Research paper, Department of Mechanical and Manufacturing Engineering University of Calgary Calgary, AB., T2N-1N4, CANADA.

Family Health International (FHI). (2004), *Introduction to Monitoring and Evaluation, Monitoring HIV/AIDS Programmes, A Facilitators Training Guide,* A USAID Resource for Prevention, Care and Treatment, Implementing AIDS Prevention and Care Project (Impact). HRN: A 00 97 0017 0.

Farag, M.A.M. (2008), *Egyptian Highway Construction Projects in Need of Lean Management,* PhD Paper, Institute for Technology and Construction Management, Karlsruhe University.

Feindel, K.(2010), *Gravel Road Maintenance Manual: A Guide for Landowners on Camp and other Gravel Roads*, Marine Department of Environmental Protection, Bureau of Land and Water Quality, USA.

Fellows, R. Langford, D. Newcombe, R., and Urry, S. (2007), *Construction Management in Practice,* Brackwell Science Limited, 9600 Garsington Road, Oxford OX4 2DQ, UK, ISBN:978-0632-06402-1.

Fellows, R. and Liu, A. (2006), *Research Methods for Construction,* Brackwell Science Limited, 9600 Garsington Road, Oxford OX4 2DQ, UK, ISBN: 13-978-0-632-06435-9.

Feng, P.P. and Ballard, G. (2010), *Standard Work from a Lean Theory Perspective,* PhD paper, Civil and Environmental Engineering, Department, University of California at Berkeley, CA, USA.

Fewings, P.(2008), *Construction Project Management, An Integrated Approach,* Taylor and Francis, 2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN, England, UK, ISBN:10:0-415-35905-8, ISBN:10-415-35906-6.

Fleming, Q., W and Koppelman, J., M (2010), *Earned Value Project Management,* Project Management Institute, Newtown, Pennsylvania 19073 – 3299 USA. ISBN: 978 1 935569 08 2.

FIDIC. (1999), *Conditions of Contract for Construction, For Building and Engineering Works Designed by the Employer,* World Trade Centre II, P.O Box 311, 1215, Geneva, 15, Switzerland, ISBN: 2 88432 022 9.

Field, M. and Keller, L. (1998), *Project Management,* Cengage Learning EMEA, Cheriton House, Northway Andover, Hampshire, SP10 5BE, United Kingdom. ISBN: 978 1 86152 274 0.

Filho, N. D., Heineck, L.F.M. and Da Costa, J.M. (2007), *A Project – Based View of the Link Between Strategy, Structure and Lean Construction.* Construtora Santo Amaro Ltda., Fortaleza-CE, Brazil.

Finn, T. (2007), *A Guide for Monitoring and Evaluating Population, Health, Environmental Programmes,* USAID and Measure Evaluation.

Fisher C et al. (2004), *Researching and Writing a dissertation for Business Students,* Prentice Hall, London, England, UK, ISBN 10 0273 68334 9, ISBN:13: 978 0 273 68334 6.

Fria, T.R. (2005), *Successful RFPs in Construction: Managing the For Proposal Process,* McGraw Hill Companies, Two Plaza, New York, NY, 10121-2298, USA. ISBN: 0 07 144909 4.

Fryer, B., Fryer, M, Egbu, C., Ellis, R and Gorse, C (2008), *The Practice of Construction Management,* Blackwell Publishing Limited, 9600 Garsington Road, Oxford OX4 2DQ, UK, ISBN: 978-1-4051-1110-2.

Galluzo, M. D. (2011), *Performance Based Contracting; A Concept for cost effective operation and maintenance of wind power plants,* Master Thesis, Gotland University.

Garnett, N. A. (1999), *Developing Lean Thinking in Construction: A Naturalistic Enquiry, Proceedings of IGLC-7,* University of California, Berkeley, CA, USA.

Garnett, N., Daniel, J. and Murray, S. (1998), *Strategic Application of Lean Thinking,* Lean Construction Institute, (LCI), IGCL, UK.

Garnett,N. Daniel, J. and Murray, S. (1998), *Strategic Application of Lean Thinking*, Proceedings of IGLC 1998.

Geertsema, C.J. (2003), *Emerging Trends of the Owner - Contractor Relationship for Capital Facility Projects, from the Contractor's Perspective,* Report. 32, Centre for Construction Industry Studies, The University of Texas at Austin, Austin, Texas, USA.

Genesee Transportation Council, (n.d), *Managing Unpaved Roads,* 50 West Main Street, Suite 8112, Rochester, New York, 14614, USA.

George, M.L. (2003), *Lean Six Sigma for Service, How to use Lean speed and Six Sigma Quality to Improve Services and Transactions,* McGraw-Hill Companies, New York, United States of America, ISBN 0 07 143635 9.

George, M.O.(2010), *The Lean Six Sigma, Guide to doing more with less,* John Wiley & Sons, Hoboken, New Jersey, USA, ISBN 978 0 470 53957 6.

Georgescu, D.D. (2011). *Lean Thinking, Transferring Management: The Best Defense against an Economic Recession? European Journal of Interdisciplinary Studies.* The Polytechnic University of Bucharest.

Ghosh,B.N. (2011), *Scientific Method and Social Research,* Sterling Publishers Private Limited, A-59 Okhala Industrial Area, Phase II, New Delhi, 110020, India. ISBN: 97881 207 5790 5.

Gibson, L.J., Ivancevich, J.M., Donnelly, Jr., J.H. and Konopaske, R. (2012), *Organisations: Behaviour, Structure, Processes,* McGraw Hill Companies, 1221 Avenue of Americas, New York, NY, 10020, New Jersey, USA. ISBN: 978 007 108641 7.

Glatthorn and Joyner. (2005), *Writing the Winning Thesis or Dissertation, A Step-by-Step Guide,* Corwin Press, London EC1Y 1SP, UK, ISBN 0 7619 3961 – x.

Gonzalez, V., Alarcon, L.F., and Gazmuri, P., (2005), *Design of Work in Process Buffers In Reflective Building Project: A Case Study, Proceedings of the 14th Conference of the International Group for Lean Construction,* Escuela de Ingeniería, Universidad Católica de Chile, Casilla 306, Correo 22, Santiago, Chile.

Gosling, L. (2010), *Monitoring and Evaluation; How to guide,* Bond for International Development.

Gottlieb, S.C. and Jessen, J.S. (2011), *Partnering and the Traditional, Institutional Determinants of Governments in Danish Construction,* Management and Innovation for Sustainability Built Environment, Danish Building Research Institute, Alborg University, Copenhagen, Denmark, Technical University of Denmark, Denmark. ISBN, 9789052693958.

Gransberg, D.D. Scheepbouwer, E. and Tighe, S.L. (2008), *Performance Specified Maintenance Contracting: The New Zealand Approach to Pavement Preservation,* University of Oklahoma, Construction Science Division, Norman, Oklahoma, United States of America (USA).

Gravetter, F.J. and Forzano, L.B. (2009), *Research Methods for Behavioural Sciences,* Wadsworth, 20 Davis Drive, Belmont, CA 940002 3098, USA. ISBN 13: 978 -0-495-50983-7, ISBN: 10: 0-495-50983-3.

Green S.D. (2005), *The Dark Side of Lean Construction: Exploitation and Ideology, Proceedings of IGLC -7 ,* Lean Construction Institute, (LCI), Department of Construction Management and Engineering, University of Reading, Whiteknights, P.O. 219, Reading, RG6 6AW, UK.

Green, S.D. and Susan, C.M. (2007). *Lean Construction: Arenas of Enactment, Models of Diffusion, and the Meaning of 'Leanness'*. PhD paper, School of Construction Management and Engineering, The University of Reading, PO Box 219, Reading, RG6 6AW, UK.

Greer, R. C. and Plunkett, W. R. (2007), *Supervisory Management,* Pearson Education, Prentice Hall, Upper Saddle River, New Jersey 07458, USA, ISBN 0 13 229412 3.

Griffith, A., Khalid, B. and Institution of Civil Engineers. (2009), Managing *Quality, Safety and Environment,* Vol 162, pp11, Thomas Telford Training, UK.

Guijt, I. (1999), *Socio Economic Methodologies for Natural Resources Research Best Practice Guidelines, Participatory Monitory and Evaluation for Natural Resource Management and Research,* International Institute for Environment and Development, DFID, Natural Resources Institute, CAB International, Wallingford, Oxon, OX10 8DE, UK. ISBN: 0 85954 496 6.

Halpin, D.W. and Kuechmann, M. (2002), *Lean Construction and Simulation, Proceedings of Winter Simulation Conference,* Division of Construction Engineering and Management, School of Civil Engineering Purdue University West Lafayette, IN 47907-1294, U.S.A.

Hammersley, H. (2002), *Value Management in Construction,* Coventry, UK

Hannagan, T. (2008), *Management, Concepts and Practices,* Pearson Education Limited, Edinburgh Gate, Harlow, Essex CM20 2JE, England, UK, ISBN 978 0 273 71118 6.

Harper, W. W. (1991), *Statistics, Business Handbook,* The M & E Handbook series, England, UK. ISBN: 0 7121 1899 3, ISBN: (ISE) 0 7121 1898 5.

Harris et al. (2006), *Modern Construction Management,* Blackwell Publishing Limited, Garsington road Oxford, OX4 2DQ, UK, ISBN 978-4051-3325-8.

Harris, F. (1989), *Modern Construction Equipment and Methods,* Longman Scientific and Technical, Longman House, Burnt Hill, Harlow, Essex CM20 2JE, England, UK. ISBN: 0 582 03196 6.

Harris, F. McCaffer, R. and Fotwe F, (2011), *Modern Construction Management,* Blackwell, Garsington road, Oxford oX4 2DG, UK, ISBN 978 1 4051 8

Harry, M. and Schroeder, R. (2005), *Six Sigma: The Breakthrough Management Strategy, Revolutionizing the World's Top Corporations,* Currency Books, Random House, New York, USA. ISBN: 0 385 49438 6.

Hass, K.B. (2009*), Managing Complex Projects: A New Model,* Management Concepts, 8230 Leesburg Pike Suite, 800, Venna, VA, USA. ISBN: 978 1 56726 233 9.

Heggie, I., G. (1999), *Managing and Financing of Roads: An Agenda for Reform,* World Bank Technical paper 275, Africa Technical Series, Washington D.C. USA.

Henderson M.G, Van Zyl G.D. and Naidoo, P.D (2004), *A Gravel Management System of Operations for Construction and Maintenance of Gravel Roads.* Transport and Public Works Department, Western Cape Provincial Administration, Naidoo & Associates, Cape Town, South Africa.

Hendrickson, C (2008), *Project Management for Construction, Fundamental Concepts for Owners, Engineers, Architects and Builders,* Department of Civil and Environmental Engineering, Carnegie Mellon University, Pittsburgh, PA l52l3.

Henning, T.F.P, Giummarra, G.J. and Roux, D.C (2008), *The Development of Gravel deterioration models for adoption in a New Zealand Gravel Management System,* Land Transport New Zealand, Research Report 348, Waterloo Quay, Wellington, New Zealand. ISBN: 978 0 478 30977 5, ISSN: 1177 0600.

Henrich, G. Bertelsen, S and Koskela, L. (2005), *Construction Physics: Understanding the Flows in Construction Process, Proceedings of the 14th Conference of the International Group for Lean Construction*, Lean Construction Institute, (LCI), University of Salford, Salford, UK.

Henrik, K. and Arleroth, J. (2011), *Waste In Lean Construction, A Case study of a PEAB Construction site and the development of Lean Construction Tool,* Master Thesis, Department of Technology Management and Economics, Division of Logistics and Transportation, Chalmers University of Technology, Gothenburg, Sweden, Report No. E 2011: 066.

Herold, D.M. and Ferdor, D.B. (2008), *Leading Change Management, Leadership Strategies that really work*, Kogan Page Limited, 120 Pentonville Road, London N1 9JN, United Kingdom, ISBN 978 0 7494 5331 2.

Heyworth, F. (2002), *A guide to Project Management*, European Centre for Modern Languages, Council of Europe Publishing, F 67075 Strasbourg Cedex: ISBN: 92 871 4965 8.

Hill, C.W.L. (2013), *International Business: Competing in the Global Marketplace,* McGraw Hill/Irwin Companies Inc. 1221 Avenue of Americas, New York, NY, 10020, USA. ISBN: 13 978 0 07 714065 6, ISBN: 10 07 0714065 6.

Hill, C.W.L. and Jones, G.R. (2001), *Strategic Management Theory: An Integrated Approach,* Houghton and Company limited, 222 Berkeley Street, Boston, MA 02116 3764, USA. ISBN: 0 618 1472 7.

Hillier, F. S. and Hillier, M. S. (2003), *Introduction Management Science: A Modeling and Case Studies Approach with Spreadsheets.* McGraw – Hill/Irwin Companies Inc, 1221 Avenue of the Americas, New York, NY, 10020, USA.

Hindle, T. (2008), *Guide to Management Ideas and Gurus,* The Economist in Association with Profile Books Limited, 3A Exmouth House, Pine Street, London, EC1R OJH, UK. ISBN: 978 1 84668 108 0.

Hook, M. and Stehn, L. (2008), *Lean Principles in Industrialized Housing Production: The Need for a Cultural Change.* Lean Construction Journal, Lean Construction Institute (LCI), International Group for Lean Construction, (IGLC).

Hopp, W.J., and Spearman, M.L. (n.d), *Factory Physics: Foundations of Manufacturing Management.* Second Edition, Irwin, McGraw – Hill, New York, NY, USA.

Hornsby, A. S. (2013), *Oxford Advanced Learner's Dictionary: International Student's Edition,* Oxford University Press, Great Clarendon Street, OX2 6DP, United Kingdom. ISBN: 978 0 19 479912 6.

Houvilla, P. and Koskela, L. (1999*). Contribution of the Lean Construction Principles of Lean Construction to Meet Challenges of Sustainability Development, Proceeding of IGLC '98',* Lean Construction Institute, VIT Building Technology, Technical Research Center of Finland, Helsinki University of Technology, Finland.

Howell, G. A. (1999). *What Is Lean Construction? Proceedings of the 7th Conference of the International Group for Lean Construction,* Berkeley, California, USA, 26-28 July1999.

Howell, G. and Ballard, G. (1999), *Design of Construction Operations,* Lean Construction Institute, (LCI), Lean Construction Implementation Workshop,White paper-4, University of California, Berkeley, USA.

Hoyer, W. and McInnis, D. J. (2007), *Consumer Behaviour,* Houghton Mifflin Company, Boston, New York, USA. ISBN: 13 978 0 618 64372 1, ISBN: 10 0 618 64372 9.

HSE. (2007), *Want Construction work done safely, A quick guide for clients on construction (Design and Management, 2007),* London, UK, ISBN 978 0 71766246 3.

Hunter, J. (2009), *Monitoring and Evaluation: Are we making a Difference?* Namibia Institute of Democracy, Windhoek, Namibia. ISBN: 978 99916 860 0 4.

Hyman, W.A (2009), Performance Based Contracting Maintenance, A Synthesis of Highway Practice, NCHRP 389, Transportation Research Board, Washington D.C. USA. ISBN: 0547 5570.

Ibbs, C.W., Wong, C.K. and Kwak, Y.H. (2001), *Project Change Management System*, Journal of Management in Engineering, Department of Civil and Environmental Engineering, University of California, Berkeley, CA, 94720, USA.

International Federation of Red Cross and Red Crescent Societies. (2011), *Programme/Project Monitoring and Evaluation, (M & E) guide*. P.O. Box 372, CH 1211, Geneva 19, Switzerland.

International Labour Organisation (ILO). (2007), *Evaluation Guidance: Considering Gender in Monitoring and Evaluation of Projects*, International Labour Office, Evaluation Unit.

International Union for Conservation of Nature and Natural Resources (IUCN). (2004), *Core Concepts in Planning, Monitoring and Evaluation, (PM & E), of Projects in IUCN: An IUCN Training Course for Project Managers, Participants Manual*, The IUCN Monitoring and Evaluation Office, Rue Mauverney 28, Gland, Switzerland, CH 1196.

Isato, E.L. and Fornoso, C.T. (1999). *Design and Production Interface in Lean Production: A Performance Improvement Criteria Proposition.* NORIE/UFRGS, Av. Osvaldo Aranha, 99/3º andar, Porto Alegre, RS, Brazil, CEP 90.035-190.

ITC. (2004), Principles of Lean Thinking, Tools & Techniques for advanced Manufacturing, *Journal for National Research Council, Canada & Industrial Research Assistance Programme.*

Jacobs, F., R and Chase, R., B (2014), *Operations and Supply Chain Management*, McGraw Hill Education (UK) Limited, UK. ISBN: 13 9780077151621.

Jacobs, K. (2011), *Review of Lean Research Studies and Relationship to the Toyota Production Research Framework. 47th Associated Schools of Construction (ASC) Conference Proceedings,* California Baptist University, Riverside, California, USA.

Jahren, C.T., Smith, D., Thorius, J., Rukashaza-Mukome, M., White, D., and Johnson, G. (2005), *Economics of Upgrading Aggregate Roads; Final Report*, Minnesota Department of Transportation, Research Services Section, 395 John Ireland Blvd, Ms 330, St. Paul, MN 55155.

Jallow, A.K, Demain, P, Baldwin, A.N. and Anumba, C.J. (2010), *An Integrated Requirements Management Systems for Construction Projects*, Research paper, Civil and Building Engineering Department, Loughborough University, Leicestershire, UK, Department of Architectural Engineering, The Pennsylvania State University, USA.

Jessop, D. and Morrison, A. (1994), *Storage and Supply of Materials: Inbound Logistics for Commerce, Industry and Public understandings*, Pearson Education Limited, Edinburgh Gate, Harlow, Essex CM20 2JE, England, UK. ISBN: 13 978 0 273 60323 8.

Johannassen, B. (1997), *Labour Based Road Construction and Maintenance Technology: Course Notes*, National Polytechnic Institute of Communication and Transport, International Labour Organisation (ILO), Vientiane.

John, B. (2009), *Writing a Report, how to prepare, write and present really effective report*, Begbroke, Oxford OX5 IRX, UK, ISBN 978 1 84528 293 6.

Johnson, S. (n.d), *Who Moved the Cheese? Amazing Way to Deal with Change in Your Work and in Your Life*. San Diego, USA.

Jones, T. E. (1984), *The Kenya Maintenance Study on Unpaved Roads: Research on Deterioration*, Overseas Unit, Transport and Road Research Laboratory, Crowthorne, Berkshire, UK, ISBN: 0305 1293.

Jorgensen, B. (2006), Integrating *Lean Design and Lean Construction: Process and Methods*, Doctoral Thesis, The Department of Civil Engineering, The Technical University of Denmark, (DTU), Denmark, ISBN 87 7877 223 0.

Karim, A. and Nekoufar, S. (2010), *Lean Project Management, In Large Scale Industrial and Infrastructure Project via Standardization*, Research paper, Faculty of Built Environment and Engineering, Queensland University of Technology, Queensland, Australia.

Karvinen, K. and Bennett, D. (2003), *Introducing Customer Orientation Into the Operations the Building Components Industry*. Eastern Industries Pte Ltd, Singapore. Aston Business School, Birmingham UK and International Graduate School of Management, University of South Australia, Adelaide, South Australia.

Kasongo R.M. (2009), *Health Safety Implication for Older Workers in the UK Construction Industry,* MSc Thesis, Loughborough University, Leicestershire, East Midlands, United Kingdom.

Kaul, A. (2000), *Effective Business Communication*, PHI Learning Private Limited, New Delhi, India. ISBN: 978 91 203 1709 3.

Kelly, J., and Male, S (1998), Value Management *in Design and Construction, The Economic Management of Projects,* Taylor & Francis, Milton Park, Abingdon, Oxon, Oxford OX14 4RN, UK. ISBN: 0 419 15120 6.

Kelly, J., Male, S., and Graham, D (2004), *Value Management of Construction projects,* Blackwell Publishing, 9600 Garsington Road, Oxford OX4 2DQ, UK. ISBN: 978 0 632 05143 4.

Kelly, J., Morledge, R., and Wilkinson, S (2006), Best *Value in Construction,* Blackwell Publishing, 9600 Garsington Road, Oxford OX4 2DQ, UK. ISBN: 10 0 632 05611 8.

Kerzener, H (2001), *Strategic Planning for Project Management Using A Project Management Maturity Model,* John Wiley & Sons, Toronto, Canada. ISBN: 0 471 40039 4.

Khanzode, A. (2010), *A integrated Virtual Design and Construction and Lean (IVL),Method for Coordinating of MEP,* CIFE Technical Report, Centre for Integrated Facility Engineering (CIFE), Civil and Environmental Engineering Department, Stanford University, USA, The Jerry Yang & Akiko Yamazaki Environment & Energy Building 473 Via Ortega, Room 292, Mail Code: 4020 Stanford, CA 94305-4020.

Kim H, (2009), *PMP-Project Management Professional Exam Study Guide,* Wiley Publishing Inc. Indianapolis, Indiana, USA. ISBN: 978 0 470 45558 6.

Kim, Y. and Ballard, G. (2000), *Is the Earned – Value Method an Enemy of Work Flow,* PhD paper, Construction Engineering and Management programme, Civil and

Environmental Engineering Department, 215 Mclaughlin Hall, N0.1712 University of California at Berkeley, CA 94920, USA.

Kim, Y. Ballard, G. (2000), *Activity – Based Costing and its application to Lean Construction, Proceedings of the 9th Conference of the International Group for Lean Construction*, PhD paper, Construction Engineering and Management programme, Civil and Environmental Engineering Department, 215 Mclaughlin Hall, N0.1712 University of California at Berkeley, CA 94920, USA.

Kirkham, R., Greenhalgh, B. and Waterman, A. (2008), *Ferry and Brandon's Cost Planning of Buildings, Blackwell Publishing,* Blackwell Publishing Limited, 9600 Carrington Road, Oxford, OX4 2DQ, UK. ISBN: 978 1 4051 3070 7.

Kleiner, A. (2004), *Leaning Toward Toyota Production System, (TPS), Has Revolutionized Industry, James Womack and Daniel Jones belief it can Transform the World,* New York University, USA.

Knuf, J. (2000), *Benchmarking The Lean Enterprise: Organization Learning at Work,* Peer Reviewed Paper, Journal of Management in Engineering, Lean Construction (LCI), International Group for Lean Construction (IGLC).

Koch, C. and Simonsen R. (2006), *Operations Strategy and Innovation? A Contractor Implementing Lean,* Department of Civil Engineering, Technical University of Denmark, DK- 2800 Lyngby, Denmark.

Koskela, L. (1992), *Application of the New Production Philosophy to Construction,* CIFE Technical Report, Centre for Integrated Facility Engineering (CIFE), Stanford University, USA, VIT Building Technology, Technical Research Center of Finland, Helsinki University of Technology, Finland.

Koskela, L. (2000), *An Exploration towards a Production Theory and its application to Construction,* PhD Thesis, VTT Building Technology, Technical Research Center of Finland, Helsinki University of Technology, Finland.

Koskela, L. (2004), *Moving on-Beyond Lean Thinking,* Lean Construction Journal, The University of Salford, School of Construction and Property Management, Salford M7 1NU, United Kingdom, VIT Building Technology, Technical Research Center of Finland, Helsinki University of Technology, Finland.

Koskela, L. and Vrijhoel, R. (2000), *The Prevalent Theory of Construction is an Hindrance to Innovation* , PhD paper, VTT Building Technology, Technical Research Center of Finland, Helsinki University of Technology, P.O. Box 1801, FIN-02044, Finland.

Kotler, P. and Keller, K. L. (2012), *Marketing Management,* Pearson Education Limited, Edinburgh Gate, Harlow, Essex CM20 2JE, England, UK. ISBN: 13 978 0 273 75336 0, ISBN: 10 0 273 75336 3.

Kovacheva, A. V. (2010), *Challenges in Lean Implementation, Successful Transformation towards Lean Enterprise,* Master Thesis, Aarhus School of Business, University of Aarhus, AARHUS.

Krajewski, L., J., Ritzman, L. P. and Malhotra, M. K. (2013), *Operations Management: Process and Supply Chains,* Pearson Education Limited, Edinburgh Gate, Harlow, Essex CM20 2JE, England, UK, ISBN: 10-0-273-76683-X, ISBN: 13-978-0-76683-4.

Kreamer, K., Henrich, G., Koskela, L. And Kagioglou, M. (2002), *How Construction Flows have been understood in Lean Construction,* University of Salford, UK, M5 4WT.

Krinner, M., Elezi, F., Tommelein, I.D. and Lindemann, U. (2001), *Managing Complexity in Construction Design-Using The MDM Methodology to Create Organization Modularity.* Institute of Product Development, Technische Universität München, Germany, Department of Civil and Environmental Engineering, University of California, Berkeley, USA.

Kumar, A. (2010), *Lean Construction in Building Industry*. CEE 597, Independent Study, Department of Civil & Environmental Engineering, University of Illinois at Urbana Champaign. 61801. U.S.A.

Kumar, S.A. and Suresh, N. (2008), *Production and Operations Management, With Skill Development Case - lets and Cases,* New Age International Limited Publishers, 4835/24, Ansari Road, Daryaganj, New Delhi 110002, India. ISBN 978 81 224 2425 6.

Kusek, J.Z. and Rist, R.C. (2004), *A Hand Book for Practioners; Ten Steps to a Results Based Monitoring and Evaluation System,* The International Bank for Reconstruction and Development/The World Bank, 1818 H Street, NW, Washington, D.C, 20433. ISBN: 0 8213 5823 5.

Laitineni, J. (1999), *Model Based Construction Process Management,* Research paper, YIT Corporation, Helsinki, Finland, Institute for Research in Construction, Ottawa ON, K1A 0R6,Canada.

Lancelot, E. (2010), *Performance Based Road Contracts in the Road Sector: Towards Improved Efficiency in Management and Rehabilitation, the Brazil Experience, Transport papers,* the World Bank Group, Washington D.C., TP-31.

Larson, E.K. and Gray, C.F. (2011), *Project Management, the Managerial process,* McGraw Hill, New York, USA, ISBN 978-007-128929-0 or MHD 007-128929-1.

Latham Michael (Sir). (1994), Constructing the Team, *Joint Review of Procurement and Contractual Arrangements in the United Kingdom Construction Industry,* HMSO, UK, ISBN 0 11 752994 X

Leman, T. and Reiser, P. (2005), *Maximizing Value and Minimizing Waste; Value Engineering and Lean Construction,* The Boldt Company, 2525 Roemer Rd, P.O Box 419, Appleton, WI 54912 0419.

Leng. T.W. (2004), *The application of Lean Construction to reduce waste in Construction Process,* School of Housing of Building & Planning, Universiti Sains Malaysia.

Leonard, J.F. (1997), *Physicist Transformed the Quality of Management*. American Institute of Physicists, (AIP). Industrial Physicists Journal, Woodstock, Connecticut, USA.

Lester, A (2006), Project *Management, Planning and Control,* Managing Engineering, Construction and Manufacturing projects to PMI, APM and BSI Standards, Elsevier Science & Technology Books, ISBN: 075066956 X.

Levik, R. (n.d.), *How to sell the Message 'Road Maintenance is Necessary to decision Makers,* Assistant Director General, Norwegian Public Roads Administration.

Life Cycle Asset Management, LCAM. (1997), *Value Management, It not just a good idea it is law,* Good Practice Guide, Department of Energy, Office of Field Management, Office of Project and Fixed Asset Management, SAVE International.

Liker, J., K and Hoseus, M (2008), *Toyota Culture, The Heart and Soul of the Toyota Way,* McGraw Hill, New York, USA, ISBN 978 0 07 149217 1.

Liker, J., K and Meier, D (2006), *Toyota Way Fieldbook, A Practical Guide for* Implementing Toyota's 4Ps, McGraw Hill, New York, USA, ISBN 0 07 144893 4.

Liker, J., K and Meier, D., P (2007), Toyota Talent, Developing your people the Toyota Way, McGraw Hill, New York, USA, ISBN 13 978 0 07 147745 1.

Liker, J., K and Convis, G., L (2007), *The Toyota Way to Lean Leadership,* McGraw Hill, New York, USA, ISBN 13 978 0 07 178078 0.

Liker, J.,K. and Franz .J.K. (2011), *The Toyota Way to Continuous improvement, Linking Strategy and Operational excellence to achieve superior performance,* London, UK, ISBN978 0 07 147746 8.

Liker, J.K. (2004), *The Toyota Way, 14 Management principles from world's greatest Manufacturer,* London, UK, ISBN 13 978 0 07 058747 2, 21st reprint, 2010.

Lind, D., A., Marchal, W.G. and Wathen, S.A. (2012), *Statistical Techniques in Business and Economics,* McGraw Hill/Irwin, 1221 Avenue of the Americas, New York, NY, 10020, USA. ISBN 978-0-07-131698-9.

Lowenthal, J.N (2010), *Six Sigma Project Management; A Pocket Guide,* American Society for Quality (ASQ) Press, Milwaukee, Wisconsin, USA. ISBN: 978 81 234 2802 5.

Lucy, T. (2007), *Quantitative Techniques,* Cengage Learning, Cheriton House, North Way, Andover, Hants SP10 5BE, London, UK. ISBN-13: 978 – 84480 -111-4

Lysons, K. and Farrington, B. (2012), *Purchasing and Supply Chain Management,* Pearson Education Limited, Edinburgh Gate, Harlow, Essex CM20 2JE, England, UK, ISBN: 978-0-273-72368-4.

Macmillan, H. and Tampoe, M. (2000), *Strategic Management: Process, Content and Implementation,* Oxford University Press, Great Clarendon Street, Oxford OX2 6DP, England, UK. ISBN: 978 0 19 878229 2.

Madigan, D. (1997), *The Standard New Road Project, Benchmark Method*, Agile Construction Initiative, Agile, School of Management, University of Bath, Bath BA2 7AY, UK. ACI/DLV/96/017.

Maleyeff, J. (2007), *Improving Service Delivery In Government with Lean Six Sigma*, Lally School of Management and Technology, Rensellaer Polytechnic Institute, Hartford Campus, IBM Centre for the Business Government.

Mamoekesintho and Tumelo Tsikoane National University of Lesotho. (2003), *Integrating Gender into World Bank Financed Transport Programs, Case study of Lesotho, Integrating Gender into the Ireland AID financed Rural Roads and Access Programs*, Lesotho.

Mangheni, M.N. and Bukenya, C. (2003), *Participatory Monitoring and Evaluation for Uganda's National Agricultural Advisory Services Programme: Development of Methodology, Capacity Building and Piloting, Final Report, Volume One*, Department of Agricultural Extension Education, Makerere University, Uganda.

Maqsood, T., Finegan, A.D. and Walter, D.H.T. (2004), *Five Case Studies Applying Soft Systems Methodology to Knowledge Management,* PhD Research paper, CRC for Construction Innovation, RMIT University, Melbourne, Victoria, Australia.

Maramaldo, (2002), *Wealth generation through value,* Journal for Value Management, Vol.8 No.1, 2002, the Hong Kong Institute of Value Management, (HKIVM) ISSN 1029-0982, Wanchai, Hong Kong.

Martin, J. and Fellenz, M. (2010), *Organisational behaviour and Management,* Cengage Learning EMEA, Cheriton House, Northway, Andover, Hampshire, SP10 5BE, United Kingdom. ISBN: 978 1 4080 1812 5.

Massachusetts Department of Environmental Protection Bureau of Resource Protection and U.S. Environmental Protection Agency, Region 1. (2001), *The Massachusetts Unpaved Roads BMP Manual, A Guide on how to improve water quality while addressing common problems,* Berkshire Regional Planning Commission, 33 Dunham Mall, Pittsfield, MA 01201. USA.

Maylor, H. (2010), *Project Management,* Pearson Education Limited, Edinburgh gate, Harlow, Essex, CM20 2JE, England, UK.

McCracken, J.,R. and Narayan, D. (1998), *Participation and Techniques, Tool Kit and Techniques,* The International Bank for Construction and Development/The World Bank, 1818 H Street, N.W. Washington, D.C. 20433, USA. ISBN: 0 8213 4186 3.

Mekong Capital. (2004), *Introduction to Lean Manufacturing for Vietnam*, MEKONG CAPITAL, Vietnam.

Miller, M.J. (n.d), *Reliability and Validity*, Res 600: Graduate Research Methods, Western International University, USA.

Ministry of Communication and Transport. (2002), *Transport policy,* Sector policy, Republic of Zambia, Lusaka.

Mintzberg, H., Lampel, J., Quinn, J.B. and Ghoshal, S. (2003), *The Strategy Process: Concepts, Contexts, Cases*, Pearson Education Limited, Edinburgh Gate, Harlow, Essex CM20 2JE, England, UK, ISBN: 0-13-122790-4.

Moen, R.D. and Norman, C.L. (2010)). *Circling Back: Clearing up Myths about Deming cycle and seeing how it keeps evolving*. Basic Quality, Associates in Process Improvement in Georgetown, TX.

Mohammad, N., et al, (2010), *Investigation of the Causes of Variation Orders in the Construction Building Project-A Study in the State of Selangor,* Journal of Building Performance, University of Partahanan National Malaysia, Kem Sungai Besi 57000, Malaysia, Kuala, Lumpur, Malaysia. ISSN: 2180 2106.

Mossman, A. (2005), *Last Planner, Collaborative Production Planning and Collaborative Programme Coordination*, Last Planner Overview, Lean Construction Institute, LCI, United Kingdom (UK).

Mossman, A. (2009), *Why is it UK Construction Industry going Lean with gutso*. Lean Construction Journal, Lean Construction Institute (LCI) International Group for Lean Construction (IGLC). 19 Whitehall, Stroud, GL5 1HA, UK 01453.

Mota, B.,P., Mota, R.R. and Alves, T.C.L, (2005), *Implementing Lean Construction Concepts In a Residential Project*, Civil Engineering, Federal University of Ceara, Brazil.

Mugumya,G. and Koyama, S. (2002), *Applying Participatory Monitoring and Evaluation (PM&E), Approaches to Weapons Collection and Weapons for Development Programmes.* Geneva, Switzerland.

Mullins, L.J.(2010), *Management and Organizational Behaviour*, Pearson Education Limited, Edinburgh Gate, Harlow, Essex CM20 2JE, England, UK, ISBN: 978-0-273-72408-7.

Mulwa, F.W. (2008), *Demystifying Participatory Community Development*, Paulines Publications Africa, Daughters of Saint Paul, P.O. Box 49026, 00100, Nairobi, GPO, Kenya, ISBN:9966 08 314 4.

Mulwa, F.W. (2008), *Participatory Monitoring and Evaluation of Community Projects*, Paulines Publications Africa, Daughters of Saint Paul, P.O. Box 49026, 00100, Nairobi, GPO, Kenya, ISBN:9966 08 314 6.

Muya, M. (2010), *Environmental Project Brief for the Borrow Pits on the Choma Output and Performance Based Road Contracts*, Department of Civil and Environmental Engineering, University of Zambia, P.O Box 32379, Lusaka, Zamba.

Myres, D. (2008), *Construction Economics: A new approach*, Taylor & Francis, 2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN, UK. ISBN: 0 415 46228 2, ISBN: 0 415 46229 0.

Nalewaik, A. (n.d) *Systemic Challenges in Construction: Change is the Only Constant*, Research paper, e-Builder, Integrated Capital Programme and Project Management Software, 2450 N., Lake Ave. No. 335 Altadena, CA 91001, USA.

National Research Council, ITC. (2004), *Principles of Lean Thinking, Tools and Techniques for Advanced Manufacturing*, Industrial Research Assistance Programme, Canada.

New South Wales (NSW) Treasury. (2004), Total Asset Management, Value Management Guidelines, TAM-14, Level 27 Governor Macquarie Tower 1 Farrer Place Sydney NSW2000, ISBN: 0-7313-32962.

Nicholas, J.M. (1990), *Managing Business and Engineering Projects: Concepts and Implementation*, Prentice Hall, Englewood Cliffs, New Jersey, USA, ISBN: 0 13 551854 7.

Nightgale, D. (2009), *Principles of Enterprise Systems, Second International Symposium on Engineering Systems,* Massachusetts Institute of Technology Cambridge, MA 02139-4307, USA.

Noe, R.A. (2012), *Human Resource Management: Gaining a Competitive Advantage,* McGraw Hill Companies Inc. 1221 Avenue of the Americas, New York, NY, 10020, USA. ISBN: 13 978 00771 4089 2, ISBN: 10 00771 4087 3.

Nulty, D. D. (2008), *The Adequacy of response rates to online and paper surveys, what can be done? Assessment and Evaluation in Higher Education, Vol. 33, No.3, 301-314,* Routledge, Taylor and Francis Group, Griffith University, Queensland, Australia.

O'Brien, W.J.(1998), *Construction Supply – Chain Management: A Vision for Advanced Coordination, Costing, and Control,* Department of Civil Engineering, University of Florida, P.O. Box 116580, 345, Weil Hall, Gainesville, FL 32611-6580, USA.

O'Flaherty, C., A (2002), The Location, *Design, Construction and Maintenance of pavements,* Elsevier Butterworth Heinemann, Linacre House, Jordan Hill, Oxford OX2 8DP, UK. ISBN: 0 7506 5090 7.

O'Grady, J. D. (2009), How *Apple Inc. Changed the World,* Jaico Publishing House, A-2 Jash chambers, 7-A Sir Phirozshah Mehta Road, Fort Mumbai-400 001. ISBN: 978 81 8495 054 0.

Olander, S. (2006), *External Stakeholders Analysis in Construction Project Management,* Doctoral Dissertation, Department of Construction Management, Lund University, P.O Box 118, Lund, SE 221 00 Lund, Sweden, ISSN 1651 0380, ISBN 91 85257 95 8.

Orr, C. (2005), *Lean Leadership in Construction, Proceedings of the 13th Conference of the International Group for Lean Construction,* Lean Construction Institute, (LCI), RWD Technologies, Birmingham, UK.

Orrechia, F. and Howell, G.A. (2000), *Reflections on Money and Lean Construction, Proceedings of the 7th Conference of the International Group for Lean Construction,* Berkeley, California, USA, 26-28 July1999.

Panthi, K. (2009), *A Methodology Framework for Modelling Pavement Maintenance Costs for Projects for Performance Based Contracts,* Doctoral Thesis, Florida International University, Miami, Florida, USA

Park, B. and Meir, R. (2007), *Reality-Based Construction Project Management, A Constraint Based 4D Simulation Environment,* Peer-Referred Article, National Association of Industrial Technology, USA.

Park, M. (2008), *Dynamic Change Management for Fast - Tracking Construction Projects,* Department of Building, School of Design and Environment, National University of Singapore, Singapore.

Partouche, R., Sacks, R. and Bertelsen, S. (2010). *Craft Construction, Mass Construction, Lean Construction: Lessons from the Empire Estate Building.* Faculty of Civil and Environmental Engineering, Technion – Israel Institute of Technology, Haifa 32000, Israel.

Pasha, S.,A., Sanganal, A. and Jagannatha, V. (n.d), *Training Module on; Project Formulation, Implementation, Monitoring and Evaluation: Urban Water Supply and Drainage Services,* Faculty (Development Economics and Planning), Administrative Training Institute, Mysore 570 011.

Pasteur, K. and Blauert, J. (2000), *Participatory Monitoring and Evaluation in Latin America: Overview of the Literature with Annotated Bibliography,* Institute of Developmental Studies (IDS), University of Sussex, Brighton, BN1 9RE, Sussex, England, UK.

Peel, E. (2007), *The Law of Contract,* Sweet & Maxwell, Thomson Reuters, 100 Avenue Road, London, NW3 3PF, United Kingdom. ISBN: 978 0 421 94840 2.

Pengelly, C., (2009), *State Monitoring and Evaluation Coordination Project, Final Report,* Department of Agriculture and Food, Australian Government, Sydney, Australia.

Pestana, A.C.V.M.F. and Alves, T.D.C.L. (2011), *Study of the Submittal Process Using Lean Production Principles,* Management and Innovation for Sustainable Built Environment, San Diego State University, San Diego, CA, USA. ISBN: 9789052693958.

PIARC. (1994), *International Road Maintenance Handbook: Practical Guidelines for Rural Road Maintenance,* Road Research Laboratory, Berkshire, England, UK. ISBN: 0 9521860 20.

Picchi F.,A. and Granja, A.D. (2002), Construction *Sites: Using Lean Principles to Seek Broader Implementation,* Research Article, Architecture and Construction Department, School of Civil Engineering, Architecture and Urban Design, University of Campinas, Campinas/SP, Brazil.

Pillai, M., Sandelands, E. and Ashokan, G. (2010), *Developing the Engineering, Procurement and Construction Companies (EPC) Value Chain in the Upstream Oil and Gas Sector in Middle East,* Middle East Oil and Gas Business, Kentz Qatar.

Pinard, M. (2006), *New Approaches to sustainable Provision of Low – Volume Sealed Roads,* World Bank Workshop, SSATP/World Bank Consultant, Accra, Ghana.

Plummer, J. (2010), *Efficiency Rating in Performance – Based Road Maintenance Contracts,* Master Thesis, Virginia University, Virginia Department of Transport, VDOT, USA.

Potts, K. (2008), *Construction Cost Management, Learning from Case Studies*, Taylor & Francis, 2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN, UK, ISBN: 10: 0 415 44287 7.

Public Private Infrastructure Advisory Facility (PPIAF), (2009), Tool kit for Public – Private Partnership in Roads & Highways, World Bank publication, Washington, D.C. USA.

Price, J. (1994), *Lean Production at Suzuki and Toyota: A Historical Perspective,* Studies in Political Economy.

Public Private Infrastructure Advisory Facility (PPIAF), (2009), *Country case study:* Zambia, World Bank publication, Washington, D.C. USA.

Public Private Partnerships in Roads & Highways (PPIAF). (2009), Country *Case study: Zambia,* World Bank, Washington D.C., USA.

Quagraine, V.K. (2007), *New Strategies to Improve the Management of Capacity of Contractors, for Labour Based Methods in Road Rehabilitation, in Ghana,* Doctoral

Dissertation, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, USA.

Raghuram, G. and Rangaraj, N. (2000), *Logistics and Supply Chain Management: Cases and Concepts,* Micmillan India Limited, Delhi, India. ISBN: 0333 93342 7.

Rahman, M.M., Kumaraswamy, M.M. and Rowlinson, S. (2003), *Performance Improvements through Flexible Organizational Cultures,* PhD Paper, CIB, TG 23 International Conference , University of Hong Kong, Hong Kong, China.

Richard, T.F. (2005), *Successful RFPs in Construction, Managing Request for Proposal process,* McGraw – Hill Companies/Professional, Two Penn Plaza, New York, NY, USA, ISBN: 0 07 144909 4.

Road Development Agency (2012*), Road Sector Annual Work Plan,* P.O Box 50003, Fairley Road, Lusaka, Zambia.

Road Development Agency. (2006 -2013) *Annual Reports,* P.O Box 50003, Fairley Road, Lusaka, Zambia.

Road Development Agency. (2008), *2nd Quarterly Report,* P.O Box 50003, Fairley Road, Lusaka, Zambia.

Roads Department Training School (2004), *Contractor's Handbook for Labour Based Road Works,* Intech Beusch & Co. ILO/ASIST, Harare, Zimbabwe.

Robbins, S.P. and Coulter, M. (2007), *Management,* Pearson Education International, Upper Saddle River, New Jersey 07458, USA.

Rother, M (2010), *Toyota KATA, Managing People For Improvement, Adaptiveness and Superior Results,* McGraw Hill Education, New York, USA. ISBN: 978 0 07 163523 4.

Rowan, K., Porter, P and Fergerstrom, R (2008), *Preliminary Report on Contract Format for Output and Performance Based Contracts for Roads,* Punjab State Road Sector Project Consultancy Services Project Preparatory Studies for Package II (Phase II), OPUS, No. 79, Sector 16A, Chandigarh, India.

Rumelt, R. P. (2011), *Good Strategy, Bad Strategy,* Crown Business Group, Random House Inc. New York, USA. ISBN: 978 0 307 8862 1.

Salem, O Solomon, J., Genaidy, A. and Luegring, M., (2006), *Lean Construction: From Theory to Implementation,* Journal of Management in Engineering, American Society of Civil Engineers, ASCE, USA.

Salem, O. and Zimmer, E. (2005), *Application of Lean Manufacturing Principles to Construction.* PhD Research paper review, Lean Construction Journal, Lean Construction Institute (LCI), Construction Engineering and Management Program, Deptartment of Civil and Environmental Engineering, University of Cincinnati, P.O. Box 210071, Cincinnati, OH 45221.

Salem, O., Solomon, J., Genaidy, A. and Luegring, M. (2005), *Site Implementation and Assessment of Lean Construction Techniques,* PhD Research paper, Construction Engineering and Management Program, Deptartment of Civil and Environmental Engineering, University of Cincinnati, P.O. Box 210071, Cincinnati, OH 45221.

Salem, O., Solomon, J., Genaidy, A. and Luegring, M.. (2005), *The Path from Lean Manufacturing to Lean Construction: Implementation and Evaluation of Lean Assembly,* PhD Research paper, Construction Engineering and Management Program, Department of Civil and Environmental Engineering, University of Cincinnati, P.O. Box 210071, Cincinnati, OH 45221.

Salkind, N.J. (2005), *Exploring Research,* Pearson Education, Upper Saddle River, New Jersey, 07458, USA. ISBN: 0 13 193783 9.

Sambare, R. (2012), *Modern Construction: Lean Project Delivery and Integrated Practices: Book Review,* Lean Construction Journal, Lean Construction Institute, UK and USA.

Sarhan, S. and Fox, A. (2013), *Barriers to Implementing Lean Construction in the UK Construction Industry,* Faculty of Science and Technology, University of Plymouth, UK.

Shahin, M., Y (2005), *Pavement Management for Airports, Roads, and Parking Lots,* Springer Science and Business Media, 233 Spring Street, New York, NY, 10013, USA. ISBN: 10 0 387 23464 0.

Saunders, M. (1997), *Strategic Purchasing & Supply Chain Management,* Pearson Education Limited, Edinburgh gate, Harlow, Essex CM20 2JE, England, UK.ISBN: 978 0 273 62382 3.

Saunders, M., Lewis, P. and Thornhill, A. (2012), *Research Methods for Business Students,* Pearson Education Limited, Edinburgh Gate, Harlow, Essex CM20 2JE, England, UK. ISBN: 978 0 273 75075 8.

SAVE International (2008), *Value methodology, a pocket Guide to Reduce Cost and Improve Value through Function Analysis,* Goal/QPC, Salem, NH, USA. ISBN 978 1 57681 105 4.

Scarborough, N. M. (2011), *Essentials of Entrepreneur and Small Business Management,* Pearson Education Limited, Edinburgh gate, Harlow, Essex CM20 2JE, England, UK.

Schliessler, A. (2006), *Issues in applying Output and Performance Based Road Contracts,* Transport Forum, World Bank, Washington D.C.

Scholes. K., Whittington, R. and Johnson, G. (2011), *Exploring Strategy, Text & Cases*, Edinburgh Gate, UK, ISBN 978 0 273 73549 6.

Schroeder, L. (1998), *Managing and Financing Rural Road Maintenance in Developing Countries,* Decentralization: Finance & Projects. Metropolitan Studies Program, Maxwell School of Citizenship, Syracuse University.

Scot, V. (2009), How *Google Changed the World,* Jaico Publishing House, A-2 Jash chambers, 7-A Sir Phirozshah Mehta Road, Fort Mumbai-400 001. ISBN: 978 81 8495 053 3.

Selim, A. A. and Skorsef, K. (n.d), *The New U.S.A. Gravel Road Manual*, South Dakota State University, USA.

Senaratne, S. and Sexton, M. (2008), *Managing Construction Project Change: A Knowledge Management Perspective,* Research paper, Research Institute for the Built and Human Environment, University of Salford, Salford, UK.

Sezen, B. and Erdogan, S. (2009), Lean *Philosophy in Strategic Supply Chain Management and Value creating,* Gebze Institute of Technology, Turkey.

Shah, K.R. (2011), *Innovative Methodology for Location – based Scheduling and Visualization of Earthworks in Road Construction Projects*, Unpublished PhD Thesis, Teesside University.

Shalker, R.J. (2007), *The Construction Project Manager,* Lean Construction Institute (LCI) and International Group of Lean Construction (IGLC).

Shen, G.Q.P. and Liu, G. (2002), *Journal of Value Management,* The Hong Kong Institute of Value Management, HKIVM, Hong Kong, Vol. 8. No. 1. 2002, ISBN 1029 0982.

Shimizu, J.Y. and Cordoso, F.F. (2002), *Subcontracting and Cooperation Network in Building Construction: A Literature Review,* Civil Construction Engineering Department, Escola Politecnica, University of Sao Paulo. CNPq grants. Av Prof Almeida Prado, travessa 2, 83, Sao Paulo, SP, 05508-900, Brazil,

Simchi, D., Kaminsky, P. and Simchi, E. (2009), *Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies,* McGraw Hill Companies, 1221 Avenue of the Americas, New York NY, 10020, USA.

Simonsson, P. and Emborg, M. (2007), *Industrialization of in Swedish Bridge Engineering: A Case Study of Lean Construction,* Division of Structural Engineering, Lulea University of Technology, 971 87 Lulea, Sweden.

Slack, N. and Lewis, M. (2011), *Operations Strategy,* Pearson Education Limited, Edinburgh Gate, Harlow, Essex CM20 2JE, England, UK,ISBN:978-0-273-74044-5.

Slack, N. and Lewis, M (2010), *Operations Management*, Pearson Education Limited, Edinburgh Gate, Harlow, Essex CM20 2JE, England, UK,ISBN:978-0-273-73046-0.

Slocum, N. (2005), *Participatory Methods Toolkit. A Practioner's Manual Method, Participatory Assessment, Monitoring and Evaluation,* United Nations University, Comparative Regional Integration Studies, Legal Depot, D/2005/2893/19. ISBN: 90 5130 506 0.

Soares, R. (2012), *Change Orders Ordeal: The Output of Project Disintegration*, Research paper, International Journal of Business, Humanities and Technology, College of Computing, Engineering and Construction, University of North Florida, Jacksonville, Florida, USA.

Song, L., Liang, D. and Javkhedkar, A.M.T. (2008), *A Case Study on Applying Lean Construction to Concrete Construction Projects.* University of Houston, Houston, Texas, USA.

Soto, L., Minami, N.A. and Rhodes, D. (2005), *Improving the Naval Construction Process Through Lean Implementation,* United States Navy, Massachusetts Institute of Technology, 77 – Massachusetts Avenue, Cambridge, MA, USA.

Sriprasert, E. and Darwood, N. (2002), *Next Generation of Construction Planning and Control System: The 'Lewis' Approach, Proceedings of the 10th Conference of the International Group for Lean Construction*, PhD Research paper, Centre for Construction Innovation Research, School of Science and Technology, University of Teesside, Middlesbrough, TS1 3BA, UK.

Schaufelberger, J., E and Holm, L (2002), *Management of Construction Projects, A Contractors perspective,* Prentice Hall, Upper Sadle River, New Jersey, Columbus Ohio, USA. ISBN: 0 13 084678 3.

Stankevich, N., Qureshi, N and Queiroz (2005), *Performance Based Contracting for Preservation of Road Assets,* Roads and Rural Transport Thematic Group, Transport Notes, World Bank, Washington D.C., USA. Transport Note No.TN-27.

Stokes and Wilson. (2010), *Small Business Management and Entrepreneurship* Cengage Learning EMEA, Cheriton House, North way, Andover, Hampshire, SP10 5BE, United Kingdom, ISBN: 978-1-4080-1799-9.

Sullian, R.G. and Harper, M.V. (1997), *Hope is not a Method: What Business Leaders Learn From American's Army, Former Army Chief of Staff*, Broadway Books, New York, USA. ISBN: 13 978 0 7679 0060 7.

Sun, M., et al, (2004), *Managing Changes in Construction Projects,* Industrial Report, University of the West England, Bristol, University of Loughborough, Leicester, University of Salford, A Greater Manchester University, UK.

SurveyMonkey., (1999-2011), *Smart Survey Design*, The Guide on Writing effective Survey Questions.

Susan, K., Kashiwagi, D. and Carey, B. (2008), *Analysis of the Use of Performance Information in the Construction Industry. First International Conference on Construction In Developing Countries (ICCIDC–I),* Arizona State University, Tempe, AZ, USA.

Tamin, R.Z, Tamin, A. Z and Marzuki, P.F (2010), *Performance Based Contract Application Opportunity and Challenges in the Indonesian national roads Management,* Ministry of Public Works, Indonesia.

Tastle, W.T, Russel, J. and Wierman, M.J. (2005), *A New Measure to Student Performance Using the Likert Scale,* Department of Business Administration, Ithaca College, Ithaca, New York 14850, USA.

Telsang, M. T. (2013), *Production Management,* S.Chand & Company Private Limited, Ram Nagar, New Delhi-110 055, India.

Tembo, Y. (2014), *A diagnostic Study into the Road Financing Paradoxes which have led to inefficient Road Asset Management in Zambia* , PhD Research Thesis, Atlantic International University, Honolulu, Hawaii, USA. UD21097STR29202.

Tezel, B.A. (2007), *A Statistical Approach to Lean Construction Implementations of Construction Companies in Turkey,* Master Thesis, Middle East Technical University.

Thagesen, B. (1996), *Highway and Traffic Engineering in Developing Countries,* E & FN Spon an Imprint of Chapman & Hall, 2-6 Boundary Row, London SE1 8HN, UK. ISBN: 0 419 20530 6.

The Folk Group. (2009), *Lean Manufacturing, 5S and Six Sigma,* Doylestown, PA, 18901, 1 215 340 9072.

The Synergy Project. (2005), *Case Study of an NGO Capacity Building Project in Mexico: Developing a Participatory and Monitoring Plan,* US Agency for International Development (USAID), World Bank, The Synergy Project, TvT Associates, Inc. 1101 Vermont Avenue, NW Suite 900, Washington D.C. USA.

The Zambian National Assembly and Parliament. (2002), *The Road Traffic Act No. 11 of 2002, The Public Roads Act No. 12 of 2002, The Road Fund Act No. 13 of 2002,* Government Printers, P.O Box 30136, 10101, Lusaka, Zambia, Nos. 5, 6 & 10 of 2006.

Thomson, A. A., Peteraf, M.A., Gamble, J.E. and Strickland III, A.J. (2012), *Crafting Executive Strategy: Concepts and Cases,* McGraw Hill Companies, 1221 Avenue of the Americas, New York, NY, 10020, USA. ISBN: 978 0 07 131700 9.

Timm, P.R. (2007), *How to Make Winning Presentations: 30 Action Tips, for Getting Your Ideas Across with Clarity and Impact*, JAICO Publishing House, 3 Tice Road Franklin Lakes, NJ 07417, USA. ISBN: 81 7224 925 X.

Toledano, J., et al. (2002), *Community Based Monitoring and Evaluation Team: Sleeping on our Mats: An Introductory Guide to Community Based Monitoring and Evaluation*, The World Bank, Rural Development, African Region.

Tracy, B. (2011), *Full Engagement: Inspire, Motivate, and Bring Out the Best in Your People*, AMACOM, 1601 Broadway, New York, 10019, USA. ISBN: 13 978 0 8144 1689 1, ISBN: 10 0 8144 1689 6.

Tzortzopolous, P. and Formoso, T.C.(2000), *Consideration of Application of Lean Principles to Design Management, Proceedings of the 7th Conference of the International Group for Lean Construction* (IGLC), Lean Construction Institute, (LCI), University of Rio Grande do Sul, Brazil.

UNDP, (n.d), *Monitoring and Evaluation Training Guide*, Evaluation Office, UNDP.

Uren, J and Price, B (2010), *Surveying for Engineers*, Palgrave McMillan, 175 Fifth Avenue, New York, NY 10010, USA. ISBN: 978 0 230 22157 4.

Usunier, J. C. and Lee, J.A. (2005), *Marketing Across Cultures*, Pearson Education Limited, Edinburgh Gate, Harlow, Essex, CM20 2JE, England, United Kingdom. ISBN: 0 273 08529 5, ISBN: 978 0 273 08529 6.

Valadez, J. and Bamberger, M. (1994), *Monitoring and Evaluation Social Programmes in Developing Countries: A Handbook for Policymakers, Managers, and Researchers*, EDI Development Studies, International Bank for Reconstruction and Development/The World Bank, 1818 H Street NW, Washington D.C, 20433, USA. ISBN: 0 8213 2989 8.

Venkataraman R., R and Pinto, J., K (2008), *Cost and Value Management in Projects*, Wiley (John Wiley and Sons, Hoboken, New Jersey, USA. ISBN: 978 0 470 06913 13 4.

Verma, D. (2008), *Word Origins, An exhaustive compilation of the origin of familiar words and phrases*, Sterling Publishing (P) Limited, A-59, Okhla Industrial Area, Phase-II, New Delhi-110020, India. ISBN: 978 81 207 1930 9.

Verzuh, E (2005), *The Fast Forward MBA in Project Management, Quick tips, Speed solutions, Cutting – Edge Ideas,* John Wiley & Sons, Toronto, Canada. ISBN: 0 471 69284 0.

Wandahl, S. (2005), *Value in Building*, Doctoral Thesis, Department of Production, Aalborg University, Denmark.

Wandahl, S., Bejder, E., (2004), *Value – Based Management in the Supply of Construction Projects*, Doctoral Thesis, Department of Production, Aalborg University, Denmark.

Weigel, A. L. (2000), *A Book Review, Lean Thinking by Womack and Jones*, Assignment for ESD. 83, Research Seminar in Engineering Systems.

Weston, J.F., Chung, K.S., and Hoag, S.E., (2004), *Mergers, Restructuring and Corporate Control,* Prentice Hall Private Limited, New Delhi – 110 001, India. ISBN: 81 203 1011 X.

Whelton, M., Ballard, G. and Tommelein, R. (2002), *Application of Design Rationale Systems to Project Definition – Establishing A Research Project:* PhD Paper, IGLC, Lean Construction Institute (LCI), University of California, Berkeley, USA.

Wignall, A. and Kendrick, P.S. (1982), *Roadwork: Theory and Practice*, William Heinemann Limited, 10 Upper Grossvenor Street, London WIX 9PA. UK. ISBN: 432 9223 0.

Wilcox, M. (2002). *Wither Pragmatism. Research paper, presented at the 8th Annual Deming Scholars Seminar at Fordham University*, NY University of Durham Business School, Mill Hill Lane, Durham, DH1 3LB United Kingdom.

Wilcox, M. (2003). *The Philosophy Shewhart's Theory of Prediction, Research paper, presented at the 9th Annual Deming Scholars Seminar at Fordham University,* NY University of Durham Business School, Centre for Business Performance; Cranfield School of Management, Cranfield University, Cranfield, United Kingdom. MK430AL.

Wilson, L (2010), *How to implement Lean Manufacturing*, McGraw Hill, New York, USA. ISBN: 978 0 07 162507 4.

Wireman, T. (2005), *Developing Performance Indicators for Managing Maintenance,* Industrial Press Inc. New York, NY. USA.

Wodalski, M.J. (2011), *Applying Lean Techniques in the Delivery of Transportation Infrastructure Construction Projects,* National Centre for Freight and Infrastructure Research and Education, Department of Civil and Environmental Engineering, College of Engineering, University of Wisconsin, Madison.

Wolbers, M., Evans, R.J.E, Holmes, M., Pasquire, C.L., and Price, A.D.F (2005), *Construction Management and Lean Thinking, in Highways Maintenance,* Department of Civil and Building Engineering, Loughborough University, Loughborough, LE11 3TU UK, AmeyMouchel, Area 9 MAC, Stanford Park 10, Telford, TF3 3BU UK.

Womack J and Jones D.T. (2003), *Lean Thinking, Banish waste and create worth in your corporation,* Chatham ME5 8TD, UK, ISBN 13 978 0 7432 3164 0.

Womack, J. P., Jones, D.T. and Roos, D. (1990). *The Machine That Changed the World: The Story of Lean Production.* MacMillan Publishing, New York, NY.

Woodward, J.F. (1997), *Construction Project Management: Doing it Right First Time,* American Society for Civil Engineers, (ASCE), Thomas Telford Services Limited, 1 Heron Quay, London E14 4JD, 345 East 47th Street, New York, NY, 10017-2398.

Worku, I. (2011), *Road Sector Development and Economic Growth, Ethiopia Support Strategy Programme II- Internation Food Policy Research Institute,* EDRI Working Paper 004, Ethiopian Development Research Institute. Addis Ababa.

Wright J.N. (1999), *The Management of Service Operations,* Continuum, Tower Building, 11 York Road, London SE1 7NX, England, UK. ISBN: 0 8264 5969 2.

Wyatt, S. (2010), *The Secret Laws of Management: 40 Essential Truths for Managers,* Headline Publishing Group, 338 Euston Road, London NW1 3BH, UK. ISBN: 978 0 7553 6094 9.

Wysocki, R.K and McGary, R (2003), *Effective Project Management, Traditional, Adaption, Extreme,* John Wiley Publishing, Toronto, Canada. ISBN: 0 471 69284 0.

Yahya, A.M. and Mohamad, M. I. (2011), *Review of Lean Principles for Rapid Construction,* PhD paper, Civil Engineering Faculty, University Technology of Malaysia, 81310 UTM Johor Bahru, Malaysia.

Zarinpoush, F. (2006), *Project Evaluation Guide for Non Profit Organisations, Fundamental Methods and Steps for Conducting Project Evaluation,* Imagine Canada, 425 University Avenue, Suite 900, Toronto, Ontario M5G 1T6, ISBN: 1 55401 315 1.

Zettel, G. Criswell, B. And Blackburn, L. (2012), *Applying Lean Principles,* Turner Construction, FEFPA Summer Conference, Broad Industry Support for CEU's, Lean Construction Institute (LCI), UK.

Zietlow, G. (2007), *Cutting costs and improving quality through Performance based Road Management and Maintenance Contracts, -The Latin America experiences,* University of Birmingham, Birmingham, England, UK.

Zimmerman, J.L. (2009), *Accounting for Decision Making and Control,* McGraw Hill Companies, 1221 Avenue of the Americas, New York, NY, 10020, USA. ISBN: 978 007 126745 8.

Zwiers, V. (2011), The Business Analyst, Information Technologist's Paradigm Shift. Juta and Company Limited, First Floor, Sunclrare Building, 21 Dreyer Street, Claremont, 7708, Cape Town, South Africa, ISBN: 978 0 70218 861 9.

BIBLIOGRAPHY

Adadevo, D. (2007), *Leading Transformation in Africa,* International Leadership Foundation, USA, ISBN: 1 60000 000 2.

ASCE and GEO Institute (2011), *Pavement and Geotechnical Engineering for Transportation, American Society for Civil Engineers,* 1801 Alexander Bell Driver, Reston, Virginia, 20191-4400, USA. ISBN: 978 0 7844 1281 7.

Bain, R (2009), *Toll Road Traffic and Revenue Forecasts, an Interpreter's guide,* Publicaciones Digitales, SA, Saville. ISBN: 978 0 9561527 1 8.

Basu, R. (2004), *Public Administration: Concepts and Theories,* Sterling Publishers Limited, A-59 Okhla Industrial Area, Phase II, New Delhi- 110020, India. ISBN: 978 81 207 2763 2.

Bertselen, S. and Koskela, L. (2002), *"Managing The Three Aspects Of Production In Construction."* Proceedings of the 10th Conference of the International Group for Lean Construction, Gramado, Brazil, August 6-8.

Chika, O. (2006), *"Capitalist Nigger" The Road to Success, a spider web doctrine,* Jonathan Ball Publishers, Johannesburg & Cape Town, P.O Box 33977, Jeppestown 2043, R.S.A, ISBN:978 1 86842 270 8.

Delaney, J. Johnson, A. Johnson, D. and Trenslan, D. (2010), *Student Perceptions for of Effective Teaching in Higher Education, 26th Annual Conference on Distance Teaching and Learning,* Board of Regents of the University of Wisconsin Systems, Memorial University, Creative Commons, 171 Second Street, Suite 300, San Francisco, California, 94105, USA

Denhardt, R. B. and Dehardt, J. V. (2009), *Public Administration: An Action Orientation,* Wadsworth, Cengage Learning, 25 Thomson place, Boston, MA 02210, USA. ISBN: 13 978 0 475 50516 7, ISBN: 10 0 495 50516 1.

ELNET (2012), *Life Change Studies, Transformation Leadership Principles,* Life Ministry Resource Centre, Jabavu Rd, Nairobi, Kenya.

Evdorides, H., and Robinson, R (2009), *Restructuring Road Institutions, Finance and Management,* University of Birmingham, Birmingham, UK. ISBN: 978 0 704427 17 4.

Garber, N., J and Hoel, L., A (2009), *Traffic and Highway Engineering,* Cengage Learning, 200 First Standard place, Suite 400, Stamford CT06902, USA. ISBN: 13 978 133 60515 7.

Haung Y., H (2004), *Pavement Analysis and Design*, Prentice Hall, Upper Saddle River, New Jersey, NJ 07458, USA. ISBN: 13 142473 4.

Hornsby, A.S. (2013), *Oxford Advanced Learner's Dictionary*, International Student's Edition, Oxford University Press, Great Clarendon Street, OX2 6DP, UK

Howell, G. A. and Ballard, G. (1994a). *"Lean Production Theory: Moving Beyond'Can-Do'."* Proc. Conference on Lean Construction, Santiago, Chile. September, 1994.

Howell, G. A. and Ballard, G. (1994b). *"Implementing Lean Construction: Reducing Inflow Variation."* Proc. Conference on Lean Construction, Santiago, Chile. September, 1994.

Huhn, Z. (2012), *The Role of Place Cells and Grind Cells in Spatial Navigation*, Doctoral Dissertation, Department of Biophysics KFKI, Research Institute for Particle and Nuclear Physics of Hungary Academy Sciences, Faculty of Sciences, Eotvos Lorand University, Budapest, Hungary.

Ibrahim, A. (n.d), *A Systematic Approach to Modelling Change Processes in Construction Projects*, Research paper, Department of Structural Engineering, Faculty of Engineering, Mansoura University, Egypt.

Johari, J., C. (2012), *Contemporary Political Theory: New Dimensions, Basic Concepts and Major Trends,* Sterling Publishers Private Limited, A-59 Okhla Industrial Area, Phase II, New Delhi-110020, India. ISBN: 978 81 207 6992 2.

Kelsey, R (2013), *Being More Confident; Why Smart People Can lack Confidence and what you can do about it*, John Wiley and Sons Limited, The Atrium, Southern gate, Chichester, West Sussex, PO19 3Q, United Kingdom. ISBN: 978 0 837 08309 8.

Kelsey, R (2013), *What is Stopping you?, Why smart people don't always reach their potential*, John Wiley and Sons Limited, The Atrium, Southern gate, Chichester, West Sussex, PO19 3Q, United Kingdom. ISBN: 978 0 857 08307 4.

Knapton, N. (1996), *The Roman and Their Roads- The Original Small element Pavement Technologists,* University New Castle, New Castle Upon Tyne, UK

Lengewa, P (2014), *The ELNET Mentoring Handbook, Level1,* Life Ministry Resource Centre, Jabavu Rd, Nairobi, Kenya.

Lunenburg F.C. and Irby B.J. (2008), Writing *a successful thesis or dissertation, tips and strategies for students in the social and behavioural Sciences,* Corwin Press, London, UK, ISBN 978 – 1- 4129-4224-9.

Mandela, R. N. (2011), *Nelson Mandela: Conservations with Myself,* Pan MacMillan, 20 New Wharf Road, London N1 9RR, Basingstoke and Oxford, UK. ISBN: 978 0 720 75594 9.

Mastroianni, R. and Abdelhamid, T. S. (2003). "The Challenge: The Impetus for Change to Lean Project Delivery". Proceedings of the 11th Annual Conference for Lean Construction, 22-24 July 2003, Blacksburg, Virginia, 610-621.

McMillan and Weyers. (2007),*How to write Dissertations and Project Reports,* Pearson Education Limited, Harlow, England, UK, ISBN 978-0-273-71358-6

Mubarak, S (2010), *Construction Project Scheduling and Control,* Wiley (John Wiley and Sons), Hoboken, New Jersey, USA. ISBN: 978 0 470 50533 5.

Murray. (2006), *How to Write a Thesis*, Mcgraw-Hill Education, Maidenhead Berkshire, England, UK.

N'gan'ga, N.N. (2013), *A Leader's Source of Influence*, Taruma Consultants, Nairobi, Kenya, ISBN: 978 9966 1622 5 0.

N'gan'ga, N.N. (2013), *Integrity the Litmus Test of Good Leadership*, Taruma Consultants, Nairobi, Kenya, ISBN: 978 9966 1622 6 7.

N'gan'ga, N.N. (2013), *Leadership King David's style, Lessons from the Book of 2nd Samuel,* Taruma Consultants, Nairobi, Kenya, ISBN: 978 9966 1622 3 6.

Oracle. (2009). *Change Management Best Practices for the Engineering and Construction Industry*, Research paper, Oracle Corporation, World Head Quarters, 500 Oracle Parkway, Redwood Shores, CA, 94055, USA.

Papagiannakis, A.,T and Masad, E., A (2008), *Pavement Design and Materials*, Wiley (John Wiley and Sons), Hoboken, New Jersey, NY, USA. ISBN: 13 978 0 471 21461 8.

Paterson, S., E and Allan, L., K (2009), *Road Traffic Safety, Modelling and Impacts*, Nova Science Publishers, New York, USA. ISBN: 978 1 60456 884 4.

Peterson, G.T. (1998). *The Influence of C.I. Lewis on Shewhart and Deming*, Excelsis Business Advisers.

Robinson, R (2009), *Restructuring Road Institutions, Finance and Management*, University of Birmingham, Birmingham, UK. ISBN: 978 0 704426 98 6.

Rodgers, W. V. H. (2010), *Winfield & Jolowicz on TORT*, Sweet & Maxwell, Thomson Reuters, 100 Avenue Road, London, NW3 3PF, United Kingdom. ISBN: 978 1847 03793 0.

Roess, R., P, Prassas, E., S and McShane, W., R. (2011), *Traffic Engineering*, Pearson Education Limited, Upper Saddle River, NJ 07458, USA. ISBN: 13 978-0-13 613573-0

Samantha, R., J (2011), *Highways Construction, Management and Maintenance*, Nova Science Publishers, New York, USA. ISBN: 978 1 61728 862 3.

Smart, J (2013), *Clarity; Clear Mind, Better Performance and Bigger Results*, John Wiley and Sons Limited, The Atrium, Southern gate, Chichester, West Sussex, PO19 3Q, United Kingdom. ISBN: 978 0 857 08448 4.

Smith, C. (2012), *Mandela: In Celebration of a great life*, Struck Travel & Heritage, Wembley square, Solan Road, Gardens, Cape Town, 8001, P. O. Box 1144, 8000, South Africa. ISBN: 978 1 43170 079.

Stankevich (2005). *Performance Based Contracting for Preservation and Improvement of Road Assets*, Transport Note No. 27, The World Bank, Washington D.C, USA.

Washburn, S., S and Mannering, F (2013), *Principles of Highway Engineering and Traffic Analysis*, Wiley (John Wiley and Sons), USA. ISBN: 978 1 118 12014 9.