ASSESSMENT ON THE EFFECTIVENESS OF DESIGN-BUILD VERSUS DESIGN-BID-BUILD PROJECT DELIVERY METHOD IN FEDERAL ROAD CONSTRUCTION PROJECTS

By
Mekonnen Asaminew

A Thesis Submitted to the School of Graduate Studies of Addis Ababa University in partial fulfillment of the requirements for the degree of Master of Science
In
Civil Engineering
Construction Technology and Management

Advisor
Wubishet Jekale (Dr-Eng)

December 2013
Addis Ababa, Ethiopia

ADDIS ABABA UNIVERSITY SCHOOL OF GRADUATE STUDIES
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING
CONSTRUCTION TECHNOLOGY AND MANAGEMENT STREAM

ASSESSMENT ON THE EFFECTIVENESS OF DESIGN-BUILD VERSUS DESIGN-BID-BUILD PROJECT DELIVERY METHOD IN FEDERAL ROAD CONSTRUCTION PROJECTS

BY
Mekonnen Asaminew

APPROVED BY BOARD OF EXAMINERS:

Advisor	**Signature**	**Date**
Internal Examiner	**Signature**	**Date**
External Examiner	**Signature**	**Date**
Chair Person	**Signature**	**Date**

ACKNOWLEDGMENT

First and foremost I would like to thank my Lord and Savior Jesus Christ without whom I would have neither joy nor peace. I cannot explain my appreciation enough to Dr.-Eng Wubishet Jekale for his patience, encouragement and sage advice. I have truly enjoyed our relationship and it has been a true pleasure working with him. I would like to thank him for offering his continuous time, knowledge, and advice throughout the development of my thesis. I feel very privileged for the opportunity to have him as an advisor.

My acknowledgement also goes to all the members of Ethiopian Roads Authority Design-Build Directorate, Northern region Directorate as well as Eastern Region Directorate who directly or indirectly helped me obtain the data for this research work. My appreciation is also goes to Ato Esayas Sahilu, who is an instructor in Addis Ababa University, for his contentious advice and support during my thesis writing. I would like to acknowledge those who participated in answering the questionnaire by giving their precious time. I would also like to extend my gratitude to Ato Saifu Bedane and the family, who raised me from childhood without whom I would not be successful in my current academic carrier.

Finally, I would like to acknowledge the Ethiopian Roads Authority for giving me the opportunity to attend for my post graduate study in the Construction Technology and Management Stream. Last but not least, I said thank you for my beloved wife Emnet Hibdo and our children Abigail and Noel for their continuous support and patience during my research. God bless all of you.

Table of Contents

Abbreviation

AGC	Associations of General Contractors
AIA	American Institute of Architects
ACWP	Actual Cost of Work Planed
BCWS	Budgeted Cost of Work Scheduled
BCWP	Budgeted Cost of Work Planed
BOT	Build-Operate-Transfer
CV	Cost Variance
CEI	Construction engineering and inspection
CM	Construction Management
DB	Design-Build
DBB	Design-Bid-Build
DBFO	Design-Build-Finance-Operate
DBIA	Design-Build Institute of America
DBOM	Design-Build-Operate-Maintain
DOT	Department of Transport
DBST	Double Bitumen Surface Treatment
ECoTMPA	Ethiopian Construction Technology and Management Professionals Association
EOT	Extension of Time
ERA	Ethiopian Roads Authority
ETB	Ethiopian Birr
FHWA	Federal Highway Authority
FDOT	Federal Department of Transport
GC	General Contractor
GMP	Guaranteed Maximum Price
GOE	Government of Ethiopia
IFB	Invitation for bid
KDOT	Kansas Department of Transport
LS	Lump Sum or Fixed Price
MoWUD	Ministry of Works and Urban Development
PASDEP	Plan for Accelerated and Sustained Development to End Poverty
PDS	Project Delivery System
RFP	Request for Proposal
ROW	Right of Way
RSDP	Roads Sector Development Program
SV	Schedule Variance
TCRB	Transport Cooperative Research Program
TRB	Transportation Research Board
VO	Variation Order

Lists of Tables

Lists of Figures

Lists of Appendices

Abstract

The Federal Democratic Republic of Ethiopia has placed increased emphasis on improving the quality and size of the road infrastructure. In order to meet this Ethiopian Roads Authority is assigned by the Federal Government as an implementing agency to follow up the execution of the federal road construction projects to be timely and cost effective. As literatures show absence of proper project delivery system is one of the reasons for long delay and cost increment on many projects. This research therefore, tries to analyze the performance of DBB and DB project delivery systems to see whether one is more effective than the other with regard to time and cost. The study also evaluates which delivery method is the better approach to meet the needs of Ethiopian Federal roads projects. In order to assess the effectiveness of DB versus DBB for federal road projects the literature review is conducted and factors were explored that can influence the successful and proper implementation of project delivery system for Ethiopian Federal road projects.

The questionnaire survey and case studies together with desk study are applied and data was collected from samples of 5 DBB and 5 DB federal road projects. The collected data has been analyzed and interpretations and discussions are made on the results. The findings of this research revealed that, if the contractors properly identify and consider their risks DB project delivery system would be more effective than DBB. The research also indicated that projects delivered using the DB approach performed better than those delivered through the DBB delivery systems. Specifically, the analysis revealed that the DB projects experienced less cost and schedule growth. DB project delivery system has increasingly been adopted worldwide due to its many advantages. However, Ethiopian federal road projects were delivered using the traditional DBB, and it is very recently that ERA is trying to implement the innovative project delivery system on some projects. The result of this research is therefore encouraging and very helpful for ERA in its leap from DBB to DB. The research further provides conclusion and recommendations under what circumstances the project delivery system is more feasible and effective to Federal road construction projects.

CHAPTER 1

1. Introduction

The Federal Democratic Republic of Ethiopia is located in the eastern part of Africa, with a population estimate of more than 80 million, spread over a territory of 1.1 million km2 (CSA 2001). The Ethiopia's transport infrastructure as measured by density of the road network in 2007 stands at 38.6 km per 1000 sq. km and 0.55km per 1000 population (ERA, 2007). Proportion of area more than 5km from all weather road and average distance to all weather roads during the same period are 68% and 13km respectively. Despite considerable efforts to expand the road network over the past few decades, the density is still below the average density of 60 km per 1000 sq. km for Africa.

The contribution of the Ethiopian construction industry to the economy has now reached 8.2%, and public construction projects share an average annual rate of 60% of the Government's capital budget. However, the present state of the construction industry falls short of meeting domestic and international quality standards and the performance demand expected from the sector (MoWUD 2006). Therefore, the Government of Ethiopia's (GOE) Plan for Accelerated and Sustained Development to End Poverty (PASDEP), issued in September 2006, aims at developing a competitive construction industry to ensure quality of design and workmanship, with increased efficiency in designs and constructions of infrastructure.

Being aware of the need to expand the road network in facilitating development and growth, the Government of Ethiopia (GOE) had launched the 10-years Roads Sector Development Program (RSDP) that run from July 1997-June 2007. The first phase of this program (RSDP I: July 1997-June 2002) was officially launched in September 1997, and completed in June 2002. This phase has focused on the restoration of the road network to an acceptable condition.

The second phase of the program (RSDP II: July 2002-June 2007) aims to consolidate the achievements of the first phase, increase the network connectivity and provide a sustainable road infrastructure to rural areas (ERA 2007). During the 10 years period, a total of 78,569 km of roads were constructed, upgraded/rehabilitated and maintained; of which 10,282 km are federal roads and 10,523 km are newly constructed/maintained regional roads.

The third phase of the Road sector Development program (RSDP III), has started in July 2007, and will be completed in July 2010 (ERA 2007). At the end of the program, the average distance to all weather roads will be 11 km, and the road density will also be 45.7 km/1000km2 and 0.59km/1000 population. According to Ethiopian Roads Authority (ERA), RSDP III envisaged for the three years (2007 – 2010) includes planned expenditure of Birr 29.7 billion for Federal

roads. It is believed that similar program will continue beyond 2010. The programs require not only capacity to execute, but also improvement of drawbacks from past performances.

The fourth phase of the Road sector Development program (RSDP IV), has started in July 2010/11, and will be completed in July 2015/16 (ERA 2007). RSDP IV consists of rehabilitation of 728 km of trunk roads, upgrading of 5,023 km of trunk and link roads, construction of 4,331km of new link roads, heavy maintenance of 4,700 km of paved and gravel roads and routine maintenance of 84,649 km of road net work. The program also consists of the following regional and wereda road components, that are construction of 11,212 km of new rural roads by the Rural Roads Authorities and construction of 71,523 km of wereda roads by the wereda road offices. The total cost of implementing RSDP IV is estimated to be ETB 125.3 billion Ethiopian Birr, out of which ETB 84.5 billion for federal road projects, ETB 14.4 billion for regional projects and ETB 26.4 billion for wereda road projects.

Having allocated such amount of big finance, the owner Ethiopian Roads Authority is typically looking for the proper delivery of projects, based upon predetermined requirements including function(s), quality budget, and schedule. To obtain this desired product, the owner has to buy the services of a group of professionals, a process partly relying on assumptions made regarding the capabilities, performance and competence of this group, and surrounded with uncertainties due to factors related to market conditions and project-specific conditions.

For this reason, the selection of the proper project delivery method is of primary importance. It establishes the foundation for a successful and equitable relationship allowing all stakeholders to achieve their objectives, while at the same time fulfilling the intent of the contract documents. This research paper is therefore, undertaken to assess and identify which project delivery method Design-Bid-Build (DBB) or Design and Build (DB) is more applicable in Federal Road Construction Projects and to evaluate the opportunity for their applicability to the local situations. This is to provide a useful supplement to the existing methods so that all stakeholders in the construction industry will benefit.

1.1 Background

Considering the different types of alternative project delivery methods that are available, there is no clear-cut formula for the selection of one versus the other. Increasing requirements for reduced project costs, fewer claims, better quality and improved schedules have pushed the owners to look for innovative project delivery methods which could help achieve these objectives. Some of these alternative methods include construction management, DB and DBB.

In selecting a contracting methodology for any type of project, the owner should consider a number of factors including the ability to define criteria of what is to be built, unforeseen conditions, potential changes in the work, funding, allocation of risk, cost, schedule constraints,

constructability issues, and so on. In order to focus the efforts of the project team to produce a quality product at a reasonable cost and within a pre established schedule, each member of the team must work under a process that guarantees the ability to manage risks and that deals with issues in a positive, cooperative manner.

One of the key purposes of any contract is to allocate risks and benefits between the parties to the contract. In the construction context, various project delivery methods have been developed to deal with the different ways, owners, developers, contractors, consultants and public entities view and accept risk. For the construction solicitor the objective then is to ensure that the form of contract and its drafting properly allocate the risks associated with the project to the party who has accepted and has been (or will be) compensated for bearing the risk.

Accordingly, the two project delivery methods DBB and DB based on their relevance to the local situation in Federal Road Construction Projects of Ethiopia have been evaluated; their merits, demerits, and requirements identified. So as to draw reliable inference, data was collected from four clusters of stakeholders in the construction industry, namely; Ethiopian Roads Authority (ERA), contractors, and consultants and reputed professionals. The research design was based on descriptive survey, desk study, and descriptive approaches. Besides, the research instruments used were questionnaire, discussions and document reviews. The participants include ERA, contractors, and consultants. The respondents were selected from contractors and consultant that are actively participated in DB projects and the employer Ethiopian Roads Authority (ERA).

As one of the core responsibilities of the thesis work, assessment of the prioritization of these project objectives by the concerned bodies has been conducted. Accordingly, it is understood that the main objectives of the research is aimed to ensure project time certainty in the first place. Their second critical requirement is to attain project cost certainty. Thirdly, they want to reduce the administrative burden to them project. The current projects construction delivery method in Federal Road Construction Projects is the traditional DBB method. It is also noted the other project delivery method DB has been practically introduced recently.

The DBB method has been short of meeting the above mentioned project requirements set by the users in the study area. Hence, there is a positive attitude towards the application of the innovative project delivery methods with the public offices. It has been thought that the local construction industry in Ethiopia is a cost-driven industry. Taking the Federal Road Projects as a study area this thesis work, however, shows that ERA wishes the industry to be a time-driven one. This is because, when the project time is controlled, reduced or maintained the overhead costs and the consultancy fees can be dramatically reduced. They have also come to understand that if project time is maintained or reduced, the cost overrun due to price escalation and inflation can be minimized.

Based on the assessment of the local construction industry, however, the other project delivery method, that is DB, can be effectively applied in the study area. This could be accomplished by partnering between consultants and/or contractors and proper contractor and/or consultant selection. Partnering maximizes the effectiveness of each of the partner's resources, and proper contractor/consultant selection avoids selection of a contractor/consultant that is not fit for the job to be undertaken.

The traditional DBB method can also be employed in situations when the employer wants to involve in several aspects of the project and when time is not a constraint. It can, however, be argued that the transition from the traditional method to the innovative methods needs time and involvement of everyone in the construction industry. And, this paradigm shift ought to be advocated through short trainings, tailor-made short courses, workshops, research and construction magazines, and any other relevant means.

The traditional Project delivery method widely applied in Ethiopia is DBB contracts. In this type of contract the client is responsible for the design and the contractor for the execution. However, it has been argued that traditional contractual arrangements do not support effective collaboration in construction projects (Kadefors 2004). Therefore, there is a need to examine the project delivery practices to execute Federal road projects. The research, thus, briefly explores the underlying concepts of project delivery methods with a view to evaluate which system, DBB or the DB system that is more applicable to Ethiopian Federal Road projects that have an impact on schedule and total cost of projects.

1.2 Structure of the Thesis

The strategy adapted for this research is qualitative research of exploratory type which diagnoses a situation; assess alternatives for better performances between the two project delivery systems. The flow chart and the structure followed for the research has four main parts as described hereunder.

i. **Establishing the basis of the research:-** aimed at defining the theoretical basis, and formulating the research questions.
ii. **Data Collection:-** aimed at finding which project delivery method is more applicable for the Ethiopian federal road construction projects
iii. **Analyzing the findings:-** aimed at analyzing the findings of case studies in relation to theoretical propositions, and that of the interview using descriptive statistics method of analysis.
iv. **Conclusion and recommendation:-** aimed at concluding the research findings, and drawing recommendations.

Figure 1.1 below illustrates the foregoing approach to the research

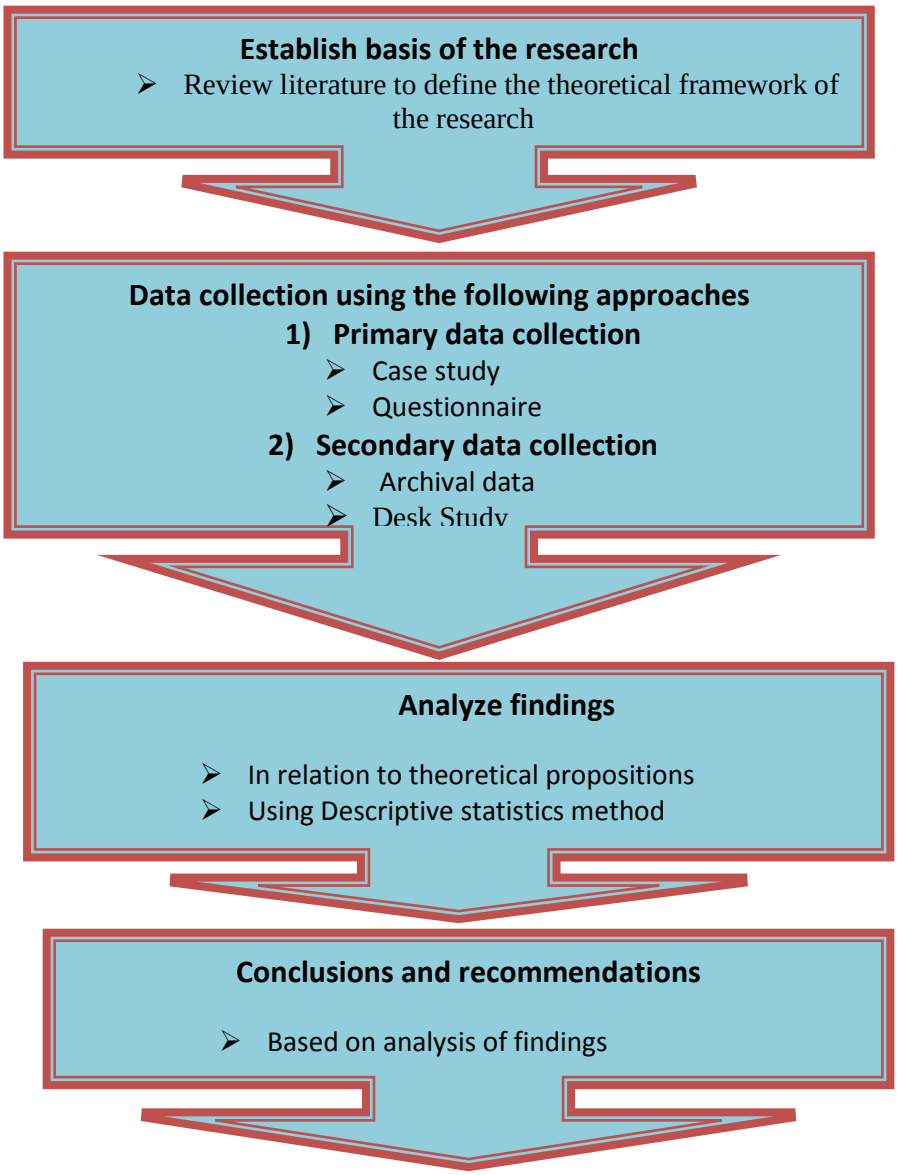


Fig.1.1:- Flow Chart of the Thesis

1.3 Objectives and the Research Questions

The objective of this research study will be to assess and evaluate the effective project delivery system for Ethiopian Federal Road Projects using the traditional delivery method (DBB) versus the innovative project delivery (DB) method in order to determine which delivery method is the best approach to meet the needs of Ethiopian Federal Roads construction projects.
The specific objectives of the research paper will be to evaluate and asses to:

1) Develop a preferable project delivery system for federal road construction projects in Ethiopia that can be used to draw credible conclusions on the performance differences between design build and DBB;
2) To analyze the relative cost and schedule differences between the two project delivery systems.
3) Provide an overall evaluation of DBB and DB delivery methods.

The study will follow a rigorous research approach. The research can be used to compare DB performance to conventional DBB performance for some selected road construction projects. The results of the study will be presented in a full research report, including background information on project delivery methods, a survey of road project constructions in the Federal Roads of Ethiopia and an overall evaluation of DB and DBB delivery methods for sampled road projects.

In the process of assessing and selecting acceptable project delivery system, the research should address the following questions

i) What are the factors used to select which delivery system (DBB vs. DB) for the successful completion of federal road projects?
ii) Under what circumstances does DBB or DB delivery system is the better approach for federal road projects?

1.4 Scope of the Study

This research focused on the assessment of the effectiveness and implications of DB project delivery versus the traditional DBB project delivery in terms of selected project characteristics and relevant/measurable performance criteria based on the data collected from Ethiopian Roads Authority. Project performance examined in this study is limited to the installed costs, and schedule measures of the projects reported. The time and costs to accomplish pre project planning activities and programming documentation are not included in this research.

The main problem in this study is the number of DB projects which are very limited in the country. The DB project delivery is started recently and it is somewhat difficult to get sufficient or enough data for the study regarding the Design Build projects. In comparison to DB delivery the DBB project delivery method has somewhat better available data. Therefore, the findings of this study are influenced by the insufficiency of data from the DB project delivery method. In spite of the fact that the DB delivery method is recently adapted to the Ethiopian Federal Road Authority, as much as possible it is tried to evaluate the data available at hand. Therefore, care should be taken to interpret the results of this study for other types of projects.

Hence, the significance or merit of this study lies in making a contribution to the understanding of the importance of appropriate project delivery systems, as there seem to be some linkage between project delivery method and cost and time overruns and the project performance.

1.5 Outlines of the Research

This thesis will have the following broad categories.

Chapter I: Introduction/The research background

Chapter II: Literature review

Chapter III: The research design and methodology

Chapter IV: The research analysis and discussions

Chapter V: The research conclusions and recommendations

Each of the above chapters will contain the following contents as stipulated below.

Chapter I describes the research overview, its initiation and purposes. It also indicates the research objectives, how the research process is conducted and the contents of the research.

Chapter II covers the literature review part of the thesis; the literature review will include general information about the historical back ground of DBB and DB, and their overall effectiveness in project delivery of Ethiopian Federal Road Projects.

Chapter III covers the research methodology. The methodological approach consists of the overall research strategy; the research design, the analysis of the data and writing of the research paper .

Chapter IV contains the discussion and analysis part. It contains the findings on the effectiveness of DBB versus DB project delivery system for the Ethiopian Federal Road Construction and finally;

Chapter V in this part, the research conclusions and recommendations are presented.

CHAPTER 2

2. Literature Review

Road construction under Ethiopian Federal Road Authority across the country are now starting to move away from the traditional delivery method, DBB, and implement the use of alternate delivery methods, such as DB. There have been many research studies done regarding DBB and DB delivery methods for highway and the majority of these studies has been of a qualitative in nature, and has relied heavily upon surveys and case studies. According to (Chan et al. 2001) selecting an appropriate PDS is one of the most important success factors for construction projects.

Performance-based project delivery methods are thought to offer a way to develop the sector and to benefit all stakeholders. Construction industry employs about 20% of the workforce and covers about 30% of the capital budget of the governments in developing countries (Abebe and Girmay, 2003). However the construction industry accounts even for more than 50% of the capital budget in developing countries (Wubishet, 2004), according to him, for instance, in Ethiopia (1997/98 to 2001/02), the industry accounted for 58.2% of the capital budget. It should be noted, in both cases, that the industry covers a fairly large portion of the government's capital expenditure and so it needs to be developed.

In the developed world, the excessive use of the DBB method has given reasons to investigate innovative project delivery methods. Although a proliferation of construction projects delivery methods are available, there is still considerable confusion about their application and use. Clarification of their differences is critical to understanding how they can best be utilized to enhance the project procurement process and leverage in-house expertise and project funding.

Based on literature reviews, the primary reason why innovative project delivery methods are selected by public-works owners is to shorten the duration on specific projects by merging the design and construction processes. Cost effectiveness, time effectiveness and a single point of responsibility are also cited as reasons to pursue these innovative methods.

Further more, early collaboration on projects between designers and contractors usually enhances their relationship and often results in change order minimization because the process encourages the contractor to point out problems in the design or constructability issues early in the bidding or design process. An appropriate project delivery system may greatly improve the efficiency of a project (Oyetunji and Anderson, 2006) and reduce the transaction cost of a project. (Mahdi and Alreshaid, 2005).Thus, this thesis attempts to present a guidance to provide sufficient basis on

effectiveness evaluation for both DB and DBB project delivery systems in the Ethiopian federal Road projects.

The review of the other literatures and research papers proved to be extremely valuable in gaining knowledge and understanding different methods for project procurement as well as alternate delivery methods. This in turn contributed to the successful completion of this research project. This chapter will summarize the literature review of DB and DBB project delivery methods used for Ethiopian Federal Road Projects.

To date, in Ethiopian Federal Road Authority there have been no sufficient studies done in relation to evaluation of the effectiveness of DBB and DB delivery methods on Federal Highway projects in terms of cost and schedule growth. The findings of this current study will help the Ethiopian Roads Authority to decide what delivery method and under which circumstances will be more advantageous and preferable for them in terms of controlling cost and schedule.

2.1 Project Delivery System

A project delivery system has been defined as the set of "relationships, roles and responsibilities of project team members and the sequence of activities required" for the deployment of a capital project. (Sanvido VE and Konchar MD,1998). Project delivery system according to Wubishet (2009), is the way project owners, regulates and financiers determine the assignment of responsibilities among project stakeholders along the construction process. Ali Touran et al (2009) defined project delivery system as the process by which a construction project comprehensively designed and constructed for an owner referring to all contractual relations, roles & responsibilities of the stakeholders.

The AGC (2004) defines project delivery method as "the comprehensive process of assigning the contractual responsibilities for designing and constructing a project. A delivery method identifies the primary parties taking contractual responsibility for the performance of the work". The Texas DOT (2001) defines project delivery method as follows: "A project delivery method equates to a procurement approach and defines the relationships, roles and responsibilities of project team members and sequences of activities required to complete a project. A contracting approach is a specific procedure used under the large umbrella of a procurement method to provide techniques for bidding, managing and specifying a project."

Project delivery methods have evolved to deal with the many ways in which contracting parties wish to allocate their risk, from the traditional stipulated price/ general contract to the development of alternative financing and procurement methods. Each project delivery method has its advantages and disadvantages, and it is the role of the construction solicitor to ensure that his or her clients are protected to the greatest extent possible against the risks that they have chosen to accept.

A critical element for controlling the cost, schedule and scope of a project is gaining and maintaining control of the design process. Failure to control and manage this process will result in delay and increased construction costs. Hence, many problems that are encountered during construction can be traced back to the design process (Jergeas, 1989; Alshawi and Underwood, 1994; Madelsohn, 1997; Griffith and Sidwell, 1995). These problems can be as high as 75% of the total problems encountered during construction (Madelsohn, 1997). (Angelo and Day, 2001) have identify and recommended proper project delivery system has an important role to narrow such discrepancy on projects. The proper project management limits delays, budget overruns, and claims between parties. This increases the chance of meeting project objectives, which in turn maximizes the likelihood of achieving broader goals in terms of the project benefits (Hillson, 2003).

As the size and complexity of projects have increased, ability to manage risks throughout the construction process has become a central element preventing unwanted consequences (Maytorena et al. 2007). Hence, different project risks have to be allocated to the project's actors on the basis of who has the best qualifications for dealing with a specific risk (SOU 2000). As different project delivery options imply different ranges of responsibilities and liabilities in the project, selecting an appropriate project delivery option is a key issue for project actors.

Projects can be designed and constructed in a variety of different combinations in delivering a complete and useable facility. Some of the generic names assigned to delivery mechanisms are construction management at risk, construction management agency, program management, multiple-prime contracting, DB and DBB. According to (Ireland, 1982), all the various delivery method definitions attempt to "describe the roles of participants, the relationships between them, both formal and informal, the timing of events and the practices and techniques of management that are used."

Therefore as applied to this research, a project delivery system is defined as the roles, interaction, and obligations of contracted parties and the sequence of activities necessary to provide a facility project from design concept initiation through to final construction completion. Two of the main project delivery systems mentioned previously, DB and DBB, are evaluated in this research. Although each system can exist in various organizational forms, each system is based on different fundamental commitments to the project owner.

This research study was built on previous studies conducted on this topic involving highway construction; this study also used questionnaire as a means of surveys. The thesis is based on previously completed DBB projects, and on DB projects that are currently under construction. Literature reviews on previous studies were analyzed, compared, and interpreted; the results then were applied to the current research problem.

The motivation behind this research study lies in the desire to find a solution to the delivery method problems being faced by Ethiopian Federal Road Projects and also to create awareness of the different alternatives they have. Furthermore, motivation is driven by the desire to help the Ethiopian Federal Roads Authority arrive at a more productive delivery method that meets its schedules and keeps their costs manageable. Several DB options include: design professional as the DB entity; general contractor as the DB entity; joint venture between general contractor and design professional as the DB entity; and DB company with both in-house design and construction capability (Sanvido et al., 1992).

2.2 Historical Perspective of DB and DBB PDS

According to (Beard, et al 2001). The earliest form of infrastructure delivery involved a master builder serving as both project designer and builder. Throughout most of recorded history, this form of DB project delivery has been used to develop infrastructure projects such as pyramids, temples, aqueducts, cathedrals, and major public buildings. The widespread use of DB project delivery reflected the need to have the project designer intimately involved in the construction of the project to ensure the proper execution of the design plans and consideration of construction challenges posed by the design before it is completed.

In the absence of scientifically-based engineering principles, standards, and specifications, only the master builder had the experience and understanding of fundamental engineering and construction principles and techniques to know what could be built and how to build it. These master builders typically passed on their specialized skills and knowledge from one generation to the next, gradually enhancing the profession through the development and application of new techniques, often based on trial-and-error. By integrating these two sequential and highly interdependent phases of project development, the early design-builders could adjust the design to fit prevailing site conditions and to take advantage of new techniques or alternative sources of materials.

It was only in the period starting in Europe with the Renaissance that the knowledge and skills involved in project design and construction became increasingly complex, better documented, and more specialized. This enabled the design function to become more distinct from the construction function. Along with increased complexity and specialization came concerns over the accountability and responsibility of the various functions that comprise the project development process. To respond to concerns over the objectivity and integrity of the project development process for large infrastructure projects in United States of America , particularly after the Transcontinental Railroad showed how favoritism and process manipulation could lead to fraud, waste, and abuse in the development of infrastructure, government agencies in the United States instituted contracting reforms late in the nineteenth century that culminated in the development of the two-step project delivery process known as DBB.

Key legislative events in the United States that led to the formal separation of design and construction phases of infrastructure projects included the following:

- 1893 Congressional Act formally separating the design and construction phases of a capital project.
- 1926 Omnibus Public Buildings Act required all capital project plans and specifications be completed and approved before the construction phase can begin.
- 1947 Armed Services Procurement Act required that architectural and engineering (design) services be procured on a negotiated basis, while construction services continued to be procured through a formal advertisement and low bid selection process.
- 1949 federal procurement legislation extended the 1947 Armed Services Procurement Act requirements to all federal civilian agencies.
- 1972 Brooks Architect-Engineers Act required all design contracts for federal capital projects be awarded based on qualifications and not low bid.

Once it became institutionalized through laws and regulations, DBB became the traditional form of procuring and delivering government infrastructure projects in the United States over the ensuing 50 years. This included Interstate highway facilities, whose genesis (starting with the National Defense Highway Act of 1956, which initiated the Interstate program of superhighway construction) postdated passage of most of the laws mandating DBB for government projects. Under the DBB form of project delivery, the contracting agency first retains the services of an engineering design firm to prepare plans, specifications, and estimates (PS&E) for a project (unless the contracting agency uses in-house architects and engineers to do this). Once the PS&E is completed, the contracting agency then selects a contractor to construct the project.

This two-step project delivery process separates the design and construction phases of project development, with the contracting agency assuming responsibility for the completeness and accuracy of the drawings and specifications produced by the design firm. As discussed further below, until 1996, federal law (the Brooks Act) precluded the award of engineering service contracts based on price, and required that they be awarded based on the qualifications of the winning team with the price determined through negotiation. Similar restrictions continue to be imposed on the award of engineering service contracts. Construction contracts are typically awarded on the basis of price, with the lowest responsible bid being awarded the contract (i.e., a realistic and responsive bid given the scope and complexity of the project).

As noted above, the development of the DBB contracting process resulted from the increasing complexity and specialization of design and construction services, the perceived need to provide a check and balance between the development and execution of project plans, and a desire to

produce projects at minimum cost. The primary benefits of DBB were to reduce favoritism in the procurement process and spur competition among construction firms.

However, as with most institutionalized processes, the benefits of DBB began to be eroded by its inhibiting effects on the development and application of more efficient procedures and technology. Despite the prevalence of the DBB approach to project delivery among public works agencies, DB project delivery has numerous advocates among private corporations not subject to federal procurement statutes and regulations, and certain public agencies responding to urgent requirements for project completion.

Starting in the late 1960s, based in part on the successes achieved by the private sector in applying DB to their capital projects and the need to expedite needed infrastructure projects and stretch scarce financial resources, a number of government agencies at the federal, state, and local levels began to experiment with and apply the DB project delivery approach to reduce the time and cost to complete their projects. However it was not until the 1996 Federal Acquisitions Reform Act (Clinger-Cohen Act) that federal agencies received the legal authority to engage in DB projects and use a new two-phase design build process.

While DB has become a significant project delivery approach for buildings, it is relatively new to the highway construction industry, whose roots are largely in the post World War II era in which DBB was already the established way to procure and deliver all kinds of infrastructure projects. Interest in the DB approach by sponsors of highway projects has been spurred by the reported successes achieved in applying this approach to project delivery by other infrastructure development sectors. As the nation's highway programs became increasingly challenged in the 1980s and 1990s, interest grew in alternative project development and delivery approaches that offered ways to improve the efficiency (time, cost, and quality) and cost effectiveness of traditional contracting practices.

Responding to this renewed interest in alternative ways to deliver transportation infrastructure projects, the Transportation Research Board of the National Academy of Sciences established a broad-based task force of highway project delivery experts in January of 1988 to evaluate the potential for applying innovative contracting practices to Federal-aid projects, including DB. This TRB task force (designated Task Force A2T51 – Innovative Contacting Practices) compiled information from a variety of domestic and foreign sources on contracting practices and their impacts on project cost, progress, and quality. The task force also considered impediments to the application of promising contracting approaches and made recommendations to improve contracting practices.

One of the outcomes of TRB Task Force on Innovative Contracting Practices was the establishment by the Federal High Way Authority (FHWA) of an experimental project that

would allow state transportation agencies to test and evaluate innovative contracting practices. The development of Special Innovative Contracting, provided the impetus for state transportation agencies, in cooperation with the FHWA, to try out these innovative approaches to project delivery; discover how they affect project costs, duration, and quality; and determine whether and under what conditions any of these contracting approaches might be used to improve the cost-effectiveness of Federal-aid highway projects.

2.3 DBB Project Delivery System

According to Department of the Air Force, 2000 DBB is defined as: "the project delivery approach where the Owner commissions an architect or engineer to prepare drawings and specifications under a design services contract, and separately contracts for at-risk construction, by engaging a contractor through competitive bidding or negotiation." (DBIA, 2007a)

Federal laws and regulations mandated the use of the DBB method for the public sector (Beard et al., 2001). The traditional method is a simple process to manage that is well understood by owners, designers, and builders (Department of the Air Force, 2000). This method appealed to owners due to its established track record, the complete control over project design, and the award given to the lowest bidder from competitive bidding (Webster, 1997; Department of the Air Force, 2000; Loulakis, 2003).

However, the traditional method came under criticism in the 1970s due to increases in claims, disputes, and project delays (Cushman & Loulakis, 2001). The traditional method placed the owner as the arbitrator between the construction contractor and the designer. AF project managers in charge of MILCON projects were "managing by change order" when low bid contractors were searching for design errors and modifications to increase profits (Langley, 2007).

Under the DBB delivery method, the owner selects a design firm to create contract documents consisting of project drawings (the design) and job specifications. After the design is completed, the project drawings become the contract documents and the project is awarded to the low bidder. The job specifications can be listed on the drawings in note form; however, they are typically listed in special groups with section numbers designated by Construction When the designer completes the contract documents (100% design completion), the job is advertised and/or delivered to selected companies to begin the bidding process. General Contracting (GCs) companies acquire the contract documents and meticulously go through the plans and specifications to note all materials and work that need to be completed. Then the GCs prepare their final cost for all labor and materials, and submit this to the owner.

This is considered their "Bid" for the job. Typically, the GCs' bids must be submitted to the owner at a specific time and place; no late bids are accepted. After the bids are accepted, opened, and reviewed by the owner, the GC with the lowest bid is offered the job, contingent on their ability to provide accurate insurance and bond coverage. If the GC is able to meet the insurance and bond requirements and accepts the job, a contract is signed and the work begins. Since the design is considered as the contract document, and was completed and issued by the owner, any changes that need to be done after the work begins are the owner's responsibility. Figure 2.1 shows the contractual relationship in the DBB delivery method (Shawn D. Moore, 1998).

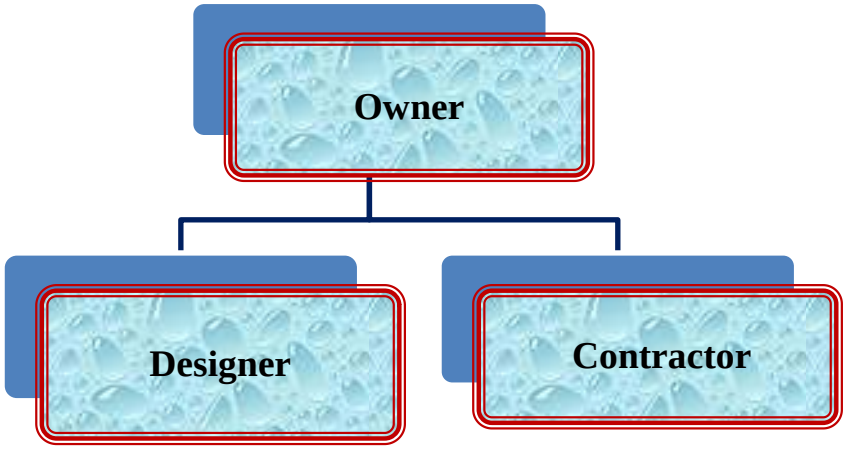


Figure 2.1 Contractual Relationships of the DBB Projects.

It is known that no one project delivery method is flawless. The advantages and disadvantages of the DBB method are shown in table 2.2. This may not include all the advantages and disadvantages known, but it does highlight the main points for a clearer understanding of this delivery method's strengths and weaknesses.

Traditional DBB procurement was the primary method used before innovative contracting was introduced in the last twenty years, primarily because of statutory public purchasing laws. In the traditional system, project award is based solely on cost, with no consideration of qualifications, schedule, or past performance. In a traditional delivery system, the design is 100% complete before the owner is able to solicit bids. The process requires the longest overall project time to completion. Also, with the design 100% complete, there is little room for the contractor to use innovative techniques that can save money and time on the project.

2.3.1 Major Stakeholders in DBB

In a typical public construction project, the contractual arrangement with an employer contractor agreement involves some of the primary stakeholders such as employer, contractor, engineer, financial institutions, subcontractors etc. The following table (Table 2.1) shows some of the

major roles of the above three primary stakeholders for a typical public construction project under a DBB contract delivery system.

Table 2.1 Major Stakeholders of the DBB Project Delivery Method

No.	Major Stakeholder	Major Responsibilities
1	Employer	Provides financial support to develop the project
		Determines the scope of the work
		Creates the necessity to build the facility
		Most important player of the process
2	Engineer	Develops drawings and specifications and prepares other contract documents
		Administers the contract and supervises the Works
		Responsible for the project design
		Idealizes the final result of the project
3	Contractor	Brings the project into reality
		Manages different resources to build the facility
		Creates the facility based on the design

Source:- PDS On Major US Construction Project David M, 2004.

Collections in recent studies on the DBB method, for instance, the study conducted by AIA signify that the method is identified by the following defining (i.e. unique) characteristics:

- ✓ Three prime players, namely, owner, designer, and builder.
- ✓ Two separate contracts, that is, the contract between the owner and the designer, and between the owner and the builder.
- ✓ Final contractor selection is based on lowest responsive bidder.

Typical characteristics of the DBB approach include the following:

1) Three linear phases – design, bid, and build.
2) Well-established and broadly documented roles.
3) Carefully crafted legal and procedural guidelines.
4) A lowest responsible bidder that provides a reliable market price for the project.
5) Contract documents that are typically completed in a single package before construction begins, requiring construction-related decisions in advance of actual construction.
6) An opportunity for construction planning based on completed documents.
7) Complete specifications that produce clear quality standards.

8) Configurations and details of finished product agreed to by all parties before construction begins.

2.3.2 Time Line of DBB

The owner first selects and made a contract with a designer. The designer is then prepares the design documents for the project under consideration. Next the owner must prepare bid package and solicit for bids to build the construction. Several contractors may bid on the project and the owner usually selects and contracts the contractor with the lowest bid. The owner takes possession of the project upon substantial completion. Fig 2.2 shows the typical sequence of events for a DBB (Tenah, K.A. 2001 Project Delivery Systems for Construction).

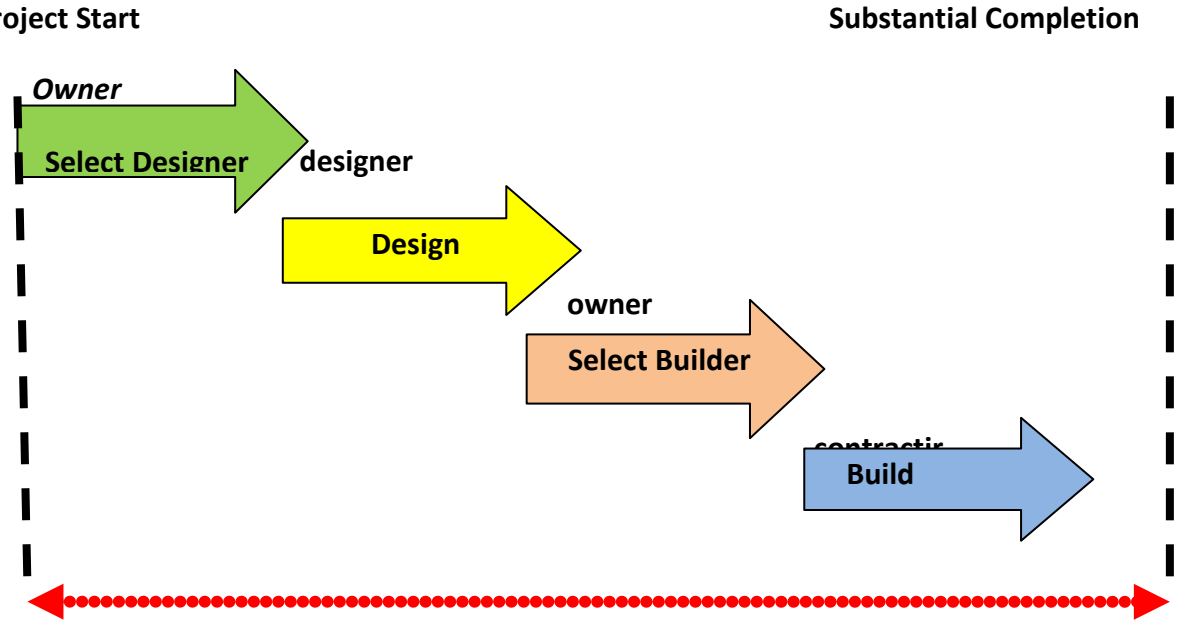


Fig 2.2 Time line for DBB

2.3.3 Advantages and Disadvantages of DBB Project Delivery System

Table 2.2:- Advantage and disadvantages of DBB project delivery system

No.	Advantages	Disadvantages
1	Contractors bid competitively, based on complete design documents to maximize the built product for the price.	DBB construction phases are sequential and may require more time
2	The owner selects the contractor on the basis of qualifications or ability. The designer's role is that of owner's legated representative.	Owner is at risk for final construction cost. Actual construction costs are not known until design and bidding are complete.
3	The designer is active in construction administration so design intentions are followed.	The designer is active in construction administration so design intentions are followed.

4	Design and construction roles are clearly defined, and responsibilities and liabilities clear.	There is shared responsibility for project delivery
5	Owner is an active participant in design process.	Owner is at risk to contractor for design errors
6	Greater certainty of means and methods to be used by contractor on the project	Design and construction are sequential, typically resulting in longer schedules
7	System is familiar to most organizations in the highway construction industry	Construction costs unknown until contract award
8	Owner controls design and construction	No contractor input in design, planning, or value engineering.
9	Design changes easily accommodated prior to start of construction.	It requires much longer time to completion for overall project
10	Design is complete prior to construction award	Many risks remain with the owner
11	Construction cost is fixed at contract award (until Change Orders)	Limited ability to work with highly qualified contractors for certain projects
12	Low bid cost, maximum competition	Projects are awarded on the basis of a single factor that is cost
13	Relative ease of implementation	System can be litigious if many claims for extension and add change orders occur.
14	Owner controls design / construction quality	Owner does not have access to contractor knowledge and experience to optimize design and resulting in construction cost reduction and other advantageous implications.

2.4 DB Project Delivery System

The DB form of project delivery system is a system of contracting whereby one entity performs both design/engineering and construction under one single contract. Under this arrangement, the design-builder warrants to the contracting agency that it will produce design documents that are complete and as much as possible free from error (DBIA 1994). According to (KDOT, 2012) DB is an alternative project delivery tool that will allow the flexibility to deliver selected projects more efficiently and cost-effectively by selecting a design-builder to complete the design and construction of the project. The difference, and a key advantage, with DB is: plans are not 100% complete for the entire project when construction starts. DB allows the contractor and designer to collaborate early and develop innovative and efficient solutions to meet the project goals.

DBB system heritage is as old as the days during the construction of the pyramids, when it was referred to with the term Master Builder, (Pekka Pakkala, 2002) . DB is simply a project delivery method in which the Owner/Client selects an organization that will complete both the design and construction under one agreement. Upon completion, the Owner is then responsible for operations and maintenance of the project. The Owner is also responsible for all the financing aspects. Appointing a single entity in charge of all aspects of a project is not a new concept. The

DB concept has a rich history descending from the "master builders" or "master masons" of ancient Egypt, Greece, and Rome (Beard et al., 2001; Cushman & Loulakis, 2001). Master builders did not distinguish a project between its design and construction phases. They coordinated and controlled every aspect of a project including material procurement and selection, project design, supervising craftsmen, and project financing (Cushman & Loulakis, 2001).

The Renaissance brought about the first challenge to the idea of a master builder at the time of the most famous master builder Filippo Brunelleschi (1377-1446).

Brunelleschi was commissioned to build the Gothic Cathedral of Florence in 1420 (Beard et al., 2001). The master builders were challenged by Leone Batista Alberti, who believed in the separation of design and construction, when he published the first architectural printed work "De re aedificatoria" (On Edifices) in 1485 (Cushman & Loulakis, 2001). The popular view of a master builder remained in the majority until the industrial revolution.

While DB project delivery is not new to the building construction industry, it is relatively new to the highway construction industry, whose roots are largely in the post World War II era when DBB was already the established way to procure and deliver many types of infrastructure projects. Interest in the DB approach by contracting agencies of highway projects has been spurred by reported successes achieved in applying this approach to project delivery by other infrastructure development sectors in this country (for buildings) and overseas (for buildings and highways) (Bennett, J.; Pothecary E.; Robinson, G. (1996). The DB Institute of America defines design-build as: "a system of contracting under which one entity performs both architecture/engineering and construction under one single contract" (DBIA, 2007a). Figure 2.3 illustrates the basic contractual relationships for DB project delivery (Shawn D. Moore,1998) where the owner holds only one contract with a design-build entity.

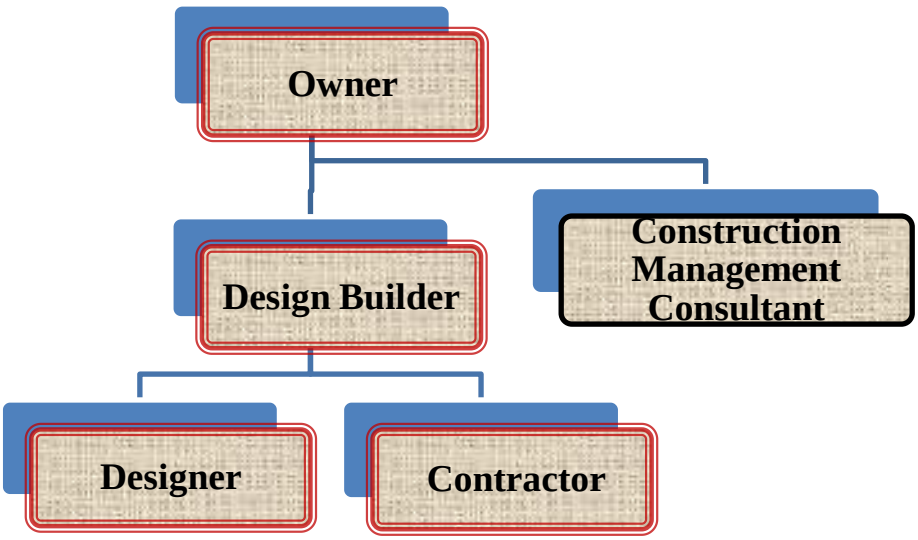


Fig 2.3: Contractual relationships for DB projects.

The rebirth of DB as a project delivery method for government-sponsored infrastructure projects can be attributed to a number of complementary factors.

1) First, DB has its roots in the genesis of infrastructure development going back millennia when design and construction functions were integrated by the design-builder position.
2) Second, in times of war or natural disaster the urgency to expedite projects has caused government agencies to suspend traditional procurement and contracting methods and permit alternative approaches such as DB.
3) Third, budget and personnel shortages or other constraints in the public sector and competitive pressures in the private sector have caused project sponsors to seek more cost-effective ways to deliver projects. Indeed, fiscal and national crises have often been the driving forces behind efforts to permit government to innovate and become more cost-effective.

DB contracts promote time savings and usually provide for the shortest overall project time compared to other contracting methods because the design phase can be shortened and the construction phase and design phase can be overlapped. DB contracts do not need a definite and final design to proceed with the RFP.

The responsibility for completing the design is placed upon the design-builder, which helps to reduce/eliminate change orders, requests for time extension, and other claims arising from design errors, conflicts, and omissions. DB contracting maximizes the contractor's ability to use innovative designs, materials, and scheduling, staging and construction techniques. DB also offers expertise of the contractor for the project.

Depending on how risk and responsibility is allocated, the use of DB can also reduce negative public opinion and improve communications within the community where the project is located. In DB, award can be made based on best value and/or most qualified status rather than just low bid. This makes DB ideal for projects requiring a high degree of technical expertise since the owner can choose the proposer with the best qualifications and/or the best technical solution, rather than being forced to take the lowest bidder. Many projects have unique technical challenges, time constraints, or space limitations. In DB, the proposal evaluation criteria can be tailored to individual project needs so that these unique challenges can be met by highly qualified proposers.

However, procurement costs for DB are higher than for traditionally procured projects, and there remains some reluctance to embrace the DB philosophy within many agencies and agency personnel because of its newness. Also, capabilities to internally manage and administer DB projects may be limited because the DB delivery method represents a fundamental shift in contracting philosophy which may be in conflict with longstanding policies, job descriptions, and

procedures within the agency. DB is not recommended for projects where risk cannot be equitably allocated or for projects where time is not of the essence.

As per Transportation Research Board (1991). "Innovative Contracting Practices," Transportation Research Circular, DB is viewed by many as one of the most promising "innovative" approaches to build highway infrastructure faster and cheaper without sacrificing product quality. One main advantage of the DB delivery method is the possibility for the owner to contract with a single entity. The DB team is responsible for providing the owner with all aspects required to deliver the facility, starting from design services to construction, and including equipment selection and procurement (Beard et al. 2001).

In this method, the risks associated with design management and controls are transferred to the DB entity. Moreover, the owner relies on the DB team for coordination, quality and cost control, in addition to schedule monitoring. DB, as a project delivery system, emerged to satisfy the owners' recent requirements to complete projects faster and at lower costs (Tulacz 2003).

2.4.1 The Role of Construction Management Consultancy

There are benefits and trade-offs that come with various delivery methods, and it can be invaluable for the owner to have professional CM advice to determine what makes the most sense for any given project or program (CMAA Owner's Guide to Project Delivery Methods - August 2012). For example, one owner may value the speed to completion and the potential for design innovation that DB promises while another owner may not wish to accept the reduction in owner control of final design that accompanies DB delivery.

In addition, many alternate delivery methods require the owner to have sufficiently experienced staff resources to fully define the project or be willing to allow another entity to define it. The owner must also be able to make decisions, handle inquiries, and manage other processes quickly enough to take full advantage of the accelerations offered by some alternate delivery methods. Regardless of the delivery method utilized, the professional CM can play a pivotal role throughout all phases of project implementation.

2.4.2 Timeline of DB

The owner or the agent first writes a request for proposal or RFP, and then select the contractor with a firm that performs both design and construction. The DB firm works with the owner and other interested agencies to prepare a preliminary design to firm up requirements then continues preparing design for the construction.

The contractor or the builder may start construction before the design is 100% completed. For example the design-build firm may prepare the site design such as rough grading, site utilities etc. for a new facility. When a site work design is at a level of completion to allow start of

construction, the contractor might begin that portion of the construction. The designer continues while the construction is already under way. The owner takes possession of the project upon substantial completion. Fig 2.4 shows a sequence of events for DB contract (Tenah, K.A. 2001).

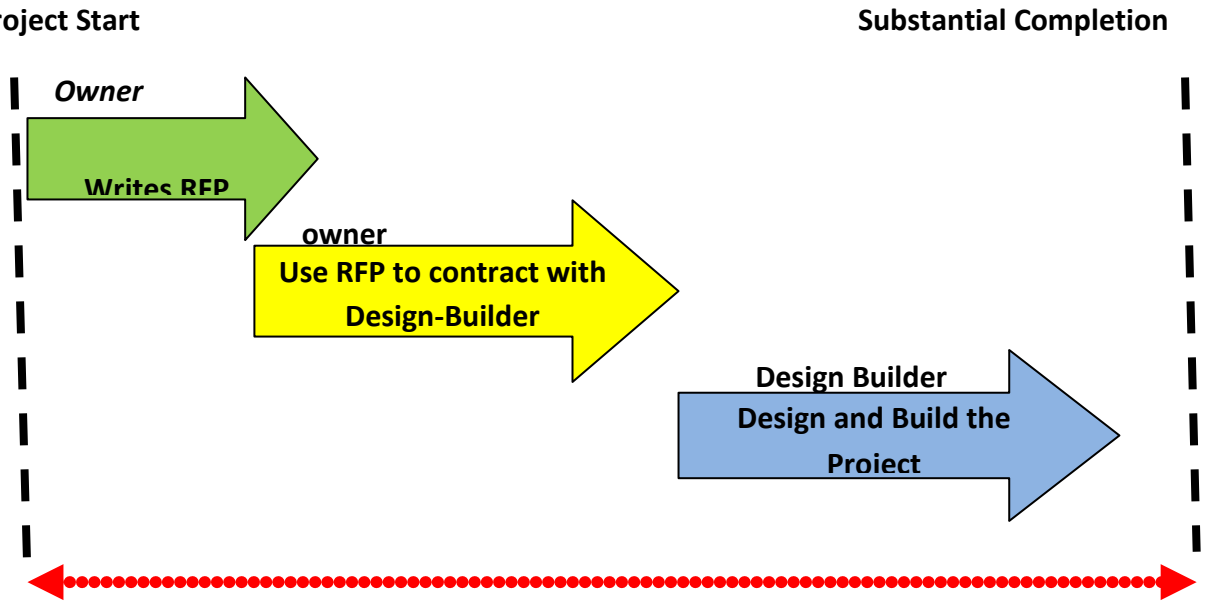


Fig 2.4 DB timeline

2.4.3 Advantage and Disadvantages of DB Project Delivery System

Proponents of DB contracting proclaim a number of advantages over typical contracting arrangements such as DBB, including:

2.4.3.1 Advantage Through Time Saving

1) Early contractor involvement that enables construction engineering considerations to be incorporated into the design phase and enhances the constructability of the engineered project plans;
2) Fast-tracking of the design and construct portions of the project, with overlapping (concurrency) of design and construction phases for different segments of the project; and
3) Elimination of a separate construction contractor bid phase following completion of the design phase.

2.4.3.2 Advantage through Cost savings

1) Communication efficiencies and integration between design, construction engineering, and construction team members throughout project schedule;

2) Reduced construction engineering and inspection (CEI) costs to the contracting agency when these quality control activities and risks are transferred to the design-builder;
3) Fewer change and extra work orders resulting from more complete field data and earlier identification and elimination of design errors or omissions that might otherwise show up during the construction phase;
4) Reduced potential for claims and litigation after project completion as issues are resolved by the members of the design-build team; and
5) Shortened project timeline that reduces the level of staff commitment by the design-build team and motorist inconvenience due to reduced lane closures.

Table 2.3:- Advantage and disadvantages of DB project delivery system

No	Advantages	Disadvantages
1	Does not require 100% design prior to award	Involvement of owner is generally limited to early stages of project.
2	Allows for some construction work to be performed before final design approval	Design-Builder may provide less building than a bid approach to protect margin of profit. Construction costs are non-competitive.
3	Allows for innovative scheduling, construction techniques, and materials	Hidden reductions in quality are possible when cost-savings and design changes are determined by design builder. Short-term construction savings may outweigh life-cycle costs.
4	Creates single entity contractual responsibility	Construction documents not complete when cost commitment made. Disagreements about quality and design intentions may arise later.
5	Reduces errors, omissions, and rework claims	Major conflict of interest with role as designer and contractor.
6	Saves on time and third party costs	Reduces competition for construction services by excluding smaller firms unable to lead the larger projects most amenable to the DB approach;
7	Allows for more costs to be included in capital project budgets	Favors large national engineering and construction firms in competing for larger DB contracts that are too big for smaller local or regional firms to pursue;
8	Improves utility coordination by allowing the contractor to schedule activities directly with utilities	Provides an opportunity for favoritism to enter into the contract award process by including non-price factors in the basis for selection;
9	Allows early commitment by design-builder to overall project cost	Undermines the inherent checks and balances between design and construction teams in the traditional delivery systems, with the design team no longer independent of the construction contractor;

10	Generally fastest project delivery system.	Increases project costs due to the elimination of the low bid contractor selection criteria
11	Single entity responsible for design and construction.	Demands time sensitivity regarding permit approvals and ROW Acquisition Results in higher procurement costs
12	Early cost and scheduling commitment.	Requires greater time demands for calculating risk allocation
13	Conflicts between project professionals internalized; may not involve owner.	Increases potential for many project uncertainties if clarity of scope is not well defined at time of proposal and can result in inequitable risk assignments

In a DB project development process, the procurement of the DB contractor through a request for proposal (RFP) process might actually require substantially more time than the invitation for bid (IFB) process used to retain the construction contractor. However, overall time savings result from not having to go through two separate procurement processes, one for the design team and one for the construction team.

2.5 Evaluation Criteria for Assessing DB and DBB PDS

The criteria used for selecting (or evaluating) the appropriate method(s) among the alternative delivery methods were: project time certainty, controlling project cost, ensuring project quality, and reduction of owner's administrative burden. Different literatures have considered a number of performance criteria when analyzing the implications of DB contracting.

This research paper characterizes the implications of DB project delivery versus the traditional DBB project delivery in terms of selected project characteristics and relevant/measurable performance criteria that directly relate to the issues posed by the Ethiopian Federal Road Construction Projects.

Pertinent literature on DB project delivery reveals that proponents and critics use similar criteria for judging the applicability and effectiveness of DB and related approaches to project delivery. These criteria relate to performance objectives that proponents seek to achieve and performance standards that critics fear will be jeopardized by using design build. This research used the following criteria to assess the effectiveness of the DB project delivery versus DBB project delivery system, based on the advantages and disadvantages of using DB versus DBB in federal road projects in Ethiopia.

1) Duration of project development, comprising the following two phases:

   - From concept to contract award
   - From contract award to completion

2) Total cost of project development, including the following:

   - Project planning
   - Project administration
   - Design
   - Construction

Among these factors, proponents generally agree that project duration or speed of delivery is the most significant factor motivating project sponsors to try DB, particularly when an emergency or other urgent condition exists. Besides the contractual relationships, these two delivery systems are also defined by relative sequence of activities illustrated in Figure 2.5. The DB contract typically begins after formal acceptance of the design-build entity's proposal at the conclusion of the construction procurement phase. However, partial design may be developed during the construction procurement phase to satisfy the request for proposal's design submittal criteria.

Therefore, the date of project advertisement would reflect the actual start of design for the DB project. Furthermore, the design-build bridging option may initiate an architectural engineer to start concept design in the design phase to prepare the request for DB proposals used in the construction procurement phase (Shawn D Moor,1998). The DBB delivery system sequence begins with the start of conceptual design. Typically, once design is completed through the contract documents, the project is advertised for bid. This begins the construction procurement phase. During the construction procurement phase, general contractors formulate their bids based on the contract documents and submit them usually in open competition. The construction notice to proceed date identifies the start of the construction phase (Shawn D Moor,1998).

Figure 2.5 shows relative time saving of DB in relation to DBB. (Source: Dr. Keith Molenaar)

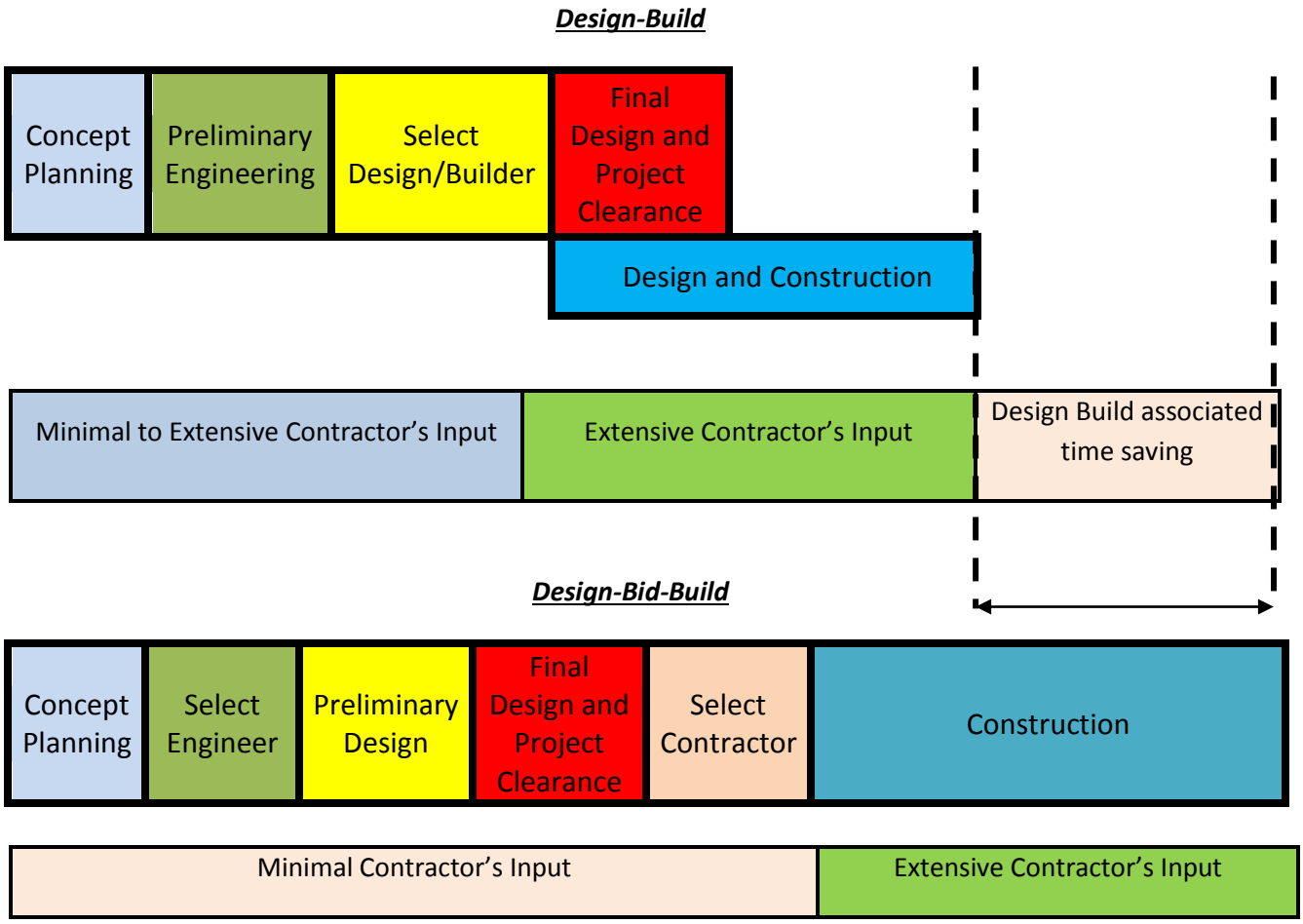


Fig 2.5:-Relative Time saving of DB versus DBB.

Source:-Keith Molenar

Cost control is the next most frequently cited reason for using DB, particularly for contracting agencies who wish to minimize the extent and impact of change orders on project costs. Quality is the one feature of a project that both proponents and critics agree must be preserved regardless of the applied delivery approach. Where warranties are included as a part of the contract, the emphasis on project quality takes on even more significance due to the added cost exposure of the project delivery team.

Equity and competition are both important issues in the DB versus DBB debate, prompted largely by a concern that innovative project delivery is merely a way to get around current regulations that protect the interests of and promote continued competition among competent project design and construction firms.

A prevailing complaint is that innovative contracting approaches will change the competitive landscape for companies involved in a particular highway project development program by

placing local firms at a distinct disadvantage to larger national firms that have significantly more experience. Another concern is that increased use of DB will lead to fewer business opportunities for small businesses, including disadvantaged business enterprises and minority-owned firms.

Other performance indicators for judging the success of DB contracting include:

- ✓ Integration of various functions that constitute the project development process by establishing singular responsibility for project design and construction;
- ✓ Transfer of project risks to the design-build team;
- ✓ Reduction in administrative burden following contract award; and
- ✓ Application of innovative techniques and products.

Each of these features can be measured by the five primary performance criteria listed above. Indeed, these five criteria reflect the specific areas of focus for this study, based on the results of the literature search, project surveys, and projects databases available from ERA as well as from different local road consultants in Addis Ababa.

2.6 Causes of Schedule delay on PDS

Internal causes of delay include the causes arising from four parties involved in the project. These parties include the owner, designers, contractors, and consultants. Other delays, which do not arise from these four parties, are based on external causes for example from the government, materials suppliers, or the weather. Chan et al (1996), Ogunlana et al (1996), Kaming et al (1997), Alwi et al (1999), Ahmed et al (2003) and Alaghbari et al (2007) mentioned the possible following factors causing delays in construction projects: A number of researcher have categorized the factors that causing delays in the four categories, those are:

2.6.1 Contractor's Responsibility

The factors that related to contractor's responsibility are; delay in delivery of materials to site; shortage of materials on site; construction mistakes and defective work; poor skills and experience of labor; shortage of site labor; low productivity of labor; financial problems; coordination problems with others; lack of subcontractor's skills; lack of site contractor's staff; poor site management; and equipments and tool shortage on site.

2.6.2 Consultant's Responsibility

The factors that related to consultant's responsibility are; absence of consultant's site staff; lack of experience on the part of the consultant; lack of experience on the part of the consultant's site staff; (managerial and supervisory personnel); delayed and slow supervision in making decisions; incomplete documents; and slowness in giving instructions.

2.6.3 Owner's Responsibility

The factors that related to owner's responsibility are; lack of working knowledge; slowness in making decisions; lack of coordination with contractors; contract modifications (replacement and addition of new work to the project and change in specifications); and financial problems (delayed payments, financial difficulties, and economic problems).

2.6.4 External factors

The factors that related to external factors are; lack of materials on the market; lack of equipment and tools on the market; poor weather conditions; poor site conditions (location, ground, etc.); poor economic conditions (currency, inflation rate, etc.); changes in laws and regulations; transportation delays; and external work due to public agencies (roads, utilities and public services) (Alghbari et al 2007). Chan et al (2002), Alwi et al (2002), Assaf (2006), Odeh and Battaineh (2002) and Alghbari et al (2007) Classified factors that cause time overrun into eight groups (owner, contractor, consultant, material, labour and equipment, contract, contractual relationships and external factors).

2.7 International Market Trend of DBB and DB

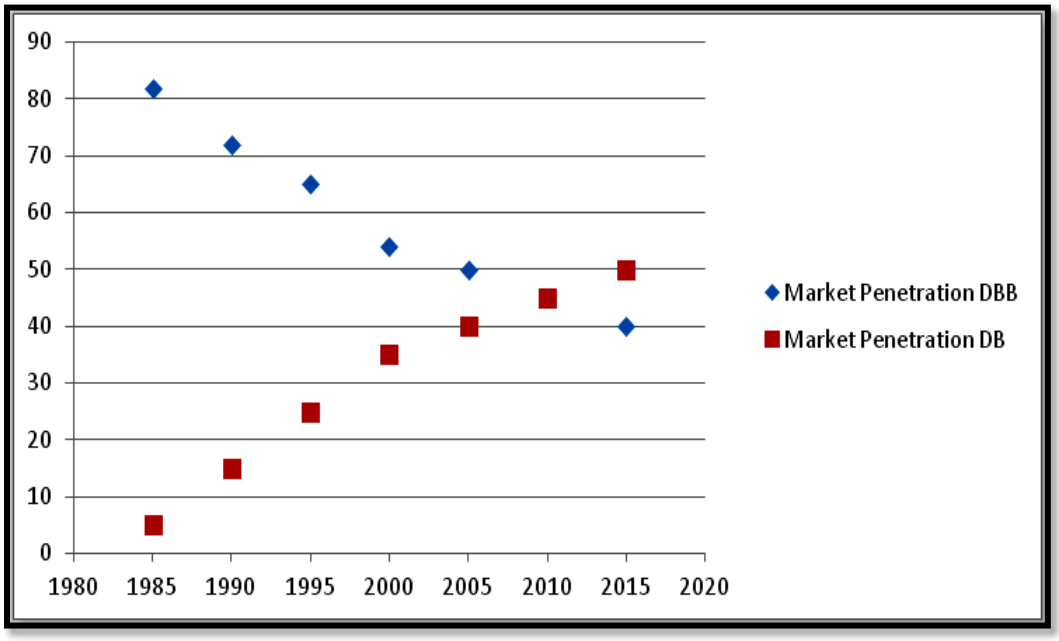
In a study conducted at Pennsylvania State, USA, sponsored by the Construction Industry Institute (CII), the design-build delivery system was identified as offering, on average, the best project performance. Design Build Institute of America (DBIA) also indicates that compared to the design-bid-build and innovative project delivery method , the trend for adopting the design-build approach is increasing since 1995, when only 10% of the projects were delivered via the design-build method.

In 2001, the number of design-build projects accounted for more than 30% of the

construction in the United States. And, different market sectors are increasingly shifting to the design-build approach and, hence, in healthcare, design-build accounted for 15% of the medical institutions in 1997 and currently is accounting for 46%.

According to DBIA, 2005 In the U.S. public sector, the federal government and many states and local governments employ DB contracting for a significant percentage of their building programs. In the seven years from 1986 to 1992 total use of design- build in the public and private sectors grew 172% according to (Engineering News record Report of 1993). Figure 2.6 (DBIA 2005) shows the projected market trend of traditional DBB and DB. There is a steady decline of the use of traditional DBB when compared to DB. By 2010 it has been predicted by the design-build institute of America that these two project delivery methods will be equal in the use. By 2015, traditional DBB is predicted to become less used than DB for project executions.

(Market %)



Year

Fig 2.6:-Projected Growth of DB as compared to DBB

Source Design Bid Institute of America,2005

2.8 Project Delivery Methods Available to Owners

A project delivery method is a system designed to achieve the satisfactory completion of a construction project from conception to occupancy. A project delivery method may employ any one or more contracting formats to achieve the delivery. Because of financial, organizational and time constraints, various project delivery methods have evolved to fit particular project and owner needs. Most delivery methods used today are variations of three methods: DBB, Construction Management At Risk, and DB, while the focus of this paper is on DBB and DB.

2.8.1 Contracting Alternatives

Contracting and compensation methods for professional services and construction services will generally fall into one of three categories: (CMAA Owner's Guide to Project Delivery Methods - August 2012)

1. Fixed Price or Lump Sum (LS)
2. Guaranteed Maximum Price (GMP)
3. Reimbursable

These methods are not specific to any particular delivery method, and may be applied to contracting for professional services, such as design, engineering, and construction management, as well as contracting for construction services.

2.8.1.1 Lump Sum contracting

Lump sum contract is also called Fixed Price when an owner contracts with an entity to perform a fixed scope of work in exchange for an agreed lump sum payment for the specified services. This method is one of the most commonly used.

2.8.1.2 Guaranteed Maximum

Price contracting is an arrangement in which an owner contracts with an entity to perform a fixed scope of work in exchange for a price that is guaranteed to not exceed a stated maximum price. The GMP will typically include a base cost along with several allowances and contingencies that, depending on their ultimate use, may result in a final cost below the stated GMP. These "savings" may fall to the owner or may be shared with the entity providing the GMP.

2.8.1.3 Reimbursable contracts

Reimbursable contracts come in a variety of forms, and are sometimes coupled with a not-to-exceed maximum price. With a reimbursable contract, an owner contracts with an entity to perform a fixed or variable scope of work in exchange for a payment based on some agreed calculation method.

2.8.2 Procurement Alternatives

Procurement of professional services and construction services will generally be accomplished in one of three ways:

1. Priced based
2. Qualifications based
3. Combination of 1 and 2

Procurements may also involve a one-step process, in which there is just a single round of submittals that determine the selection, or a two-step process, which may include a qualifications submittal as the first step and then a price proposal as the second step.

2.9 Earned Value

According to (Suketu Nagrecha, March 2002), *e*arned Value Analysis is a better method of program/project management because it integrates cost, schedule and scope and can be used to forecast future performance and project completion dates. It is an "early warning" program/project management tool that enables managers to identify and control problems before they become insurmountable. It allows projects to be managed better – on time, on budget.

Earned Value analysis is a method of performance measurement. Earned Value is a program management technique that uses "work in progress" to indicate what will happen to work in the future. Earned Value is an enhancement over traditional accounting progress measures. Traditional methods focus on planned accomplishment (expenditure) and actual costs. Earned Value goes one step further and examines actual accomplishment *(Suketu Nagrecha, March 2002).*

This gives managers greater insight into potential risk areas. With clearer picture, managers can create risk mitigation plans based on actual cost, schedule and technical progress of the work. Earned Value Management System is not a specific system or tool set, but rather, a set of guidelines that guide a company's management control system.

The Parameters that form the basis for cost performance measurement using Earned Value Management are:

- Budgeted Cost of Work Scheduled (BCWS) or Planned Value (PV),
- Budgeted Cost of Work Performed (BCWP) or Earned Value (EV)
- Actual Cost of Work Performed (ACWP) or Actual Cost (AC).
- Cost Variance (CV)
- Schedule Variance (SV)

Budgeted Cost of Work Scheduled (BCWS) or Planned Value (PV) is the sum of budgets for all work packages scheduled to be accomplished within a given time period. Budgeted Cost of Work Performed (BCWP) or Earned Value (EV) is the sum of budgets for completed work packages and completed portions of open work packages. For clarification and graphical representation see Figure 2.7

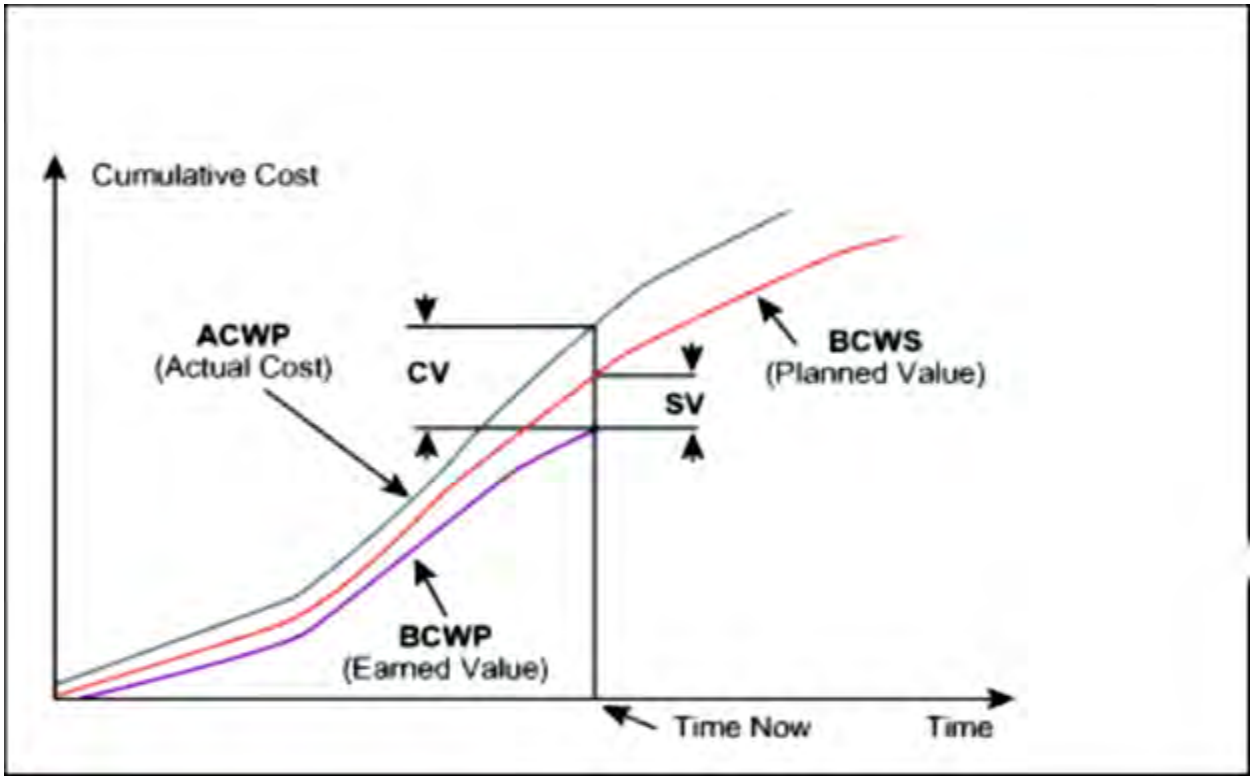


Fig 2.7:-Sample S-Curve for Earned Value Analysis

Source:-Public Procurement Best Practice Guide

2.9.1 Earned Value Analysis

Earned value analysis is a method of performance measurement. Many project managers manage their project performance by comparing planned to actual results. With this method, one could easily be on time but overspend according to the plan *(Suketu Nagrecha, March 2002).* A better method is earned value because it integrates cost, schedule and scope and can be used to forecast future performance and project completion dates. It is an "early warning" program/project management tool that enables managers to identify and control problems before they become insurmountable. It allows projects to be managed better – on time, on budget.

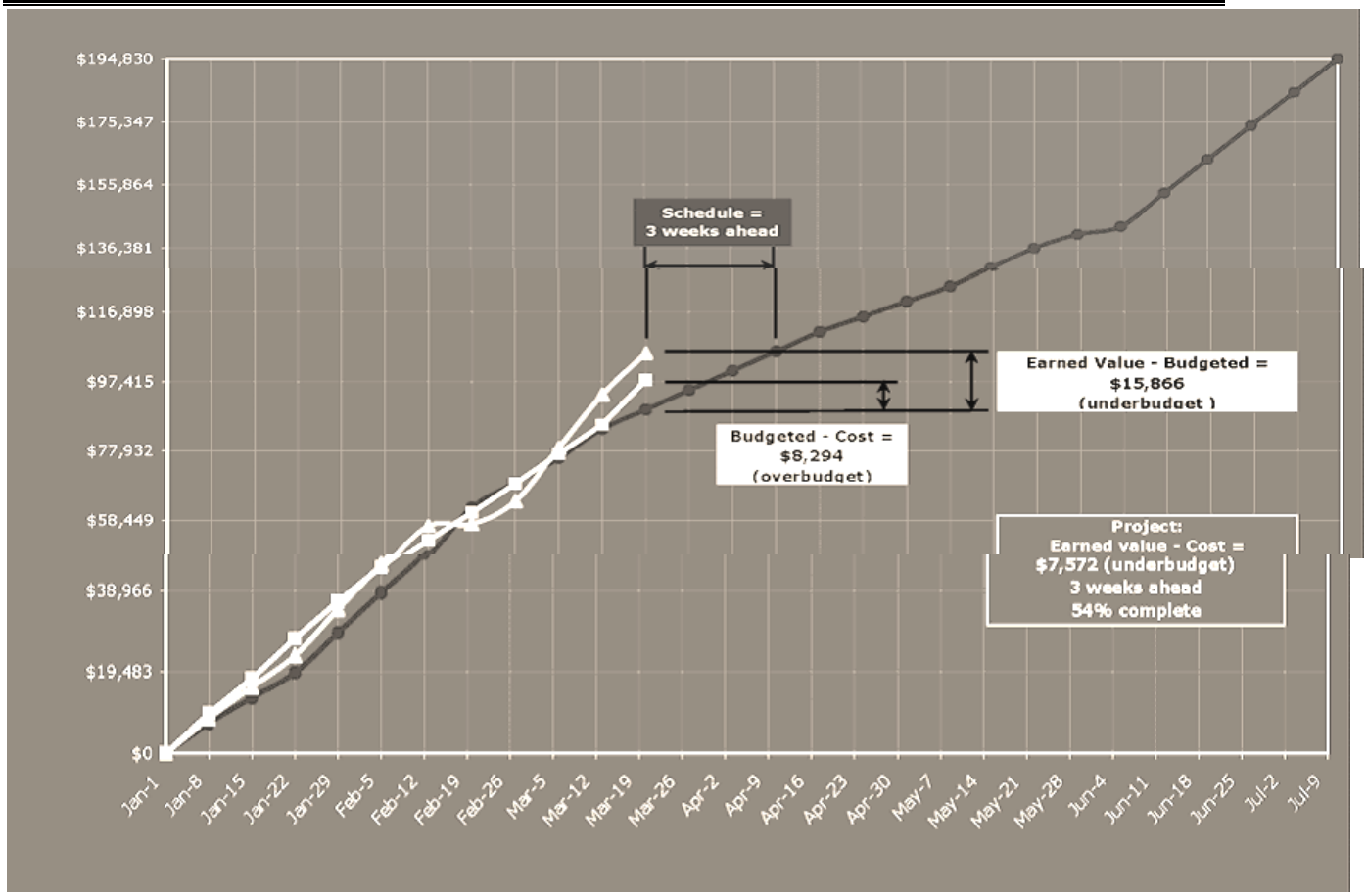


Fig 2.8:-S-Curve for Earned value Analysis

Source:-Pier Design www.pierdesign.ca

As an illustration above Figure 2.8 shows the planned value, actual cost and earned value for a project. Note that when the planned spend curve is compared to the actual spent, it shows a variance of 15,866 which shows the project team is accomplishing the planned work and doing it for less money.

2.10 DBB and DB in Ethiopia Federal Road Construction Projects

DBB delivery system is the most practiced type of delivery system in the construction industry of Ethiopia since the 1987, (Wubishet, 2004). After project owners did prepare the basic planning that identifies construction project programs, they call upon the participation of Design and/or supervision Consultants either by tender or by negotiated contracts. This consultant will carry out the design together with the necessary tender documents which will be the bases for tendering to select contractors.

In this type of delivery system, projects are divided into different packages interfacing to each other. Though the design and supervision consultant will be the prime professional on behalf of

the owner and largely the administrator of the construction contract; the employer takes the responsibility of coordinating the various project packages and their respective interfaces.

Besides, designers have not been required to guarantee results but rather methods. That is, they are held accountable on the basis of their superior knowledge and sufficient competency and ability to design with a reasonable degree of technical skills. As a result, contracts and courts focused on professional duty of care, not results or project goals, contractors are also responsible to construct works with due care and diligence and complete them in accordance with the contract, but they are not held responsible for design deficiencies.

Since the 1980, this traditional approach becomes less popular due to the following factors (Wubishet Jekale 2013):

1) Severe Adversarial relations between the design plus contract administration consultant and the contractor.
2) Fragmental contract for the project owner.
3) Project owner responsibility for risks associated with the design and contract administration consultant.
4) Lack of impartibility of the Design and Contract Administration services.
5) The inability of design and contract administration consultants to cope up with new construction technologies and constructability issues of their designs.
6) Severe adversarial relationships between Urban planners and Architects on the one hand; and Architects and Engineers on the other hand on building projects.
7) The indirect contractual obligation assigned for the Design and contract Administration Consultants
8) The incompatibility of consultancy fee to the desired activities they are required to provide.

DB delivery system is a response to problems associated to the DBB delivery systems. DB delivery system reduces numbers of procurement processes engaged in the fragmented process and employ only one procurement process and a single contractor to provide the entire construction implementation process (Design & Construction Implementations). In the 1970s, large firms began to offer both design and construction services in order to provide project owners with a single source for project delivery. At the beginning, this delivery system was limited to complex projects such as industrial, big plants and big infrastructural constructions.

DB delivery system led lead contracting firms to form a team or consortium of designers and specialty contractors who work together to meet the entire demand. Such services are initiated after the project owner built the project concept during the basic planning phase and brought to the DB contracting Firms. The project concept should clearly define the performance criteria

such as output, input, waste and any other performances the employer may desire. This makes an additional responsibility to the contractor which is “fitness to purpose." Fitness to purpose is beyond the professional duty of care and places liability on the contractor for any failure of the design to perform the standards required (Wubishet Jekale 2013).

2.11 Challenges of DB in Ethiopia Federal Road Project

DB project delivery is one of the many different types of project delivery systems that are being practiced by many public and private project owners in many countries worldwide. When it is observed back at the history of road project delivery system which ERA has been managing in the past this could be the second time that it is bringing the DB system, the first one being implemented towards the end of the 1990s. During that time about 14 projects were given to contractors with end results that have not made both the client and the contractors happy. Although ERA might have its own reasons for abandoning the system after only a short trial, it has currently given about 12 projects for contractors on DB system thus waiting to see how it ends.

From the information gathered, some of the contractors involved in the first package were not happy in the outcome since the prices they offered did not cover their expenses. Some of them complained that they have encountered different site conditions which they did not expect at the beginning on some of the projects they came across marshy areas & highly expansive soil that need to be removed and filled back with better quality material. These materials may have to be hauled from far places. The increase in quantity of rock excavation that was not originally estimated, as well as increase in the number of minor and major structures has increased their cost thus putting them at a loss (Eshete Mulat ECoTMPA, 2012).

CHAPTER 3

3 Research Design and Methodology

3.1 Introduction

This chapter describes the methodology used to analyze the effectiveness of DBB or the traditional method and DB project delivery methods for the Federal Roads projects of Ethiopia. The procedures used by this study are organized into three sections: data source, data collection, and data analysis. Each section will explain the definitions, decisions, and criteria used for the study data analysis.

In this chapter, the research design and methodology followed to achieve the ultimate goal of the research which is specified at the beginning will be discussed. In addition data and information sources, research instruments, sample size and method of analysis were presented. The following section provides a general description of the research strategy adopted for this thesis, as well as justification of the methodology.

The first step of data analysis was to identify a data source that contained consistent and accurate project information for traditional and DB projects. The Ethiopian Roads Authority, road construction consultants and different GC1 contractors are considered in the providing the required data for the analysis of both DBB and DB project delivery methods.

Ethiopian Rods Authority tracks an enormous amount of project information in order to manage both the DBB and DB project delivery methods. In addition to this the originality of the data the data source helps in the applicability and realistic representation to retrieve project information for this study.

3.2 Research Design

The strategy followed in this research was first started with problem identification which has been done through unstructured literature review, archival study and informal discussion with Ethiopian Road Authority, GC1 Contractors, Road Construction Consultants as well as professionals in the sector; and then the research design was formulated.

Then data and information sources were determined based on the formulated research design. On the basis of the data and information sources the research instruments were decided; and available documentary sources relevant to the research were reviewed. The review includes books, journal and articles, internet sources and archival document search such as progress and

completion reports within Ethiopian Roads Authority− the DB directorate of the road sector development program in Ethiopia. The document search was mainly intended to collect variables in relation to the effectiveness of the DBB and Db project delivery methods.

Finally, after an in-depth review of literature and desk study, a case study and an interview was designed and scheduled contacts were made to contractors, consultants, the employers, ERA−DB directorate staffs and reputed construction professionals to get their professional opinion based on their experience. Upon obtaining the desired data, checking and sorting of data has been done. The data were then analyzed for cross-checking the validity and conformity of the information obtained through the overall research work. This was followed by thorough discussions in order to draw a conclusion and to forward recommendations based on the findings of the study.

A descriptive and exploratory survey design was used in this study. It was attempted to collect data from the relevant population, implementing agency−ERA, consulting firms, contractors, and experts to evaluate the perception of different stakeholders on the issues of DBB and DB project delivery methods their effectiveness, and the current practice of both delivery methods in federal road construction projects.

3.3 Data Collection

3.3.1 Questionnaire

The questionnaire is aimed to answer the first and the second research questions. In line with these objectives the Questionnaire was sent to owner, contractors, consultants and reputed professionals who were asked to review the questionnaire and give their recommendations. The respondents were asked to fill the questionnaire and they have assured that the information will be confidential and only for research purpose.

The questionnaire included two parts the first part was a covering letter with information about the research project, contents of the questionnaire, and how the responses would be utilized. The second part was the questionnaire regarding the general characteristics of the project under question. At the same time the questionnaire helps to give highlights that related to the factors of time and cost overruns at construction projects in the federal road construction projects.

3.3.2 Case Study

In order to obtain answer for the question, “Under what circumstances does DBB or DB delivery system is the better approach for federal road projects?”, sampled DBB as well as DB projects, whose status is 60% and above completed were chosen.

The approach used to select samples/projects for the case study was Non probability of sampling in which, a case that serves the real purpose and objectives of the research is selected. Thus 5 projects from DBB and 5 projects from DB were selected to discover whether the effectiveness of project delivery system either DBB or DB is contributory to these effects.

3.3.3 Desk Study

Desk study is defined as an investigation of the available facts and figures relevant to a specific issue, often before starting a new or more detailed study (Microsoft Encarta 2009). Therefore the desk study was chosen as one of the instruments to assess the practices from relevant studies, reports and documents.

3.4 Research Instruments

Two research instruments were used for the collection of relevant information. To identify the effectiveness of DBB Vs DB project delivery methods in Federal Road construction projects in Ethiopia, they are desk study approach and case studies were carried out.

The desk study was mainly carried out to obtain actual data from the source documents which mainly included the cost and schedule variation as well as completion reports to have contextual bases on schedule and cost overrun in federal road construction projects.

The other instrument employed was to solicit professional opinion and relevant data through a questionnaire survey. Besides this a literature review to develop conceptual basis for the study was also conducted. Through the literature review, and other research papers it is tried to find extremely valuable information and in gaining knowledge and understanding of different methods for project procurement as well as alternate project delivery methods were identified. The review provided the basis to design the questionnaire which was made to professionals involved in the road sector program. For the questionnaire survey the respondents were randomly selected from the employer's organization (ERA), contractors, consultants and construction professionals who have been involved in the road sector development program.

3.5 Sample Size/Research Population

Based on the project delivery framework, questionnaire and case studies were developed to organize and analyse project data known to impact project performance. The study population was drawn from Ethiopian Roads Authority, contractors and consulting offices that have exposure to both DBB and DB or one of the two project delivery systems, and professionals.

As much as possible attempts have been made so that the samples drawn from the population are representatives. The following table presents the samples and their distributions, including the response rate.

The following table 3.1 presents the samples and their distributions, including the response rate.

Table 3.1 Respondent distribution

Respondent Category	Questionnaire Distributed	Questionnaire Collected	Response Rate (%)
Owner	4	4	100
Contractor	13	11	84.6
Consultant	12	12	100
Professional	26	26	100
Total	**55**	**53**	**96.4**

Professionals include those reputed experts engaged in the construction industry. The questionnaires were used in the distribution of the survey and were intentionally directed to those professionals who may have exposure for different project delivery systems and willing to fill the questionnaire. The contractors included were all Category 1 and General Contractors (GC).

The respondents included in the survey comprised of a total of 55 people, out of which 4 from owner, 13 from contractors, 12 from consulting offices, and another 26 from reputed professionals. The numbers were determined on the basis of the time available for conducting the research work, available fund for the study (project), and the reliability of the respondents so that the overall research work would indicate the reality-purposive sampling was used.

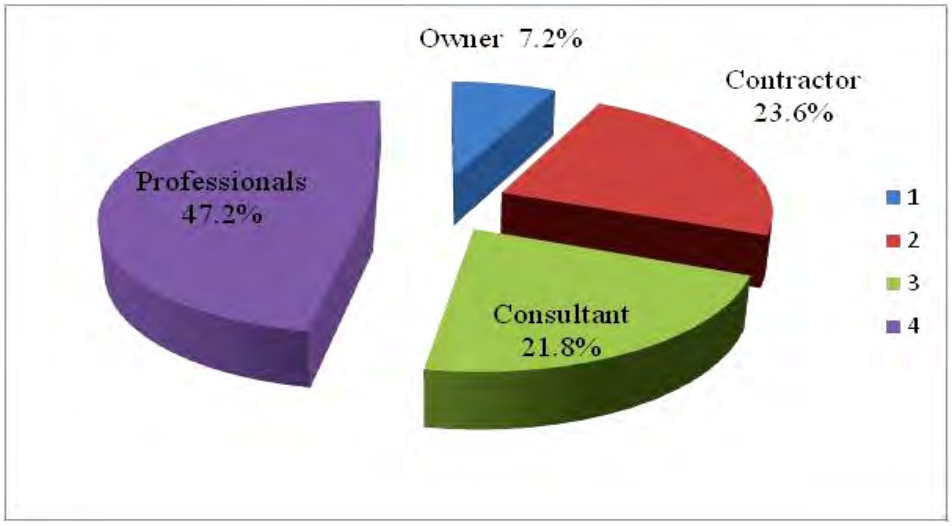


Figure 3.1 Percentages and Types of respondent Category

The research population of the DB projects are those projects which are currently active and drawn from three parties which are participating in federal road construction projects that are: owner Ethiopian Roads Authority (ERA), contractors, and consulting firms. Those professionals

include reputed experts engaged in the construction industry and were involved in road construction projects. The percentage and type of the respondent category is shown in figure 3.1

The contractors included were all Category 1 and were either General Contractors (GC) or Road Contractors (RC) specially participated in DBB and or DB road project in the federal road construction. The list of contractors and consultants currently involved in road construction projects were obtained from Ethiopian Roads Authority (ERA).

3.6 Data Analysis

The case study and desk study were analyzed in relation to the theoretical propositions. The method used to analyze the questionnaire data is descriptive statistics method. This method of analysis helps to analyze the responses in actual numbers. Accordingly, the data tabulated into categories and determine the number of individual or cases belonging to each category, which were presented in the form of table.

CHAPTER 4

4 Research Analysis and Discussion

4.1 Overview

This research paper tries to analyze the performance effectiveness of DBB vs. DB to see if one project delivery method is superior in regards to time and cost. The usual method of project delivery method in Ethiopia is DBB method. However, recently the DB delivery method is introduced in many road projects. Accordingly the proposed study characterizes the assessment of the effectiveness and implications of DB project delivery versus the traditional DBB project delivery in terms of selected project characteristics and relevant/measurable performance criteria.

The purpose of this study is to analyze the effectiveness of DBB Vs. DB contract delivery method for the federal road projects in Ethiopia. Through the research it has been tried to provide an understanding on the advantages and disadvantages of both project delivery method in the federal road construction projects in Ethiopia. In this chapter the data collected is analyzed and presented in a different form by combining with literature review.

4.2 Ethiopia and Innovative Project Delivery Methods

The Ethiopian roads authority has some previous experience and tried to undertake some of the road projects with the innovative methods of project delivery system in the local construction industry. It is not the scope of this research to analysis the Ethiopian exposure to innovative project delivery system; however it is convincing to high light that the public owner's primary goal in choosing a delivery method should be to ensure that the method will meet the project objectives and at the same time allow the project to be delivered on time and within budget.

When we look back to the history of road project delivery system which ERA had managed in the past, this could be the second time that it is bringing the DB system, the first one being implemented towards the end of the 1990s.(Eshete Mulat, ECoTMPA, April 2012). The choice should also consider the required project quality, safety, and owner's involvement during both design and construction periods. The practice in Ethiopia, however, does not seem that these aspects are considered. Contractor's capacity to discharge the contract responsibility should also be one of the criteria in adopting methods for project delivery.

Majority of the construction projects are delivered using the traditional DBB method, there are also experiences on the innovative delivery methods that has been practiced in Ethiopia. For example, the Ethiopian Roads Authority (ERA) has attempted the DB method for some fourteen (14) rural roads projects. A document review and some other relevant studies indicate that there

were some problems in applying the DB method, especially, in the case of ERA. These are also briefly demonstrated in the accompanying sub-sections of the thesis.

4.3 Factors for Selecting Project Delivery Systems

According to Finnish Road Enterprise (2002) the choice of which approach to use for effective project delivery system for a particular project depends up on the factors such as: size and complexity of the project; available budget for the project; legal and regulatory ability to use various innovative project delivery techniques; sources of funding for the project; capability and creativity of the contracting agency; and urgency of completing the project. However the following points discussed in detail below are the major factors that play the greatest role in the selection of effective project delivery system for a particular project.

4.3.1 Project size

In competitive design-build selection programs, the size of the project must be sufficiently large (and potentially profitable) to warrant the proposer's risk to obtain the contract. In other words, is the risk and effort to propose proportional to the reward? Is the cost to prepare a comprehensive design-build proposal commensurate with the opportunity to profit from the contract to complete the design and construct the facility? While size alone, namely, the cost value of the contract, is only one factor in a potential design-builder's evaluation of the risk to pursue the contract, it is one of the first measures that will be examined in their analysis.

If the project is too small, it probably will not justify the expense to prepare a design-build proposal. The owner's limited submittal requirements can mitigate the cost to prepare the design-builder's proposal (Jeffrey and Michael, 2004). If a project is too large, it may exceed the capabilities of the design-builders (or potential design-builders) in the region. If the location of the DB team is not an issue with the owner, then contract scope, in and of itself, will not likely be a problem. Through joint ventures and subcontracting arrangements, design-builders can devise contracting organizations that can adequately accept the risk of very large contracts.

Typically, the very largest construction projects have always been the purview of the design-builder. These projects include power-generating facilities, paper plants, nuclear power plants, and complex chemical processing plants and refineries. The risk of separating the responsibility for design from that of construction is too great for the owners of these large facilities (Edward C Wundram, 2004).

4.3.2 Project Complexity

Highly complex projects may require specialty design and construction knowledge that may benefit from early construction input. However, if complexity causes confusion in the owner's program, it will cause proposers to have differing understandings of the owner's needs and expectations, and lead to unsatisfactory results.

Project types that often have complex or loosely defined programs, such as research facilities, manufacturing plants with new production technology, and other high-technology constructions, where the facility's needs are constantly evolving. These types of facilities may also require new and untried design solutions that are clearly experimental. Up-front pricing of these types of facilities is not practical. However, DB contracting methods can still be effectively employed in these situations if contract clauses for compensation recognize the need to keep the design decisions (and their corresponding budget and schedule impacts) fluid as long as possible.

4.3.3 Employer's Requirements and Risk Considerations

An owner has several areas of concern when embarking on a construction program or project. It is necessary to choose an overall project delivery and contracting strategy that effectively and efficiently delivers the project. The following are some of the factors that employers requirement and risk considerations will influence the selection of the project delivery method for a project (CMAA Owner's Guide to Project Delivery Methods - August 2012)

4.3.4 Budget

Determining a realistic budget before design to evaluate project feasibility, to secure financing, to evaluate risk, and as a tool to choose from among alternative designs or site locations is a primary need. Once the budget is determined, the owner requires that the project be completed at or near the established budget figure. Owners must decide how quickly they need to establish final project costs and with what risk level of exceeding this cost.

4.3.5 Design

The most important issue to the project stakeholders is that the desired facility functions as envisioned while successfully fulfilling the needs of the owner and users. Therefore, the design team should be well qualified in the type of facility being designed. In addition, the owner must ensure that the program needs are clearly conveyed to the design team. Since the design of the facility must be buildable and design intent must be properly communicated, the owner requires that the design documents are constructible, complete, clear and coordinated. The documents should properly incorporate unique features of the site to include subsurface conditions, interfaces with adjoining properties, access, and other characteristics. Owners must decide how much control they need to have over the design elements of a project.

4.3.6 Schedule

The owner has similar needs in the area of scheduling. The dates of design commencement, construction completion and ultimately the operation of a new facility can be critical, either in terms of generating revenue from the facility, or in terms of providing needed functional space by a particular deadline. Therefore, a realistic assessment of project duration and sequencing

needs to be performed early in the planning process. The schedule must then be monitored and updated throughout the design, construction and pre-occupancy phases to achieve the desired goal. An owner must decide how critical it is to minimize schedule duration for a project.

4.3.7 Risk Assessment

In construction, issues of risk are closely tied to the status of the local construction market, on-site safety, the schedule and the budget. The owner requires an understanding of the risks involved in construction, and should make a conscientious decision regarding allocation of these risks among project participants, so that all areas of exposure are properly understood.

In considering risk allocation, the owner should strive to assign risks to those parties that can best exercise control over those aspects. For example, it would typically be problematic to require that the contractor correct problems due to design errors or changes at no extra cost since a contractor generally has little control over the cause or magnitude of such errors or changes. An owner must decide how much project risk they are comfortable in assuming.

4.3.8 Owner's Level of Expertise

The owner's familiarity with the construction process and level of in-house management capability has a large influence over the amount of outside assistance required during the process, and may guide the owner in determining the appropriate project delivery method. An owner must make an assessment of its ability to properly perform under the various delivery methods.

The implementing agency, in the case of Ethiopia, ERA, needs to be educated and informed about conveying ideas to the contractor in preparing the design specifications to ensure success when adopting the DB approach (Ibbs et al. 2003). The lack of past experience in the DB project delivery system can also cause uncertainty for the client trying to adopt DB delivery system. To implement DB delivery system successfully, the client therefore need to possess special management and procurement capabilities. The DB project delivery system is a new approach in Ethiopian federal road construction projects. Experience, skill and knowledge are thus required before the design and build delivery system can be implemented successfully in Ethiopia.

4.4 Under What Circumstance DB or DBB is Better Approach

DB project delivery system is better option, and works best under the following condition:

1) The employer's requirements and expectations are clearly stated, and the proposers are likely to have consistently similar understandings of those needs.
2) The single point of responsibility for design and construction is maintained.

3) The contract terms make reasonable assignments of risks between owner and design-builder.
4) The implementing agency's organization is able to make decisions in a timely manner.
5) The project's financing is secure, and that fact is clearly communicated to the proposers.
6) The implementing agency's qualification-based selection procedures leading to a reasonable number of proposers in the final proposal stage.
7) A working environment of trust and mutual respect can be established among the implementing agency's organization and the design-build team.
8) Where early completion and utilization of the facility are of significant value (Gransberg and Molnaar, 2007).
9) When the implementing agency's objectives are well-defined, and has well-understood construction aims.
10) When the construction is large and technologically complex, and offers the most opportunities for innovation. This maximizes the scope for a designer/contractor team to benefit from matching design and method for the best possible results.

Conversely, DBB project delivery system will likely be more effective if the following conditions exist:

1) The owner insists on absolute design control over all aspects of a facility, and is not satisfied by general design definitions and performance guarantees from the design-builder.
2) The owner requests complete DB proposals and the project is speculative and may not be built.
3) The criteria for selection are not clear or their relative values to the owner are not stated.
4) The project's program is unclear or ambiguous.
5) The selection panel is not well informed about the project's requirements, or it is not truly capable of acting independent of outside influence.
6) The owner's program limits innovation and flexibility in facility design, system selection, or materials.

4.5 The Basis for the Evaluation of PDS

4.5.1 Project Characteristics

Projects were first identified by name, location, company name, company type. This information helps to evaluate both the DBB and DB projects of the Ethiopian federal road projects on the same localities or in the same region. The similarity of the location helps to evaluate both

delivery methods on a similar basis and to analyze based on realistic approach. Additionally, project location allowed for geographic identification of survey responses as well as geographic project cost references for labor, materials.

4.5.2 Project Delivery System

During the questionnaire and case study the respondents were asked to select the appropriate delivery system which best suited the project delivery mechanism used on their project. The systems are either DB, or DBB.

4.5.3 Project Schedule Performance

From the archival study the researcher tried to provide project schedule dates. These were the project commencement date and the project completion date which includes the original completion date as well as the revised completion (substantial project completion). Dates were provided for the as-planned or budgeted schedule and the as-built or actual schedule.

Durations between events were calculated in calendar days. All dates were based on the project schedules maintained by the project respondents.

4.5.4 Project Cost Performance

Project costs were defined as the amount of money invested by the owner to accomplish the respective design and construction of the project. The cost performance of the sampled ERA projects were analyzed.

4.5.5 Project Team Characteristics

The project team component helps to describe and evaluate project team characteristics quantify the individual and collective experience and the composition of the team and its action. Project team selection identified the method used to procure the DB contracts.

Beyond individual team member experience, the collective prior experience of the project team as a unit presents many benefits to the owner in the satisfactory completion of a project. Companies consistently bidding and constructing federal road projects become familiar with the owner and their procedures as well as repeat subcontracts that can improve project team communication and team composition. Qualification of project teams based on their profession and qualification evaluates a company's capabilities and its project proposal (Potter et al., 1995). The percent design complete when the construction entity joined the project team provides significant impact to the successful execution of a project based on early input of construction expertise in the design process (Sanvido, et al., 1992).

However, inexperienced constructors and subcontractors unfamiliar with the project delivery system or facility type may be the only project bidders or proposal respondents providing input. This situation might directly and negatively impact project performance. Therefore, the individual experience of project team members with similar facilities and with the project delivery system used on the project can impact project performance.

4.6 Experience of ERA on DB Projects

Some twenty years back about 14 projects were given to the contractors which can be used as a basis for the current DB project implementation. All of the fourteen DB projects that ERA had awarded to the contractors were rural road projects intended to connect different rural towns in different parts of the country. A document review was conducted and discussions were held with concerned experts in the authority to identify the associated difficulties in bringing the intended success of the projects. Thus, the fourteen projects that Ethiopian Roads Authority (ERA) has attempted the DB method with the project costs and other relevant information are presented in the following table.

Table 4.1 ERA's Previous DB projects

No.	Project's Name	Contract Amount (ETB)	Project execution at the end of the contract period (%)	Remark
1	Fik – Imi	69,341,713.00	84.8	Completed
2	Fissehagenet- Konso	79,488,545.00	83.42	Maintenance remains
3	Serdo – Afrar Haik	64,592,648.30	81.55	Completed
4	Delbo- Bilate	10,606,800.00	80.22	Completed
5	Dawunt – Lalibela	70,926,413.00	78.97	Completed
6	Sawula- Usno	32,931,274.00	76.5	Terminated
7	Assaitta - Dicootto	15,409,374.00	68	Partially terminated
8	Diri- Masah	68,263,545.00	63.45	Substantially completed
9	Walmara - Guba	30,300,205.20	53.56	Contract terminated
10	Akista – Tenta	31,847,451.44	50.32	Completed
11	Lalibela – Sekota	97,922,236.00	36.14	Completed
12	Alemketema - Akesta	48,951,661.00	33.87	Contract terminated
13	Gog – Akobo	45,547,030.00	32.5	Contract terminated
14	Gode – Hararghe	78,366,000.00	27.47	Completed

Source: Ethiopian Roads Authority

Those project in the above table described as completed were not completed within the project original contract period, but they are the projects whose contract agreement was in circled by financial difficulties and the contract periods were significantly extended. It can be seen, from

Table 4.1, that the minimum work the respective contractor accomplished up to the end of the contract period was 27.47% and the maximum was 84.80% of the contract amount. Furthermore, from the table, it can be seen that no project has been completed within the agreed contract period.

Accomplishment of 84.80% of the works up to the end of the contract period may be taken as a signal for success in the local construction industry, which is rarely employing the DB method with the local contractors. It is also interesting to note that seven of the projects have been completed though with certain time overrun and financial difficulties as reported. This might be an indication that if some obstacles had not been there the projects would have been accomplished on time and on budget. If the innovative project delivery method is properly managed it can really improve the situation which both the contractors and the owner were in. It is also possible to make a difference in the local construction industry (Eshete Mulat, ECoMPA, April 2012). Even though the DB project delivery method was practiced some twenty years back and suspended for a short trial, currently ERA is contracted and given out road projects on DB project delivery system to contractors for about 12 federal road construction projects as shown in Table 4.2.

4.7 The Challenges on the First ERA's DB Implementation

Some of the major challenges and drawbacks in the previously implemented DB project in the 1990s were.(Lemma Mossisa, 2006)

1) Lack of the required experience and expertise with the local contractors;
2) Client itself was not having the required experience for the DB delivery method;
3) Lack of well-established pre-contract planning;
4) Local contractors lacked proficient design staff (this is the case with most of the local contractors still)
5) Sometimes the local contractors tendency to 'underbid' the works;
6) Over-extension of contractors;
7) No clear guidelines for procurement of goods and services;
8) Financial incapability of local contractors, and;
9) Inadequate equipment;

Most of the above described challenges are due to problem on the project management. Hence for the future, this project management problem and the tendency of under bidding without properly analyzing their risks, the local contractors should be avoided and they (the local contractors) should observe, in advance, the real work which they will be executing. And, also, local contractors should build the capacity to exercise their rights to the contracts. They should

claim when it should be claimed. It needs to be noted that international contractors are benefiting from such strategies.

No	Project Name	Contractor's Name	Contract Amount		Date of Contract		Contractor Mobilizati. in months	Contract Completion Date		EOT Recommended by the	March2013 Actual progress
			Original	Revised	Contract Signing Date	Contract Commence. Date		Original	Revised after approved EOT		
1	Hargele 60+000	Enyi construction	428,714.511	428,714.511	03-Aug-10	2,Sep-10	3	02-Sep-13	Not revised	None	100.00
2	km 60+000-Dolobay-Dolo Odo	Macro General Contractor & trading PLC	405,726,000	405,726.000	03-Aug-10	6Sept 10	3	5,Sept 10	Not Revised	None	62.67
3	Dejen-Felegebirhan	SATCON PLc	528,000.000	528,000.000	27,June-11	3,Aug-11	3	2,Feb-15	Not revised	None	11.57
4	Sawla-Maji contract II Laska-Salayish	SATCON Plc.	689,885.000	689,885.000	27,June-11	5,Aug-11	3	4,Aug-14	Not revised	None	25.36
5	Abala –Shaigube	SUR Construction PLC	707,955.759	707,955.759	05-Apr-10	29,July-10	3	14,Jan-13	14,Marc-13	None	82.93
6	Yalo-cercher-mehoni	Terra Construction	179,075.000	179,075.000	17-Apr-08	2,July-08	3	29,dec-10	May,01-13	2months	83.81
7	A/A -Adama Toll Motorway	China Communications	8,012.199,960	8,054.680,019	27/6/2009	21,Apri-10	3	20-Apr-14	Not revised		63.87
8	Alamata mehoni-Hewane	China Communications	645,000.000	650,695.343	31Dec,2007	29,Jan-08	3	26,July-11	Jan10,13	None	99.18
9	Injibara-Chagni-pawe junction	China Communications	2,283,390.549	2,283,390.549	22-Nov-12		4				
10	Agula-shaigube-Berahile Design & build Road Project, contract 2	Defense Construction Enterprise	969,916.753	969,916.753	03-Aug-10	30,sep-10	4	29,sep-13	Not revised	None	57.34
11	Berhale-Dalol Design & Build Road prject	Defense Construction Enterprise	1,245,261.242	1,245,261.242	3Aug,2010	29,sep-10	4	28,Sp-13	Not revised	None	54.71
12	Debark-Baahit Road Upgrading project	AKIR Construction	699,465.650	699,465.650	29,mar-2011	04-Jul-11	4	3,July-14	Not revised	None	23.24
13	Buahit -Dilyibaza Road upgrading project	SATCON PLc	947,920.000	947,920.000	29,mar-2011	25,April-11	4	25,Apr-14	Not revised	None	27.03
14	Access to kesem		3,418,512.502	3,418,512.502	22-Nov-12		4				
15	Chole-Magna	CGC oversees	869,512.870	869,512.870	01-Nov-12		4				
16	Powe junction-ayma	CGC oversees	1,337,718.925	1,337,718.925	22-Nov-12		4				

Ongoing DB Projects Under the Federal Road Project

Table 4.2 Lists of DB Contracts (Source:-Ethiopian Roads Authority DB Directorate)

Only projects currently on progress whose status is 60% and above and projects that are substantially completed at the beginning of year 2013 were considered for the fact finding surveys to ensure that complete project performance histories could be obtained and to establish a consistent basis for assessing the performance of DB contracting on Federal road construction projects.

Additional information from prior or concurrent studies regarding the relative cost, and schedule impacts of DB versus DBB project delivery was considered and included as comparative findings when applicable in terms of project types and delivery approaches considered.

4.8 Case studies on Bothe Project Delivery Systems

The usual trend in the In Ethiopian road construction practice, the key parties involved in road projects implementations are the Government of Ethiopia represented by the Ethiopian Roads Authority, Contractors and Consultants. The Ethiopian Roads Authority (ERA) is charged with the duties and responsibilities of providing adequate road infrastructure to support the socio-economic development of the country. The task involves improving the condition of existing roads and expanding the network.

Most of the local Contractors are of limited capacity and rarely do meet the requirements to participate in donor financed projects. Hence, international Contractors, who meet the requirements, have been participating in donor financed projects. The contracting company after winning the contract will take the responsibility to complete construction of the project in accordance with the contract document. Consultants, like Contractors, will take the responsibility for the design and/or supervision services they render in accordance with the contract document. International Consultants' have also been participating in donor financed projects.

The project delivery method widely practiced by ERA is the traditional DBB approach. This approach has three separate phases. First, the feasibility and/or design of a project is undertaken by a Consultant, then a bid is floated to procure a Contractor, and finally the selected Contractor completes the construction.

For the effectiveness evaluation in Ethiopian Federal Road Project purposes the researcher considers 5 of ongoing DB projects and 5 DBB highway projects. A total of 10 projects were selected. All the 10 (5 DBB and 5 DB) projects are currently ongoing highway projects being built in Federal Democratic Republic of Ethiopia and all of them are 60% and above completed.

Those five case studies for DBB projects and five case studies for DB projects were carefully selected for the evaluation of the effectiveness of both project delivery system in the federal road projects of Ethiopia and investigated. These cases discussed in depth information regarding the

causes of time and cost overruns at construction of road projects in the Ethiopian Federal Road construction, also to check the procedures and actions taken by contractors, owners and consultants.

4.8.1 Case Study of DBB Road Projects

For this research, 5 Federal Road projects were selected for DBB case study. These projects are selected on the basis of their performances on cost and schedule. As it has been illustrated in the problem statement all of these projects experienced cost and time overrun.

The projects were delivered with DBB project delivery method in the Federal road projects of Ethiopia. All of the five selected projects are 60% and above completed.

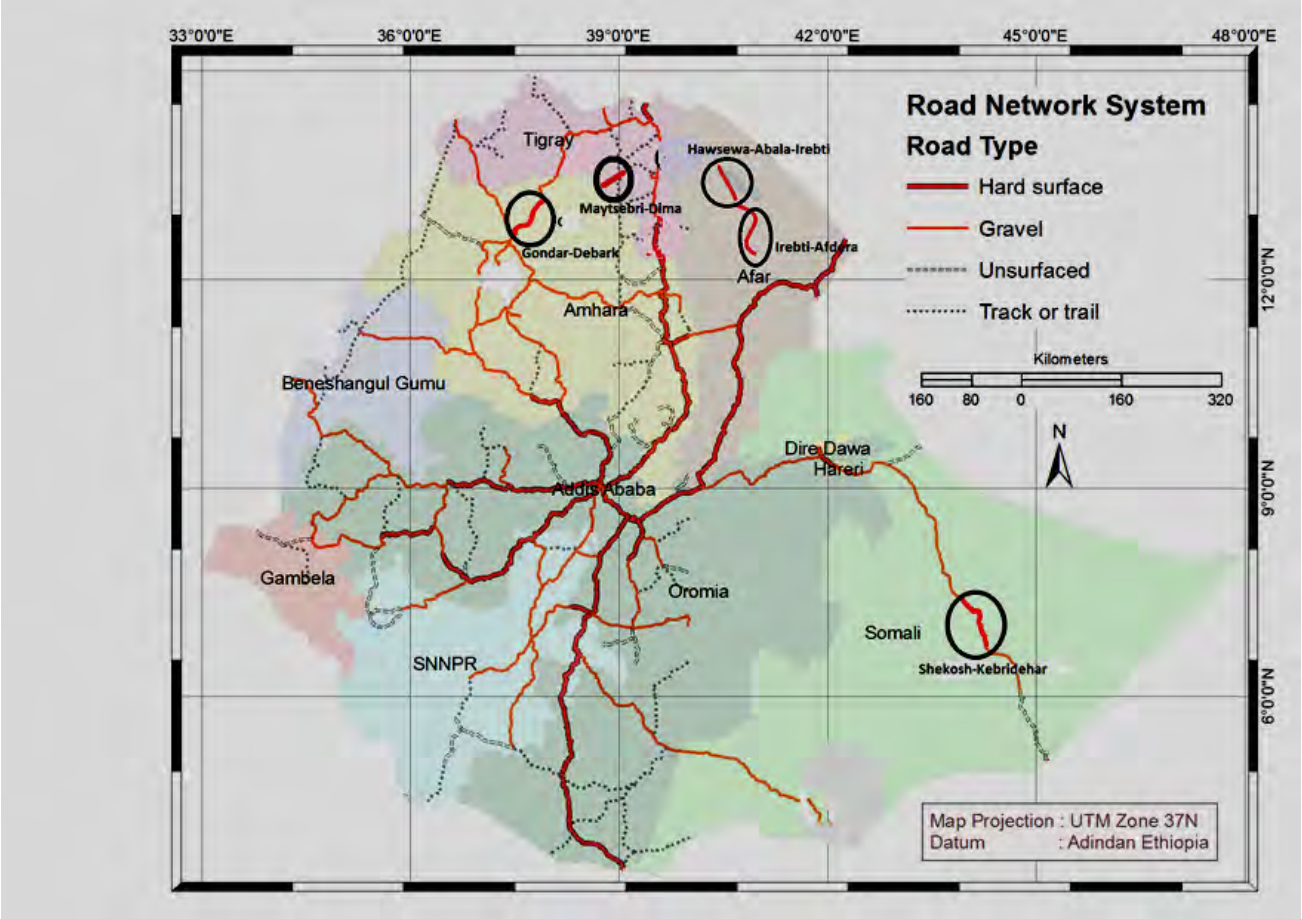


Figure 4.1:- Map Showing distributions of DBB sample Sites
Map *Source:-Central Statistical Agency, 2007*

The features of theses road projects; i.e. brief descriptions of the location, length, the contractors, nature of works, contract type, commencement and completion time, original and final contract price, and reasons of variation orders are described as follows. For more information on the DBB projects please see Appendix A-Sampled DBB Projects.

The list of the sampled DBB projects is described as follows, and their distribution on the map of Ethiopia is shown on fig.4.1 above.

1. Gonder-Debark Road Project
2. Hawusewa-Abala-Irbeti Road Project
3. May Tsebry-Dima
4. Irebti –Afdera
5. Shekosh – Kebridehar

4.8.1.1 Cost and Time overrun of Selected DBB Projects

Some sample projects of DBB projects are presented, as given in Table 4.3 to assess the status of the currently under construction road projects implemented in the federal road construction projects. The table has been used to show the associated time and cost overruns, as per the sampled projects.

Table 4.3 Original and Revised Contract Price and Contract Period of Sampled DBB Contracts

No	Project Name	Length (km)	Original Contract Price (ETB Million)	Revised Contract Price (ETB Million)	Original Contract Period (days)	Revised Contract Period (days)
1	Gondar-Debark	99.2	690.8	774.1	1095	1520
2	Hwusewa-Abala-Irbeti	94.14	746.3	865	1260	1967
3	May Tsebry- Dima	75.6	258.7	519.6	1095	1520
4	Irbeti-Afdera	117.43	727.9	815.6	1277	1924
5	Shekosh-Kebridehar	105.77	291.1	357.8	1095	2102

Source:-Ethiopian Roads Authority, April 2013 consultants report

Original Contract Price:- the cost initially estimated at the time of bid award (Contract Amount).

Revised Contract Price:- is the revised amount of money at the time of this research.

Original Contract Period: estimated project duration at the time of bid award (Contract Duration).

Revised Contract Period:- Contract period including EOT granted.

ETB:- Ethiopian Birr currency.

The total percentage of contract amount increment of the above D-B-B projects have been collected and arranged in the table below to show the significance of the contract amount cost overrun whose mean value is 32.6%. The Contract price cost increment and its respective percentages are presented in Table 4.4.

Table 4.4 Increment in Contract Price of Sampled DBB Contracts

No.	Project Name	Original Contract Price	Revised Contract Price	Increase in Contract Price	Percentage Increment in Contract Price
		(ETB Million)	(ETB Million)	(ETB Million)	(%)
1	Gondar-Debark	690.8	774.1	83.3	12.1
2	Hawusewa-Abala-Irbeti	746.3	865	118.7	16.0
3	May- Tsebri – Dima	258.7	519.6	260.9	100.1
4	Irbeti-Afdera	727.9	815.6	87.7	12.1
5	Shekosh-Kebridehar	291.1	357.8	66.6	22.9
Mean					**32.6**

From the desktop study and the archival data the contract price overrun that has been experienced in the DBB projects can be presented for better visualization in figure 4.2 below to show the comparison easily. As it is indicated on the figure, though the mean value of the percentage increment in contract price is only 32.6%, the individual percentage of the revised contract price increment is very significant.

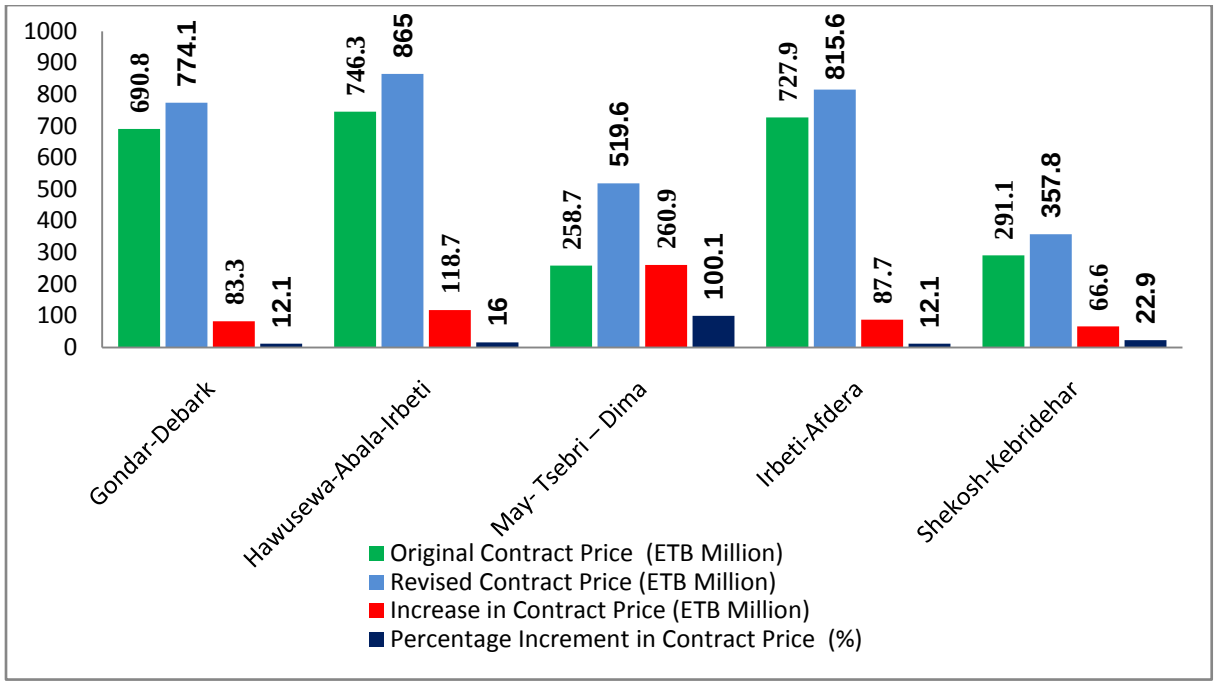


Figure 4.2:- Percentage increment as well as original and revised contract price of sampled DBB projects

The increasing days of the total contract period and its percentage of increment of the D-B-B projects is shown in table 4.5 below to show the significance of the contract period overrun. The Contract period or schedule overrun and its respective percentages are presented in Table 4.5.

Table 4.5 Increment in Contract Period of Sampled DBB Contracts

No	Project Name	Original Contract Period	Revised Contract Period	Increased Contract Period	Percentage Increment in Contract Period
		(days)	(days)	(days)	(%)
1	Gondar-Debark	1095	1520	425	38.8
2	Hawusewa-Abala-Irbeti	1260	1967	707	56.1
3	May Tsebri – Dima	1095	1520	425	38.8
4	Irbeti-Afdera	1277	1924	647	50.7
5	Shekosh-Kebridehar	1095	2102	1007	92
Mean					**55.3**

The above Tables signifies that the budget and time overruns range from 12.1 % to 100.1 % of the initial costs with mean value of 32.6% and from 38.8 % to 92 % with mean value of 55.3 % of the initially estimated time respectively.

It can be seen that the mean budget overrun itself is high though not as high as the mean time overrun.

From tables Table 4.4 and Table 4.5 it can be seen that, on average, there is about 32.6 % cost increment beyond the initially estimated budget and about 55.3 % time overrun. From the above tables one can conclude that the construction work on the federal road projects have not been running as per the durations and the budgets estimated before the commencement of the actual construction in ERA.

Table 4.6 Planned and accomplishment of the sampled DBB projects

Item	Name of the Project	Planned Progress Based on Revised Schedule	Accomplishment
		(%)	(%)
1	Gondar-Debark	100.00	97.84
2	Hawusewa-Abala-Irbeti	100.00	69.20
3	May Tsebri – Dima	93.25	90.45
4	Irbeti-Afdera	100.00	91.11
5	Shekosh-Kebridehar	92.79	73.01

Source:-Ethiopian Roads Authority, April 2013 consultants report

Among the sampled projects the minimum status of completion is Shekosh-Kebridehar project which is 73.01% and the maximum is Gonder- Debark project which is 97.84%. The planned and accomplished or the current status of the selected DBB projects is given in Table 4.6

Table 4.7 Time overrun of Sampled DBB Contracts in relation to Accomplishment

No.	Project Name	Revised Contract Period	Cumulative Planned	Cumulative Accomplishment	Time Overrun	
		(Days)	(%)	(%)	(Days)	(%)
1	Gondar-Debark	1520	100.00	97.84	60	3.9
2	Hwusewa-Abala-Irbeti	1967	100.00	69.20	1125	57.2
3	May Tsebri-Dima	1520	93.25	90.45	40	2.6
4	Irbeti-Afdera	1924	100.00	91.11	300	15.6
5	Shekosh-Kebridehar	2102	92.79	73.01	1293	61.5
Mean						**28.2**

The time overrun shown on Table 4.7 is calculated based on the earned value method derived from the s-curve of the projects on their actual schedule. Because earned value analysis is a real time performance metric tool, schedule or cost sleepage which will be presented graphically for all to see clearly and gives more reliable value than other methods.

As it is indicated in the following figure 4.3 the maximum time overrun, which is 61.5% is registerd on Shekosh-Kebridehar project and the minimum one is 2.6% at May Tsebri-Dima road project.

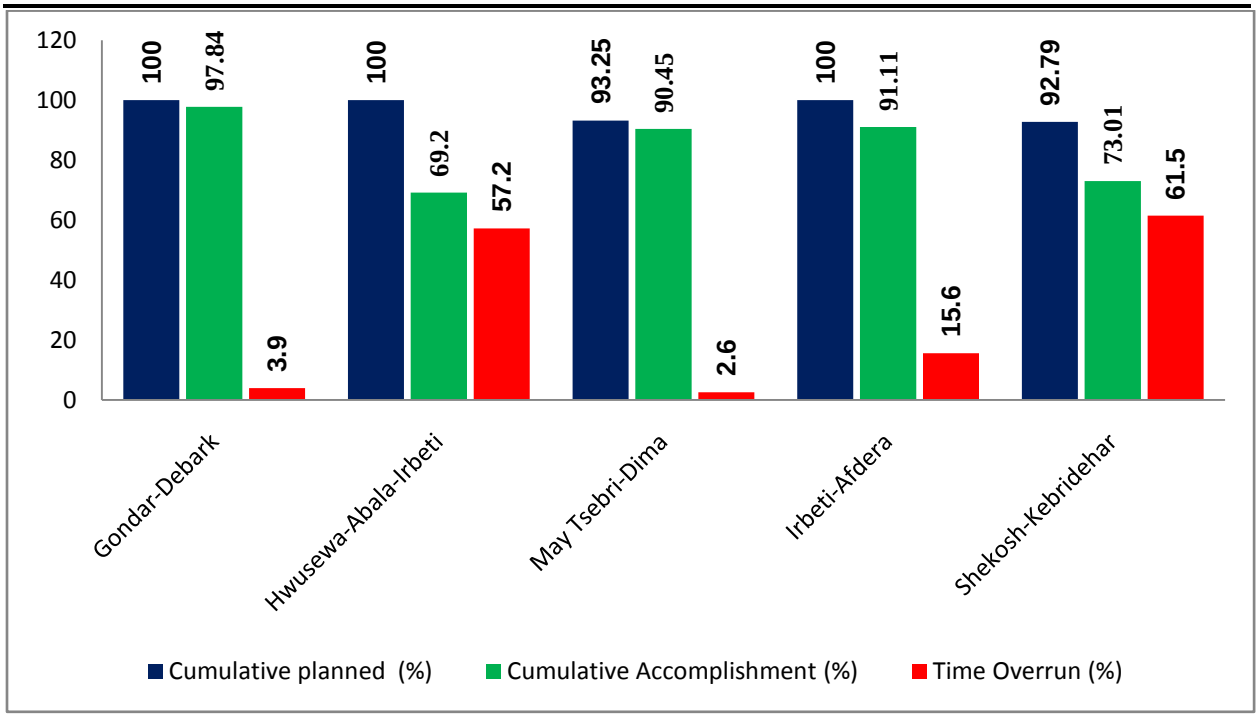


Figure 4.3:- Percentage of time over run of sampled DBB projects

Consideration given to the time and cost analysis of the above five projects based on the actual time elapsed against accomplishment indicates that the, overall time extension ranges from 2.6 % to 61.5 % with an average value of 28.2 %.

4.8.2 Case study of DB Road Projects

In a similar manner the following five projects whose completion is 60% and above are selected for the DB project delivery method in the Federal road projects of Ethiopia, the following road projects are sampled. For more information on the DB projects please see Appendix B-Sampled DB Projects).

The list of the DB projects is described as follows, and their distribution on the map of Ethiopia is shown on fig.4.4 below.

1. Hargele – km 60+000
2. km 60+000-Dolobay-Dolo Odo
3. Abala –Shaigube
4. Agula-shaigube-Berahile Road Project
5. Alamata-Mehoni-Hewani

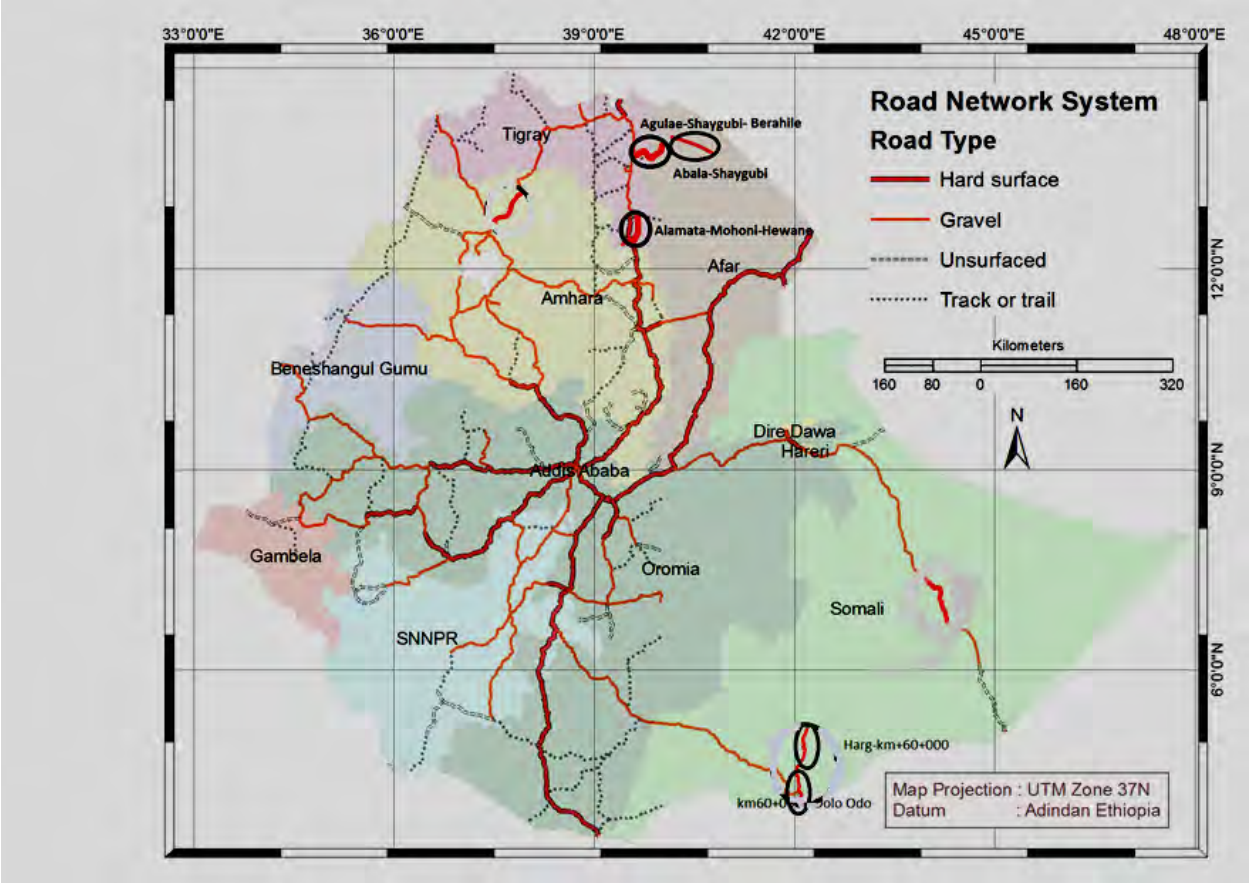


Figure 4.4:- Map Showing distributions of DB sample Sites

Map *Source:-Central Statistical Agency, 2007*

4.8.2.1 Cost and Time overrun of Selected DB Projects

The sampled DB projects shown in Table 4.8 are selected from the DB projects that are currently under construction. The projects are selected from DB federal road construction projects. The table has been used to show the associated time and cost overruns, as per the sampled projects.

Table 4.8 Original and Revised Contract Price and Period of Sampled DB Contracts

No	Project Name	Length	Original Contract Price	Revised Contract Price	Original Contract Period	Revised Contract Period
		(km)	(ETB Million)	(ETB Million)	(Days)	(Days)
1	Hargele-km 60+000	58.7	428.7	428.7	1095	1095
2	Km60+000-Dolobay-Doloodo	83	405.7	405.7	1095	1095
3	Abala-Shaygubi	56.7	707.9	707.9	928	987
4	Agulae-Shaygubi-Berahele	76	969.9	969.9	1095	1095
5	Alamata-Mohoni-Hewane	116	645	654.2	1271	2170

Source:-Ethiopian Roads Authority DBB Directorate

Sampled data from the selected DB projects have been collected and arranged in the tables below to show the significance of these problems. The percentage of time and cost overruns are presented in Table 4.9 and Table 4.10.

Table 4.9 Increment in Contract amount of Sampled DB Projects

No.	Project Name	Length	Original Contract Price	Revised Contract Price	Increase in Contract Price	Percentage Increment in Contract Price
		(km)	(ETB Million)	(ETB Million)	(ETB Million)	(%)
1	Hargele-km 60+000	58.7	428.7	428.7	0	0
2	Km60+000-Dolobay-Doloodo	83	405.7	405.7	0	0
3	Abala-Shaygubi	56.7	707.9	707.9	0	0
4	Agulae-Shaygubi-Berahele	76	969.9	969.9	0	0
5	Alamata-Mohoni-Hewane	116	645	654.2	9.2	1.42
Mean						**0.28**

As per the survey data gathered for those 5 DB projects the results of the research indicated that projects delivered using the DB project delivery system approach performed less increment in the contract price than those delivered through the DBB delivery systems. As it is indicated in the figure 4.5 below the percentage of the increment in the contract price is from 0% up to a maximum of 1.42% which is very small when it is compared against the previously described DBB project delivery system.

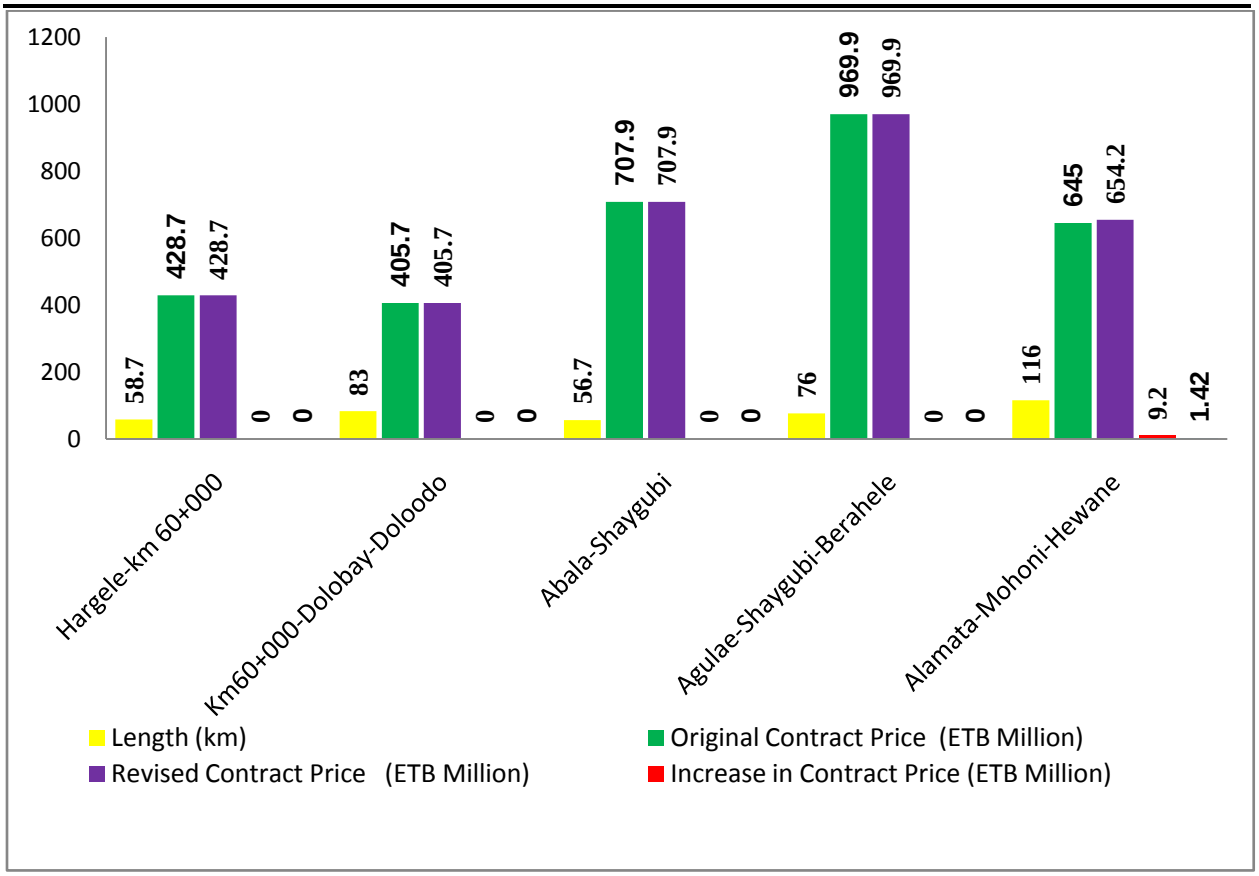


Figure 4.5:- Percentage increment as well as original and revised contract price of sampled DB projects

The survey highlights that significant number of the sampled DB projects were associated with shorter overall project time than conventional system. It is also reckoned that the reduction of the overall project period is attributed to the system's ability to overlap the design and construction phases.

It is observed also that cost and completion time is firmer under the Design and Build procurement method. This means the client knows his total financial commitment in the early stage of the project, the contractor does not introduce any changes throughout the project. Because there is no provision for bill of quantities, adequate arrangements for evaluating any changes on the price or on cost basis can be carried out earlier by including in the contract.

As it is seen in table 4.9 and table 4.10 , in most of DB procurement form, the final cost does not exceed the project budget, because as it is the fixed fee the calculate risks and the cost variations are absorbed by the contractor. In this respect, Design and Build certainly presents a better chance of the client obtaining his completed building within budget, because as it is fixed fee the cost variation is absorbed by the contractor.

Table 4.10 Increment in Contract Period of Sampled DB Projects

No	Project Name	Length	Original Contract Period	Revised Contract Period	Increased Contract Period	Increment in Contract Period
		(km)	(Days)	(Days)	(Days)	(%)
1	Hargele-km 60+000	58.7	1095	1095	0	0
2	Km60+000-Dolobay-Doloodo	83	1095	1095	0	0
3	Abala-Shaygubi	56.7	928	987	59	6.4
4	Agulae-Shaygubi-Berahele	76	1095	1095	0	0
5	Alamata-Mohoni-Hewane	116	1271	2170	899	70.7
Mean						**15.4**

The above Tables signifies that the budget and time overruns range from 0.0 % to 1.42 % of the initial costs with mean value of 0.28 % and from 0.0 % to 70.7 % of the initially estimated time with mean value of 15.4 % respectively.

Table 4.11 Time overrun of Sampled DB Contracts in relation to Accomplishment and Time Elapsed

No.	Project Name	Revised Contract Period	Time Elapsed	Accomplishment	Time Overrun
		(Days)	(%)	(%)	(%)
1	Hargele-km 60+000	1095	83	100	-17
2	Km60+000-Dolobay-Doloodo	1095	83	62.7	20.3
3	Abala-Shaygubi	987	100	82.9	17.1
4	Agulae-Shaygubi-Berahele	1095	83.3	60.2	23.1
5	Alamata-Mohoni-Hewane	2170	100	99.2	0.8
Mean					**8.9**

Cost savings may also result in time saving. The overall effects is reduction in the employer's financing charges, lesser effect of inflation and faster construction operation, which, in a commercial context, produces an earlier return on the capital, invested. From the above two tables it can be seen that, on average, there is about 0.28 % cost increment beyond the initially estimated cost and about 8.9 % time overrun.

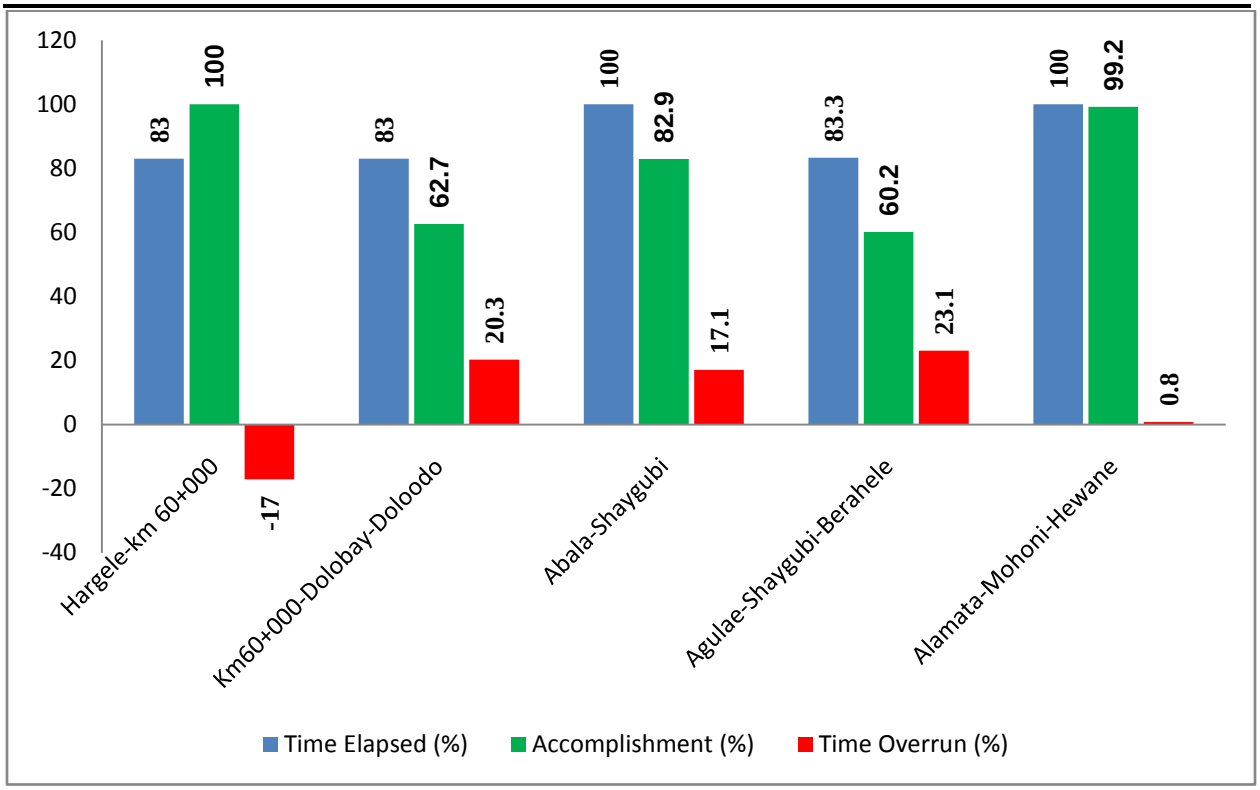


Figure 4.6:- Percentage of time overrun of sampled DB projects

Consideration given to the time and cost analysis of the five DB projects based on the actual time elapsed against accomplishment as shown in figure 4.6 indicates that the overall time overrun ranges from minimum -17 % (Hargele-km 60+000 is completed eight months before the final contractual period is elapsed) to maximum of 23.1 % with an average value of 8.9 %.

4.9 Summary of Findings

Sanvido and Konchar conducted an empirical research study whose goal was to compare the different delivery systems that are widely used in the United States. Accordingly, DBB and DB were the two main delivery approaches compared in the research. The data collection phase was achieved using a survey that gathered data for 351 projects. The scores reported through the results of the research indicated that projects delivered using the design-build approach performed better than those delivered through the design-bid-build delivery systems. Specifically, the analysis revealed that the DB projects experienced less cost and schedule growth.

Warne (2005), and Gransberg & Molnaar (2007) concluded that DB is more aligned to reduced time of construction, improved cost control, better quality and overall client satisfaction. Therefore, the suitability of DB for constructability review which minimizes design risks is more apparent than DBB widely used for Federal road projects.

Accordingly this research paper points out that the individual project outcomes are highly influenced by many difficulties to make project-to-project comparison, among these the most significant ones are project type, project size, location, contractor and project team are the most. Essentially each project is unique, accordingly with sufficient number of projects the effect of one factor can be determined, however in this research, as it has been described in the scope of the study, it was difficult to find sufficient data of large population especially for DB project delivery system.

In spite of the fact that the data on the DB projects is limited; the result of this study clearly indicates that the choice of project delivery method affects project performance. Significant difference in the project performance was found between innovative project delivery system and traditional DBB contracting methods. For example, the average time growth for DB was approximately 8.9/28.2*100=31.6 % of the time growth of the traditional DBB project delivery method. Individual project factor, however, can have a dominant effect on project outcome.

One of the major topics of interest in this research was the analysis for the effectiveness of DBB vs. DB project delivery systems. From the questionnaire distributed the owners prefer 100% DB project delivery system while 90% of the contractors are also prefers DB project delivery system. Those considering the use of DB as a project delivery methodology would benefit from understanding the thought process and motivations of other owners for using this tool.

From the distributed questionnaire and case studies the question of what motivated the owner to use DB was tried to analyze. The most common reason owner's selected DB as a project delivery method was schedule. Schedule is clearly a major motivator for owners. This study examined the schedule benefits derived from using DB on these projects. Archival data gathered indicated that time overrun for DBB projects is 28.2 % while the corresponding time overrun for DB projects is only 8.9%.

One project is 100% completed of all its execution eight months ahead of what would have been anticipated in the contract period. That means 100% the project work is completed within 77.8% of the contract period. As per the researcher discussion with the consulting staff of the time effectiveness of this project, the main reasons for the successful completion of the project is that the contractor has identified and reasonably calculated his risk, the contractor is also mobilizes the needed finance and other resources fully and abundantly on the project and the contractor also changed his normal working hour to work day and night on shift basis.

Owners are clearly seeing schedule as a significant incentive for using DB delivery system. As schedule were the most important criteria for choosing to use DB. Controlling cost growth is also of paramount importance to owners as they endeavor to manage scarce public resources for capital projects. From our case studies projects using DBB reflect a 32.6 % growth in contract amount. In the same manner the DB projects result in a 0.28% contract amount increment.

This improved cost certainty that comes from DB is a very desirable attribute and much sought after by elected officials and the public sector alike. Owners indicated particular satisfaction with the DB process. The benefits of using DB are clear and compelling. Reduced delivery schedules, better cost management, improved quality and high owner satisfaction are all outcomes that have been experienced based on the analysis.

The use of this delivery tool is growing and will become even more pronounced as more and more owners seek to build projects that will required one or more of these outcomes. All owners should give serious consideration to design build as a project delivery method for their infrastructure work.

4.10 Questionnaire Survey Result

All of the professionals reflect similar view that the Ethiopian construction industry is better to leap in to the innovative project delivery methods, and latest construction technologies. They unanimously argue that something has to be done to improve the situation. Many of the respondents specially who are actively participating in DB contract state that the traditional project delivery method (DBB) undermines the possibility of contracting firms providing broader and better services.

As per this study, for majority of the informants (76.2%) consider selecting DB project delivery methods is better to maintain or to reduce the project duration and the need for cost certainty (74.4%) as well. Respondents were also asked to express their opinion concerning the need for reduction of administrative burden to the owner when choosing among the delivery methods. Accordingly, it was reported by 87.5% of the respondents that they consider DB for reduction of administrative burden to the owner in selecting from the methods available.

In the previous studies the Ethiopian Construction industry gives tremendous consideration to the project costs (Abebe Dinku, 2003). However, from the cost and time overrun illustrated in (tables 4.3,4.4 and 4.5) it can be seen that it is the time overrun that is extremely high as compared to the cost overrun. And, hence, from this study, it can be inferred that this project time reduction preference reflects the interest of the parties which has not been met almost always in the federal road construction projects.

Almost the majority of the respondents (87%) from the contractors responded that they have one or more projects to use the innovative methods to deliver the projects. The respondents also mentioned main problems like absence of timely project completion and cost overruns as the main problems. When the contractors as well as the consultants asked if they intend to shift from the traditional method of project delivery to the innovative ones, almost all of the respondents preferred to shift to innovative PDS, in spite of the fact that, with the local situation in regard to DB there is lack of experience, lack of technically, financially, and managerially capable local contractor.

With regard to the need of training on the innovative project delivery system all of the respondents agree that the implementing agency or ERA should provide efforts prior to executing DB projects, such as training, seminars, workshop with regard to DB project delivery system. Some of the respondents comment that the education through training, seminar and workshop can be done by inviting expert from other countries who have applied DB project delivery system. Moreover, senior staffs of client who have past experience in executing DB projects should be able to educate others, share knowledge and keep communication to their junior about the DB project delivery system. From the respondents it is known that all of the DB contractors do not have in-house design crew. They are executing the DB project by subletting to other consultants. On the other hand this system by itself causes a problem on the consultant to manage the work impartially, as long as they are hired by the contractors, the consultants are influenced and expected to satisfy the DB contractor by economizing the expense that may have negative effect on the project at the end.

4.10.1 Respondent's View Regarding the Project Schedule

In this regard, the questionnaire of this study attempted to ask the delivery method that effectively meets project schedules. Accordingly, 76.2% of the respondents responded that the DB method is effective, because the contractor assumes all project responsibilities, from design stage up to the concession period, it intentionally reduces the time schedules required to process the activities. The second score (23.8%) was given to the DBB method that, according to them, this method meets the estimated project duration figure 4.7.

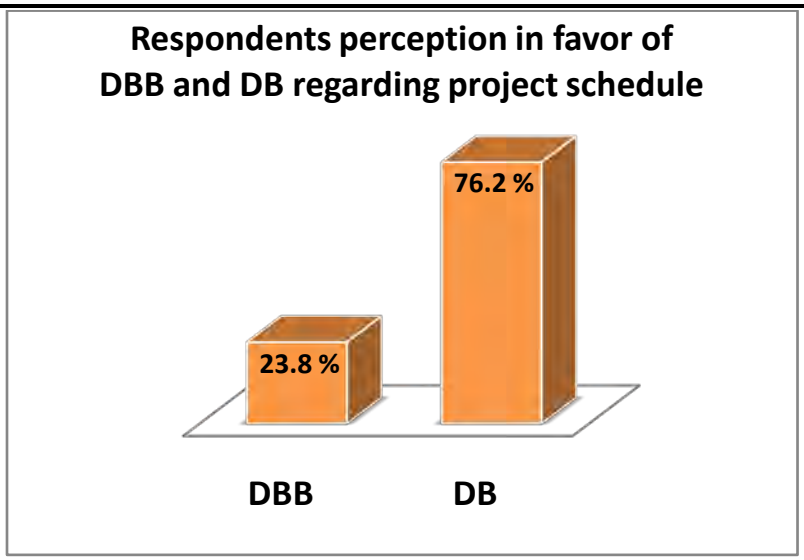


Figure 4.7:- Percentage of Respondents' perception in favor of both PDS regarding project schedules

4.10.2 Respondent's View Regarding the Project Cost

It was observed that 74.4% of the respondents indicated the DB delivery method is preferable to meet project costs. According to these respondents, the federal roads authority benefits from making both the designer and the contractor at a single point. It can be seen from figure 4.8 that respondents given their view on the cost overruns, as that of DBB project delivery system is very significant.

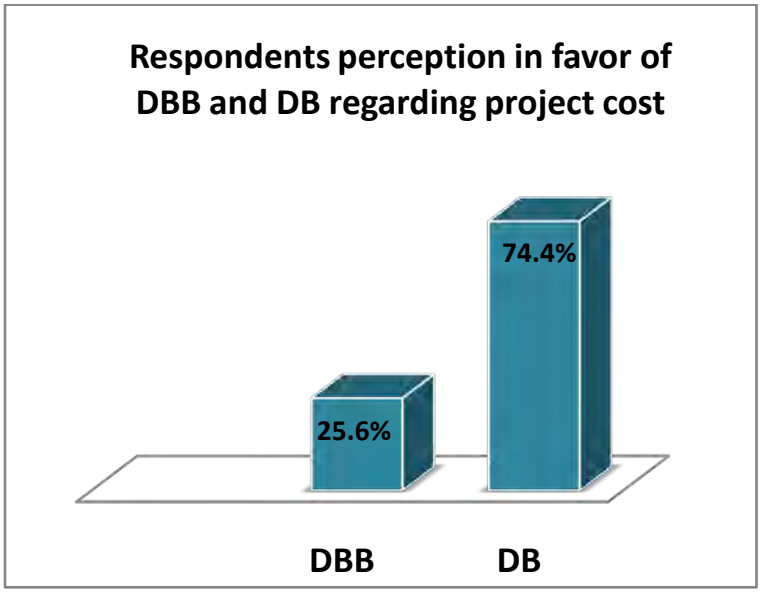


Figure 4.8:- Percentage of Respondents' perception in favor of both PDS regarding project cost

4.10.3 Overall Evaluation of the Respondents

Most of the local contractors interviewed for this research project responded that it is not within their capacity to choose the project delivery methods. It is the role of the Ethiopian Roads Authority or the client to decide the method, and they are compelled to abide by this in order to win the contract.

Accordingly, the usual method they employ is the traditional approach. But from the response of the questionnaire if they intend to shift the existing paradigm, the majority responded that they have no objection.

Majority of the contractors complain the traditional approach is not timesaving and is a costly method, and more likely to pose adversarial relationships between the concerned parties. And some even call it a dispute-prone method. One of the contractors critically recommends the adoption of the DB method of delivery as it requires lesser time and lesser overhead costs, though he believes that all methods ensure a quality project if the whole processes of design and construction are well managed.

The majority of the professionals in the construction world prefer DB as it is a better approach, but has the associated and undeniable problem of absence of knowledge in the innovative PDS, as the same contractor is assuming the responsibility for both the design and construction. And they also raise issues like concealment of design defects. It is important to pay attention as this is a serious issue unless our local contractors develop a sense of responsibility for what they do.

It was also mentioned that local consultants lack adequate construction management experience. Absence of detailed pre-contract planning is also presented as one of the reasons for disruption of construction contracts. Besides, consulting firms sometimes tend to strictly reflect the interests of the owners whenever they change ideas very often. The other problem is contractors and/or consultants' prequalification not strictly attended to. Almost all of the consulting firms share the stated problems. Other problems stated by the respondents are the local contractors are not capable enough to implement projects using the DB and\or turnkey methods. They argue that no local contractor is financially sound, technically and managerially capable, and ethically reliable.

Those respondents who support the DBB project delivery method thoroughly discussed and argued that the traditional mode (DBB method) has distinct advantages over DB. They have tried to mention some of the advantages described on page 22 and 23. In choosing this method, the owners must make tradeoffs. One major advantage is the fact that the owner knows the cost when construction begins. Nevertheless, studies indicate that this method is short of the collaboration between the design team and the construction team that could improve the design and lower the overall price (Rolstad DG).

It is also stressed that it is difficult to reduce the time required to do both design and construction using the DBB method, because the process is sequential and linear; there is no opportunity to overlap tasks to reduce the overall time. Thus, the majority of the respondents agree that the innovative or DB method reduces the project schedule and cost better than the traditional DBB methods.

CHAPTER 5

5 Conclusion and Recommendation

The aim and main objective of the research, as mentioned in section 1.4 of this thesis, is to assess and evaluate the effective project delivery system for Ethiopian Federal Road Projects using the traditional delivery method (DBB) versus the innovative project delivery (DB) method in order to determine which delivery method is the best approach to meet the needs of Ethiopian Federal Roads construction projects and to make recommendations based on the findings. The following conclusions and recommendations are, therefore, presented in line with the specific objectives designed to meet the main objective.

5.1 Conclusion

I. The first specific objective was to develop a preferable project delivery system for federal road construction projects in Ethiopia that can be used to draw credible conclusions on the performance differences between design build and design-bid-build. The assessment revealed that the DB project delivery system has credible and better performance versus the DBB project delivery system if the following actions are properly managed:

   1) The contractor should properly analyze and develop the knowledge and awareness of risks during evaluation and pricing of tender documents, esp. with respect to risk allocations
   2) If the contractors are adequately preparing themselves to procure and manage a design-build project.
   3) The employer made himself ready by timely permitting construction phases in such a way that by assisting the DB contractor through environmental clearance and right-of-way acquisition prior to award of DB contract;
   4) Leaving design guidelines loose with performance criteria designed to drive the creativity of the design-build team; and
   5) Maintaining Proper communications between the contracting agency and design-build team.
   6) Carefully choosing projects which are appropriate and fit for design-build PDS.

II. The second specific objective was to analyze cost and schedule differences between the two project delivery methods. The results showed that the mean Cost Growth of DB projects are significantly lower than that of DBB projects. The data also showed that DBB projects had also a higher Construction Cost Growth.

The case study and the questionnaire survey results revealed that DB project delivery system has significantly lesser project cost growth. The surveyed DB project managers indicated that selecting proper project delivery approach (i.e., DB versus DBB) can be a contributing factor in controlling and potentially reducing project costs. When project cost information was analyzed from the project surveys, the DB projects experienced no appreciable change in total cost. The results also showed that the means of Schedule Growth were significantly lesser in DB projects than that of DBB projects.

Despite wide variations in changes to project duration among the surveyed DB and DBB projects, the results of the surveys and case studies support the claim that the DB approach can reduce the overall time overrun on the duration of a project significantly. The study therefore, revealed that DB project delivery system can significantly reduce the schedule or the contract period time overrun by:

- ✓ Eliminating the need for a second procurement cycle by combining contracting for design and construction contracts.
- ✓ Integrating these functions during the project development lifecycle, while DBB keeps them contractually separate.
- ✓ Producing improved designs that are more constructible and that encourages innovations.
- ✓ Allowing parallel processing of activities occurring on different portions of a project while DBB keeps them sequential.

III. The third specific objective was to provide an overall evaluation of DB and DBB delivery methods. In relation to the general evaluation, the DB project delivery system is evaluated to be more effective for the Federal Road Construction Projects due to the following reasons:

1) The Contract Award Cost Growth is lower in DB projects than in DBB projects for Ethiopian Federal Road Construction Projects.
2) The Construction Cost Growth is lower in DB projects than in DBB for Ethiopian Federal Road Construction Projects.
3) The total Cost Growth is lower in DB projects than in DBB projects for Ethiopian Federal Road Construction Projects.
4) The design and Construction Schedule Growth is significantly lower in DB projects than in DBB for Ethiopian Federal Road Construction Projects.
5) The Total Schedule Growth is significantly lower in DB projects than in DBB for Ethiopian Federal Road Construction Projects.
6) The Design Change-Order Cost Growth is significantly lower in DB projects than in DBB for Ethiopian Federal Road Construction Projects.

5.2 Recommendation

Based upon the results of this study, the DB project delivery system is better applicable for Ethiopian Federal Road Construction Projects if the following points are properly addressed and given serious attention:

1) In the federal road construction projects the level of competition for DB projects is somewhat smaller than that of DBB projects, most likely due to the newness and perceived risk associated with this particular project delivery approach to the Ethiopian Federal Road Projects.

   Therefore the client ERA should encourage the contractors so that more design and construction firms participate on DB project delivery system. Because the presence of a number of competent design and construction firms interested and willing to compete for work under the DB contracting approach helps to ensure cost- competitive bids/proposals.

2) Most of the local contractors should identify, consider and allocate their risks properly during evaluation and pricing of tender documents. They have to avoid the influence of improper tendering procedure or unfair tender competition caused by very high ambition to win the job, which does not allow them to add the required risk contingencies in practice.

   Therefore all DB contractors are expected to inspect and examine the site and its surroundings and have satisfied themselves before submitting their tenders. In general, they are deemed to obtain all necessary information as to the risks, contingencies and all other circumstances which may influence or affect their tenders. This research included questions related to this issue that are raised to ask whether domestic contractors consider risks, examine tender documents, visit project sites, and add contingencies in their tender sum while submitting their tenders for public works.

3) There is a positive tendency or an attitude of implementing the innovative PDS thereby improving the overall project performance. The DB project delivery systems employed by ERA on previously mentioned 12 projects is an indication for such an attitude that a new and an alternative approach better than the traditional DBB method is being sought. Therefore this tendency should be encouraged by all the stake holders.

4) The implementing agency or ERA should provide training, seminars, workshop with regard to DB project delivery system prior to executing DB projects. Moreover, senior staffs of client who have past experience in executing DB projects should be able to educate others, share knowledge and keep communication to their junior about the DB project delivery system.

5) The following areas of study are suggested for further future studies as part of the extension of this research work:

    5.1 The DB contracts require long-term partnerships with selected DB entities and material suppliers. Supply chain management requires the creation of long-term relationships where owners and suppliers align their cultures and develop strategies to take advantages of efficiencies in the marketplace. These strategic partnerships are not sole source awards but are long-term agreements with indefinite quantities attached to the deliverables. Hence this area of study is suggested for future studies as a part of the extension of this research weather these strategic partnerships provide any benefits or savings if these concepts were adopted by the implementing agency in its acquisition of DB contract.

    5.2 Although this research focuses on the effectiveness of DB versus DBB regarding cost and schedule of the federal road projects, it did not take into account quality of the final product with respect to both PDSs. Therefore, an additional study could also be recommended to see the effect of the likelihood of quality linked to both project delivery systems.

References

- Abebe, D, and Girmay, K. (2003) *ZEDE, Journal of EEA, Vol. 20,* Claims in International Construction Projects in Ethiopia, Addis Ababa, Ethiopia.

- Ali Touran, Douglas D. Gransberg, Keith R Molinar, Kamran Ghavamifar, DJ Mason, Lee Fithian (2009) *Guide Book for Evaluation of Project Delivery Methods*, Washington DC

- Anak Parami Dewi, Eric Too and Bambang Trigunarsyah (2011) *Implementing Design Build Project Delivery System in Indonesia Road Infrastructure Projects*

- Battelle (2003) Performance Based Contracting for The Highway Construction Industry

- Bennett, J.; Pothecary E.; Robinson, G. (1996) *The Industry Today: Designing and Building a World Class Industry, Centre for Strategic Studies in Construction,* United Kingdom

- Darren R. Hale, Preman P. Shrestha, G. Edward Gibson Jr., Giovanni C. Migliacio (2009) *Journal of Construction and Engineering Management* "An Empirical Comparison Of Design/Build and Design/Bid/Build Project Delivery Methods"

- Douglas Ansberg, Joseph Datin, Keith Molenaar (2008) *Quality Assurance in Design-Build Projects,* Washington D.C.

- Douglas D Gransberg (2007) *Design – Build the National Perspective*

- Dubem I. Ikediashi, Akaninyene Mendie, Emmanuel Achuenu and Michael G. Oladokun (2012) *Key Performance Indicators of Design and Build Projects in Nigeria*

- Evaluation of Alternative Contracting Techniques on FDOT Construction Projects(July 2007) FDOT Contract Number FDOT BDC51

- Federal Highway Administration Final Report (2006) *Design-Build Effectiveness Study*

- FHWA (2002) *Design-Build Project Approvals under SEP-14 as of 12/31/2002,*

- Getachew Tsegaye(2009) Msc Thesis On *Design Risk Management In Ethiopian Federal Road Projects*

- James David Fernane(2011) *Comparison of design-build and design-bid-build performance of public university projects University of Nevada,* Las Vegas

- James W. Rosner, BS (2008) *An Analysis of The Design-Build Delivery Approach In Air Force Military Construction*

- Jody Becker and Tim Murphy (2010) *Alternative Construction Delivery Methode*
- Jomah Mohammed Al-Najjar (2008) MSc. Thesis on *Factors Influencing Time and Cost Overruns on Construction Projects in the Gaza Strip*
- Lemma Mossisa, (2006) Addis Ababa University, *Alternative Project Delivery Methods for Public Constructions, Cases in Oromia Region,* Msc. Thesis for School of Graduate Studies
- Marwa A. El Wardani (2004) *TechnicalReport on Comparing Procurement Methods For Design-Build Projects*
- Nancy B. Solomon (2005) *The Hopes and Fear of Design-Build*
- Nicola J. N. West (2012) *Evaluating the value of contractor involvement in the design phase*
- Nicola Jane Newsham West (2012) *Evaluating the Value of Contractor Involvement in the Design Phase*
- Olaf Passenheim (2009) *Project Management*
- Pardis Pishdad-Bozorgi and Jesus M. de la Garza (2012) *Comparative Analysis of Design-Bid-Build and Design-Build From the Standpoint of Claims*
- Pakkala, Pekka (2002) *Innovative Project Delivery Methods for Infrastructure: An International Perspective, Finnish Road Enterprise.*
- Parami Dewi, Anak Agung Diah, Trigunarsyah, Bambang, Too, Eric G., & Coffey, Vaughan (2012) *Factors Contributing to Design-Build (DB) Project Delivery System Implementation in Road Infrastructure Projects in Indonesia*.
- Parsons Brinkerhof (2012) *Moving Ahead on Highways*
- Pekka A. Pakkala, W Martin de Jong (2007) *International Overview of Innovative Contracting Practices for Roads*
- Primer on Project Delivery. (2004) *Provided by the Joint Committee of The American Institute of Architects and The Associated General Contractors of America.* Washington, DC, and Alexandria, Virginia.
- Ralph Ellies, Jae-Po Pyeon, Zohar Herbsman, Edward Minchine, Keith Molinar (2007) *Evaluation of Alternating Contracting Techniques on FDOT Construction Projects*

- Riecke, V. R. (2004) Public Construction Contracting: Choosing the Right Project Delivery Method, Georgia Institute of Technology.
- Rolstad, D. G., and A. Samelson (1999) *Design Build Construction-Improving Transport Projects Construction in California,* San Francisco.
- ROC52 (2003) Design – Build Projects *Lesson Learned*
- Roula A Sader (2003) *Msc. Thesis on Design-Build In The Commonwealth of Massachusetts*
- Ruben Vavie (2010) *Quality monitoring in infrastructural Design-Build projects*
- Sanvido, V.; Konchar, M. (1999) *Selecting Project Delivery Systems, Comparing Design-Build, Design-Bid-Build, and Construction Management at Risk,* The Project Delivery Institute, PA.
- Shawn D. Moor (1998) *A Comparison of Project Delivery System on United States Federal Construction Projects*
- Suketu Nagrecha, MBA, PMP, CNA March (2002) *An introduction to Earned Value Analysis*
- Tiina, K., and L. Pertti. (2004) *The Current and Future Performance of Road Project Delivery Methods, VTT Technical Research Center* Finland.
- Tsung-Chieh Tsai and Min-Lan Yang (2010) *Risk Assessment of Design-Bid-Build and Design-Build Building Projects*
- Wubishet, J. M. (2004) *Performances for Public Construction Projects in (Least) Developing Countries,* Federal Road and Educational Building Projects in Ethiopia, Dr.-Eng. Thesis Series 2004:45, NTNU, Trondheim, Norway
- Ying Li, Timothy RB Tailor (2010) *The Impact of Design Rework on Construction Project Performance*

Appendix –A

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDY

Institute of Technology
Department of Civil Engineering
Construction Technology and Management Stream

Master's Thesis Proposal

Assessment on the Effectiveness of "Design-Build" Versus "Design-Bid-Build" Project Delivery Method in Federal Road Construction Projects.

Submitted by
MEKONNEN ASAMINEW
Advisor:- Wubishet Jekale (Dr-Eng.)

November 2012

Research Proposal

Abstract

The research will compare the performance of design-bid-build and design-build to see if one project delivery method is superior in regards to time and cost.
The usual method of project delivery method in Ethiopia is Design-Bid-Build method. However, recently the Design-Build delivery method is introduced in many road projects. Accordingly the proposed study characterizes the assessment of the effectiveness and implications of design-build project delivery versus the traditional design-bid-build project delivery in terms of selected project characteristics and relevant/measurable performance criteria.

Design-Build (D-B) - The design-build form of project delivery is a system of contracting whereby one entity performs both design or engineering and construction under one single contract. Under this arrangement, the design-builder warrants to the contracting agency that it will produce design documents that are complete and free from error (design-builder takes the risk).

Design-Bid-Build (D-B-B) - Design-bid-build is another form of project delivery whereby the contracting agency either performs the design work in-house or negotiates with an engineering design firm to prepare drawings and specifications under a design services contract, and then separately contracts for at-risk construction by engaging a contractor through competitive bidding. Under this arrangement, the contracting agency warrants to the contractor that the drawings and specifications are complete and free from error (contracting agency takes the risk).

The research will focus on the assessment of the effectiveness of the design-build approach and its relative advantages and disadvantages in relation to the design-bid-build approach under the context of the federal road construction projects in Ethiopia.

Introduction

In Ethiopia the government is allocated huge amount of budget for the construction of infra structure. Construction of the road is one of the huge contracts that are currently under progress. Construction can be undertaken only when the designs and drawings of the facilities are available and the equipment and materials required for the facilities are procured. Hence construction contracts invariably involve varying degrees of design scope and delivery scope. In this research it is tried to discuss construction contracts as involving each of these scope elements. The primary deliverables of a construction project are completion schedule, as-built cost and quality.

Although there are many different methods of construction deliveries, the two major project delivery methods that are used in construction projects today are:

I. Design-Bid-Build
II. Design-Build

In spite of the fact that there are numerous variations on each of these delivery methods, the research will be focused to assess the fundamental distinctions between the two. As an increasing number of utility owners consider using project delivery methods other than design-bid-build, there is a need for research to analyze the performance of different project delivery methods as design-build in the road construction projects.

The research paper will try to provide the results of a research study that analyzes the project performance in the design-bid-build and design-build delivery methods and try to assess the effectiveness of both project Delivery methods under the context of the federal road construction projects in Ethiopia.

Literature Review

A significant body of literature comparing Design-Bid-Build and Design-Build has been published. The literature review to be conducted during this research project can be summarized as follows. It appears that DB may be a more effective delivery method over DBB in regards to cost, schedule, and change order growth. However, some studies found that the DBB method was more effective than DB. To date, there have been no studies done comparing DBB and DB delivery methods on road projects that are constructed in Ethiopia Federal road projects so far. The findings of this current study will help the road projects decide what delivery method is best for them in terms of controlling cost, schedule, and change orders.

Recently the federal road projects in Ethiopia are now starting to move away from the traditional delivery method, DBB, and implement the use of alternate delivery methods, such as DB. There have been many research studies done regarding DBB and DB delivery methods for public and private projects, highway and military projects, and general construction projects.

The majority of these studies has been of a qualitative nature, and has relied heavily upon surveys, empirical studies, and case studies. The review of the other papers proved to be extremely valuable in gaining knowledge and understanding different methods for project delivery as well as alternate delivery methods. This in turn contributed to the successful completion of this research project. This chapter will summarize the literature review of DB and DBB project delivery methods used for federal highway projects.

Critics of the design–build approach claim that design–build limit the clients' involvements in the design and allege that contractors often make design decisions outside their area of expertise. They also suggest that a designer—rather than a construction professional—is a better advocate for the client or project owner and/or that by representing different perspectives and remaining in their separate spheres, designers and builders ultimately create better buildings. Proponents of design–build counter that design–build saves time and money for the owner, while providing the opportunity to achieve innovation in the delivered facility. They also note that design–build allows owners to avoid being placed directly between the architect/engineer and the contractor.

Under design–bid–build, the owner takes on significant risks because of that position. Design–build places the responsibility for design errors and omissions on the design–builder, relieving the owner of major legal and managerial responsibilities. The burden for these costs and associated risks are transferred to the design–build team. The cost and schedule reduction and decreased litigation associated with design–build project delivery have been demonstrated repeatedly. In order to conclude if one project delivery method is superior to the other, some literatures compared the performance of DB and DBB projects. These studies statistically compared time and cost growth of DBB projects and DB projects in terms of total project duration, fiscal year duration, project start duration, project duration, project time growth, cost growth. The final objective was to test the hypotheses for the aforementioned areas that the Design-Build method outperformed the Design-Bid-Build method.

The data for this study will be collected from various different databases; this data included project description, delivery method, original contract amount, final contract amount, original project start date, project completion date, and a category code. Any data not gathered from any project descriptions or cost estimate information, was completed by means of an interview process. Not all the projects were completed at the same time or location; therefore, adjustments for time and location also were considered. In terms of overall delivery speed, it is found that DB projects were approximately faster than DBB projects. The significant variables that have an impact on this delivery speed were project size, contract unit cost, percent design complete before construction entity joined the project team, facility type, and project team communication.

The time related models for DB and DBB projects showed that both construction speed and delivery speed were affected by the size of the project. The DB and DBB models that consider

owner satisfaction showed that the basic variable that affected project performance was the contractor's technical expertise.
The owner's satisfaction is directly related to the contractor's track record, expertise, safety, and quality. Owner's satisfaction for DB projects is related to the contractor's specialized project experience and safety record. DBB project owners based their satisfaction on previous track record, number of change orders submitted during each project, and flexibility of scope.

The assessment for the effectiveness of DB and DBB projects to determine which delivery method was more effective will evaluate the influence that a project delivery method, such as DB and DBB, may have on the outcome of the federal road projects project. Information on cost, schedule, and productivity were collected from the federal road construction projects. The study will developed a questionnaire that included questions involving project delivery methods as well as changes in cost and schedule, which were used to request data on project information. It also tries to analyze productivity against schedule and cost changes in regards to the delivery method used by the project.

Several studies have analyzed the growing trend towards the use of Design-Build delivery method and the shift from more traditional delivery methods. Procurement methodologies of delivery methods are almost as important as the delivery method itself. The data analysis indicated several important trends associated with different performance metrics. Since all highway projects are unique in their own way, the choice of what delivery method to use needs to be evaluated on a project-by-project basis. In this way, the correct delivery method can be chosen that maximizes the possibility of selecting the best contractor for the project.

In addition, owner satisfaction in regards to quality of the work performed while using the DB delivery method will be addressed in this study. Some authors compared the relationship of DBB and DB projects for large highway projects in terms of cost, schedule, and change order per lane. The cost per change order for DB projects was about 50 percent more than the cost per change order for DBB projects. However, the analysis did show that the number of change orders were lower in DB projects than DBB projects.

The study will also research project characteristics (input variables) and project performance (output variables) from large highway projects. This study showed that input variables had an alliance with one or more of the output variables. The input variables related to cost growth had a significant alliance with the amount of days lost with the increase of cost. The input variables related to cost per mile had significant alliance.

In 1995, Roth compared six DBB and six DB Facilities. Using this small sample, it was found that the use of DB significantly reduced costs associated with design and construction. The results also showed that cost growth was decreased for DB projects. However, the research

sample was very small from a statistical perspective and compared projects before DB began to be used significantly as an alternative project delivery method.

Some authors concluded that DB projects outperformed DBB with respect to time, but the results relating to cost were not as convincing. They concluded that the skill of the project management team and the experience of the contractor had greater impacts on project performance than the project delivery method.

Numerous studies have shown that time can be saved by using the DB project delivery method they used a multivariate model to examine unit cost, construction speed, delivery speed, cost growth, and schedule growth. They concluded that DBB projects were more likely to have changes in schedule than DB. They also concluded that the DB project delivery method would show cost benefits.

Objectives and the Research Questions

The specific objectives of the research paper will be to evaluate and asses to:

- Develop a statistically significant data set for federal road construction projects in Ethiopia that can be used to draw credible conclusions on the performance differences between design build and design-bid-build;
- Quantify the relative cost and schedule differences between the two project delivery methods
- Provide an overall evaluation of design-build and design-bid-build delivery methods.

The study will follow a rigorous research approach. The research can be used to compare design-build performance to conventional design-bid-build performance for some selected road construction projects.

The results of the study will be presented in a full research report, including background information on project delivery methods, a survey of road project constructions in the Federal Roads of Ethiopia and an overall evaluation of design build and design-bid-build delivery methods for selected road projects.

The three critical project deliverables for the owner are project cost, project completion date and project quality. How the owner can ensure that these deliverables are controlled will be influenced greatly by the mode of contracting adopted for project delivery. In line with this the main objective of the research will be to assess and evaluate which type of contract is more applicable to the construction of the federal road projects in Ethiopia.

In the process of assessing and selecting acceptable project delivery system, the following problems should be seriously considered:

i. What are the factors used to select which delivery system (design-bid –build vs. design-build) for the successful completion of federal road projects?

ii. Under what circumstances does design-bid-build or design-build delivery system is the better approach for federal road projects?

Methodology

The study will be designed to focus on the assessment of the effectiveness of the design-build approach and its relative advantages and disadvantages in relation to the design-bid-build approach under the context of Ethiopian federal road construction projects. Hence the research design used for this research is quantitative and descriptive survey.

The first step of the research project was to formulate a problem statement that describes the objectives, and the research scope. The details, including research background, the purpose of this study, objectives, and scope will be properly addressed

Data Sources

The study will use both primary and secondary data for the evaluation of Design-Bid-Build as well as Design-Build project delivery methods. The quantitative and the qualitative data will also used for the research purpose.

Data Analysis

The type of projects collected for qualitative and or quantitative method analysis will be the Ethiopian Federal road projects that were contracted and constructed under DBB and DB delivery methods. A detailed questionnaire was developed and sent to the concerned stake holders requesting specific project information for both DBB and DB projects. The questionnaires requested specific project information for both DBB and DB projects.

After all the questionnaires were reviewed for completeness, and the incomplete questionnaires completed by talking to the participants, the data for all collected projects were entered into an Excel spreadsheet for processing. To properly sort and create formulas within the Excel spreadsheet as DB projects and DBB projects to precisely perform the statistical tests on parameters in relation to time, quality and cost.

Work Plan

Work Plan to Conduct the Research

Item	Activity to be performed	Time Schedule																					
		December				January				February				M arch				April				May			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	Litrature Review																								
2	Research Time																								
2	Data Collection																								
3	D-B-B and D-B data analysis																								
4	Evaluation of the data anlysis																								
5	Finalayzation of the study and thesis writing																								
6	Defence																								

Budget

The following table shows the budget allocation for conducting the varrious activities of the proposed project

Activity		Descriptions	Unit	Quantity	Unit cost	Day	Total Cost
Data Collection /Offices/	From employer or client	Transportation	Person	2	15 birr/Person	10	300.00
		Data Collection	Person	2	100 birr/Person	10	2,000.00
		Coordination	Person	1	100 birr/Person	10	1,000.00
	From Consulting offices	Transportation	Person	2	15 birr/Person	10	300.00
		Data Collection	Person	2	100 birr/Person	10	2,000.00
		Coordination	Person	1	100 birr/Person	10	1,000.00
	From Contractor	Transportation	Person	2	15 birr/Person	10	300.00
		Data Collection	Person	2	100 birr/Person	10	2,000.00
		Coordination	Person	1	100 birr/Person	10	1,000.00
Data Collection /Project/	From Sites	Transportation	Person	2	15 birr/Person	10	300.00
		Data Collection	Person	2	100 birr/Person	10	2,000.00
		Coordination	Person	1	100 birr/Person	10	1,000.00
Stationary	Writing materials						3,000.00
	Printing						
	Copy						
	Photographs						
	Binding						
	Flash disk						
	CD						
Sub Total							19,800.00
Miscellaneous 10%							1,980.00
Total							21,780.00
Vat 15%							3,267.00
Grand Total							25,047.00

Reference

- ***Construction Project Delivery System : Special emphasis on Design-Build***
  ECoTMPA National Workshop 2012
- ***Design Bid-Build vs. Design-Build***
  Marion County Board of Commissioners October, 2011
- ***Empirical Comparison of Design/Build and Design/Bid/Build***
  Project Delivery Methods
  Journal of Construction Engineering and Management © ASCE / July 2009/
- ***Best Practices In Project Delivery Management***
  SCAN Management, October 2009.
- ***Public -Sector Design/Build Evolution and Performance***
  Journal of Management in Engineering / March/ April 1999
- ***Design-Build Effectiveness Study***
  USDOT - Federal Highway Administration (Final Report) January 2006
- ***Design - Build procurement and administration Guide***
  ADOT Construction Group 3rd Edition December 2007
- ***Performance-Based Contracting for the Highway Construction Industry***
  Koch Industries Inc. Final Report, February 2003
- ***The Design-Build Contracting Methodology for Transportation Project***
  The Connecticut Academy of Science and Engineering, June 2010
- ***Selecting Project Delivery***
  Tyson Building Corporation © 2005

Submitted by:-

Mekonnen Asaminew	_____	_____
(Student's Name)	Signature	Date

Approved by:-

Wubishet Jekale (Dr-Eng)	_____	_____
(Thesis Advisor)	Signature	Date

Bikila Teklu (Dr-Eng)	_____	_____
(Dept's Chairman)	Signature	Date

Appendix –B

GLOSSARY

Construction Speed: The rate at which a facility is constructed measured in kilo meter per month of construction time. Construction time is the total time elapsed between the contract award date and the beneficial occupancy date. Design-build construction time begins on the construction start date and ends on the beneficial occupancy date. Some design-build projects reported the construction start date on the same date as the design build design start date.

Cost: The amount of money paid by an owner for the design and construction of a project, measured in Eth Birr. Costs exclude the value of land acquisition, extensive site work, process equipment or owner costs.

Design-Build (DB): A project delivery method in which the design and construction phases are contractually-integrated activities of the project development process. As used in this study, design-build includes the design and construction development stages. It is the process whereby an owner contracts with a single entity to perform both design and construction under a single design-build contract. Contractually, design build offers the owner a single point of responsibility for design and construction services. Portions or all of the design and construction may be performed by the entity or Sub contracted to other companies (either design or construction).

Design-Bid-Build (DBB): The traditional project delivery method in which design and construction are distinct, sequential steps in the project development process, subject to separate procurement approaches and processes. It is the delivery system in the construction industry wherein an owner contracts separately with a designer and a construction contractor. The owner normally contracts with a design company to provide complete design documents from concept (0% design) through detailed design drawings and specifications (100% design). The owner or owner's agent then solicits bids from construction contractors based on the design drawings. One contractor usually is selected and enters into a contractual agreement with the owner to construct the facility in compliance with the design drawings and specifications. The owner contracts separately with a construction contractor based on acceptable bids estimated from the design documents to execute and complete facility construction.

Project Delivery Speed: The rate at which a project is delivered from contracted concept design initiation to beneficial occupancy date at construction completion. Based on a facility's gross

square footage, delivery speed is measured in square feet per month of project duration (Shawn D. Moor et al 1998)

Project Delivery System (PDS): The roles, interaction, and obligations of contracted parties and the sequence of activities necessary to provide a construction project from design concept initiation through construction completion (Shawn D. Moor et al 1998).

Project Design Phases: The four sequential phases of a project's design throughout the entire design process from zero percent design complete to completion of construction documents. The four phases are as follow:

Concept Design Phase: (0% to 15% design) the start of the facility design process initiated by the design contract award date. This phase of design includes preliminary project estimate, site analysis, and conceptual designs. (AIA, 1987).

Schematic Design Phase: (15% to 35% design) Graphical sketches, models, and relationships from the concept phase are developed into clearly defined project site layout, parametric estimate and engineering reports (AIA, 1987).

Design Development Phase: (35% to 65% design) The phase in the design process where in a detailed construction estimate is begun, and drawings are finalized, structural foundation, outline specifications are developed into respective sections, and material selection is well-underway (AIA, 1987).

Contract Documents Phase: (65% to 100% design) The phase after design development is complete wherein the construction project estimate is finalized, construction drawing details are created and completed, all materials are scheduled, the project construction systems are fully integrated, specifications are completed, and construction bidding documents are completed (AIA, 1987).

Schedule: The total elapsed time taken by the project team to design and construct a given construction, measured in calendar days.

Appendix –C

Questionnaire

I would like to thank you in advance for the time and effort involved in your participation in this research. This questionnaire is prepared to obtain information from key informants. The information is required for the academic research entitled "Assessment on the Effectiveness of DB Vs DBB Project Delivery Systems in Ethiopia Federal Road Projects", which is being conducted as partial fulfillment of MSc. in Construction Technology and Management. The main objective of the research is to examine whether Design-Bid-Build or Design-Build is more effective for federal road projects based on their own performances, and make recommendations based on the findings.

This questionnaire guide is divided into two sections; ***General profile of the respondent*** and ***Project Characteristics.*** There are a total of 36 questions.

If not enough space is provided for the brief questions, please feel free to attach extra sheets to the document. In the questions, we ask for detailed information on project characteristics and performance.

Please do what you can to assemble this information as fully as possible. Your detailed responses will allow me to understand to what extent these project characteristics and performance measurements have influence in the evaluation of both the DBB and DB project delivery systems in the federal road construction or highway projects.

The confidentiality of the participants on this questionnaire will be maintained. This interview data will not be placed in any place except for educational and research purpose. The identity of person who provided all this information will remain anonymous. The data obtained during this interview will not be linked in any way to participants' names. Please return this questionnaire by hand, via email or by mail to the following address:

Mekonnen Asaminew
PoBox. 26694
Addis Ababa
Email:mekonnendce@gmail.com
Cell Phone:+251-930-099-136

1. General Profile of the Respondent

1.1 Name: *(Optional)*_____

1.2 Position: _____

1.3 Organization: _____

1.4 Address: (Optional) _____

1.5 How long have you worked in the road sector

☐ 0-5 Year ☐ 11-15 Year

☐ 6-10 Year. ☐ Above 15 Year

1.6 Contact Person's Phone: (Optional) _____

1.7 Contact Person's Fax: (Optional) _____

1.8 Contact Person's Email Address: (Optional) _____

1.9 Contact Person's Role / Title in this Project: _____

1.10 Did you have past work experience with the selected design-build project delivery?

☐ Yes ☐ No

2. Project Characteristics

2.1 Current State of Project

2.1.1 Project location (Region)_____

2.1.2 Total length of road _____ KM

2.1.3 Describe current state of this highway project.

Completed in _____(Days)

or

Completed percentage % (if not complete) _____%

2.1.4 Contract completion period _____(Days)

Describe the nature of this project. (Check a box)

☐ New Construction ☐ Rehabilitation

☐ Upgrading ☐ Other

2.1.5 Was this highway project constructed while maintaining traffic flow? (Check the box)

☐ Yes ☐ No

2.2 Contract

2.2.1 What is the size of the project in terms of cost? (Check a box)

☐ Less than 100 million birr

☐ 100-125 million birr

☐ 125-150 million birr

☐ Above 200 million

2.2.2 How many D-B projects have you executed before? (Check a box)

☐ One ☐ Two

☐ Three ☐ Three plus

2.2.3 What was the stage of the design of the project when construction contract was awarded? (Check a box)

☐ At inception level

☐ At detailed employer's requirement

2.2.4 To what extent were you able to minimize design risks by involving personnel with design and construction experience? (Check the box)

☐ Less than 25% ☐ 25%-50%

☐ 50%-75% ☐ 75%-100%

2.2.5 What type of contract management do you practiced?

☐ As a general contractor

☐ By joint venture

☐ By consortium

☐ Other (Please specify_____)

☐ Not applicable (For Consultants)

2.2.6 How many different sub consultants were involved in designing this project? (Check a box)

☐ 1 -3 ☐ 4-6

☐ 7-9 ☐ More than 10

2.2.7 How many sub-contractors were involved in constructing this project? (Check a box)

☐ 1 -3 ☐ 4-6

☐ 7-9 ☐ More than 10

☐ Non up to now

2.2.8 What were the major challenges you faced during the implementation of the construction of Design-Build the project? (Check a box)

☐ ROW problem

☐ Change in employer's requirement

☐ Adverse weather condition

☐ Other (please specify)_____

2.2.9 How did you manage the design activity? (Check a box)

☐ By using in house design staff

☐ By outsourcing the design work

2.2.10 Please describe any major causes of delays that occurred in the construction of the project?

☐ ROW problem

☐ Design change

☐ Adverse weather condition

☐ Other (please specify)_____

2.2.11 In which of project delivery system do you think that speed of delivery maintained better?

☐ Design-Bid-Build

☐ Design-Build

☐ I do not know

2.2.12 In which type of project delivery system do you believe that project schedule is efficiently utilized?

☐ Design-Bid-Build

☐ Design-Build

☐ I do not know

2.2.13 If you have been always employing the traditional method so far, do you intend to shift to the innovative project delivery methods?

☐ Yes ☐ No

2.2.14 If yes what is/are the reasons behind your decision(Check all applicable)

☐ To reduce project cost

☐ To reduce project time

☐ To reduce administrative burden to owner

☐ Other(please specify) _____

2.2.15 Who was responsible for procurement of the right-of-way parcels for the construction of this project? (Check a box)

☐ Contractor

☐ Owner

☐ Other

2.2.16 In relation to the newness of DB to Ethiopia, what is your recommendation for DB contractors to cope up with this situation? (Check a box)

☐ ERA should arrange training

☐ No need of training the contractor can handle

☐ I do not know

☐ If other (Please specify)_____

2.2.17 Did the delivery system enhance or hinder your ability to perform? How? (Check the box)

☐ Yes it enhances ☐ Yes it hinders

☐ I do not know ☐ Not Applicable (for consultants)

☐ If it hinders what is your proposal to improve?

_____

2.2.18 Experience for key-design personnel is one of the Employers (ERA) Requirements. How frequent can you get personnel that meet the requirements of design and construction experience?

☐ Always ☐ In most cases

☐ Sometimes ☐ Rarely

2.3 Complexity of the project

2.3.1 How do you define the complexity of the project

☐ The topography and the design is very complex

☐ The topography and the design is moderately complex

☐ The topography and the design is not complex

2.3.2 How is the owners program not to limit innovation and flexibility

☐ The owner insists on absolute design control

☐ It allows flexibility and innovation

☐ The owners program is somewhat tight in allowing flexibility and innovation

2.3.3 What are your firm practices to reduce/minimize design errors?

☐ Design review by consultant as sole task

- ☐ Design review by construction supervision consultant as part of its duties
- ☐ Carry out design and supervision by same consultant
- ☐ By using contractors project staff (office) designers
- ☐ Not applicable (For consultants)

2.3.4 From your experience, in what type of project delivery method design risks are better minimized?

- ☐ Design-Bid-Build
- ☐ Design-Build
- ☐ I do not know

2.3.5 Did you get sufficient secondary data during the bid ? (Check the box)

☐ Yes ☐ No

Appendix –D

Sampled DBB Projects

A) Gondar-Debark Road Project

Gondar-Debark road project has a length of 99.2km and it is located in the north western part of the country, linking the two primary trunk roads joining the two nearby regional states Amhara and Tigray. The project is an up upgrading of the existing gravel road to an asphalt road standard which was built years ago as Telford base and penetration macadam during the period of 1936/40 and being deteriorated for several years.

The road is planned to be upgraded to 7m carriage way with 1.5m hard shoulders. The road will be constructed according to DS3 standard according to ERA Geometric Design Mannual. The total length of the project is 100km The financer of the project are Government of Ethiopia (GOE) and International Development Association.(IDA). The construction work was carried out by the Chinese company Sino Hydro Corporation. The construction supervision work is undertaken by J BURROW South Africa in association with Omega Consulting Engineers. The commencement date of the project was April 01, 2009 the original completion date was scheduled to be March 29, 2012 with a contract period of 1095 calendar days and the revised completion date is 29 May 2013 with a revised contract period of 1520 calendar days.

By the end of April 2013 the cumulative project progress was 97.84% against the planned cumulative progress of 100%. The original contract amount was ETB 690,779,965.26 and the revised contract amount was ETB 774,086,108.5. The project has been granted 425 calendar days as an approved Extension of time. Now the status of the project is at 97.84% project completion. The project costs were increased by ETB 83,306,143.24 and its time is increased by 425 days.

B) Hawusewa-Abala-Irbeti Road Project

Hawusewa-Irbeti-Abala road project is found in Afar and Tigray regional states in the northern part of the country. The total length of the project is 94.14 km The financer of the project is the Government of Ethiopia (GOE). The construction work was carried out by the Chinese company called Jiangxi Zhongmei Engineering Construction Co. Ltd,(JXZM). The construction supervision work is carried out by International Consultant and Technocrats Pvt. Ltd in Joint Venture with ICTE and M/s Omega Engineering Plc.

The commencement date of the project was 21 August 2008 the original completion date was scheduled to be 20 February 2012 with 1260 calendar days and the revised completion date is 09 January 2014 with 1967 calendar days.

The project has been granted a total of 707 calendar days with EOT 01 and EOT 02 as an approved Extension of time. The original contract amount was ETB 746,341,435.30 and the revised contract amount was ETB 864,950,504.00. Currently the cumulative project progress is registered to be about 69.20% and the total project price is increased by ETB 118,609,068.70, The project completion period is also increase by 707 calendar days.

C) May Tsebri-Dima Road Project

May Tsebri-Dima road project is found in the Northern part of Ethiopia. The total length of May Tsemri-Diama road project is 75.6 km. The GOE is financer of the project. The construction work is carried out by the Ethiopian Construction Company, Gemshu Beyene General Contractor.

The commencement date of the project was 15 May 2009 the original completion date was scheduled to be 14 May 2012 with a contract period of 1095 calendar days. The original scope of the work was upgrading of the existing rural road to gravel road having 7m road width with DS5 design standard. However the scope of the project is changed after VO. No. 2 and VO. No. 4 to DBST with fog spray of 10m road way width.

As a result of these the revised completion date was changed to be on 13 July 2013 with a revised contract period of 1520 calendar days . The original contract amount was ETB 258,721,412.42, however after 4 variation orders the revised contract amount was changed to ETB 519,587,674.97. Currently the project status is 90.5%.

D) Irbeti-Afdera Road Project

The Afdera-Abala- road project contract 2 Irebti-Afdera project is located in the North Eastern part of Ethiopia in the Afar Regional State.

The total length of the Irbet- Afdera road project is 117.43 km The financer of the project is the Government of Ethiopia (GOE). The construction work was carried out by the Chinese company Corporation called China Railway Seventh Group CRSG. The construction supervision work is done by Core Consulting Engineers.

The works carried out under the contract consists of a new asphalt concrete surfaced road that provides 7m wide carriage and 1.5 m gravel shoulder on each side.

The commencement date of the project was 22 August 2008 the original completion date was scheduled to be 22 February 2012, which is 1277 calendar days, and the revised completion date was planned to be 31 October 2013, which is 1924 calendar days. The original contract amount was ETB 727,930,963.98 and the revised contract amount was ETB 815,609,432.21. Currently

the cumulative project completion is 91.11 %. The project amount was increased by ETB 87,678,468.23 million, and its time is increased by 647 calendar days.

E) Shekosh-Kebridehar Road Project

The construction of Degehabur- Kebridehar road upgrading project , Contract 2 Shekoshe-Kebridehar project is found in South Estern part of Ethiopia. It starts about 952km from Addis Ababa at Shekosh village on Harar – Shilabo road and terminates at Kebridehar town.

The project is an upgrading project from gravel surfaced road to double surface asphalt pavement with 7m carriage way width and 1.5m shoulder on both sides.

The total length of Shekosh-Kebridehar road project is 105.77 km The financer of the project is the Government of Ethiopia (GOE). The construction work was carried out by the Chinese Corporation called ERCC.

The commencement date of the project was 01 April 2007 the original completion date was scheduled to be 31 March 2010, which is 1095 calendar days and the revised completion date was planned to be 2 January 2013. The original contract amount was ETB 291,162,655.91 and the revised contract amount was ETB 357,837,672.38 . Currently the project has cumulative work progress of 73.01%. The project has been granted a total of 1007 calendar days as an approved Extension of time. The project amount was increased by ETB 66,675,016.95 and its revised contract period is changed in to 2102 days.

Appendix –E

Sampled DB Projects

A) Hargele-km 60+000

Hargele-km 60+000 Road is found in the south eastern part of the country. The road connects Addis Ababa with the south eastern part of the country. The total length of the project is 58.7 km. The project was designed and constructed by Enyi construction. The type of contract was design-bid contract.

The commencement date of the project was 02 September 2010 with total contract duration of 36 months the completion date was scheduled to be 02 September 2013.

The original contract amount was ETB 428,714,511. The project was substantially completed and handed over to ERA on 30 December 2012. The project work is completed 100% eight months ahead of the contract completion date.

B) km 60+000-Doloby-DoloOdo

Km 60+000 – Doloby – Dolo Odo project is the extension of Hargele-km 60+000, and it also connects Addis Ababa with the south eastern part of the country. The total length of the project is 83.0 km. The project is DB contract and the design and construction is executed by Macro General Contractor and Trading. The commencement date of the project was 6 September 2010 with total contract duration of 36 months thereby establishing a completion date of 5 September 2013. The original contract amount including contingency was ETB 405,726,000. The project is still on progress. While 83% of the total project time is elapsed the actual progress registered is estimated to be 62.7 % .

C) Abala –Shaigube

Abala - Shaigubi road project is found in the Northern part of Ethiopia. The total length of the contract is 56.7km. Abala - Shaigubi road project is one of the DB projects in the federal road construction projects. The design and construction of the project is done by SUR construction.

The commencement date of the project was 29 July 2010, and its original completion date is 14 January 2013 and its revised completion date, after approval of extension of time (EOT) is 14 March 2013, however its project cost is not revised. The actual progress of the project registered is 83% , after the approval of EOT. The approved EOT is 2 months.

D) Agula-shaigube-Berahile Road Project

The total length of Agulae-Shaigubi-Berahle road project is 76.0 km The financer of the project is the Government of Ethiopia (GOE). Agulae-Shaigubi-Berahle road project is DB project. The design and the construction work is carried out by the local contractor called defense construction enterprise.

The commencement date of the project was 18 April 2011 the original completion date was scheduled to be 22 April 2014 and the final completion date is not revised. The original contract amount was ETB 969,916,753 million and the final contract amount is not yet revised. While 78% of the contract period is elapsed, the registered project completion is about 61% .

E) Alamata-Mehoni-Hewani

Alamata- Mehoni-Hewane Road project is found in the northern part of the country. The road connects Addis Ababa with the northern Ethiopia. The total length of the project is 58.7 km. The project was designed and constructed by international contractor called China communications. The type of contract was DB contract.

The commencement date of the project was 29 January 2008. The original completion date was scheduled to be 26 July 2011 and the revised completion date was established on 10 Jan 2013 including 30 months EOT. Now the project is substantially completed.

SIGNED DECLARATION SHEET

I the undersigned, declared that this thesis is my original work and has not been presented for a degree in any university and that all sources of materials used for the thesis have been duly acknowledged.

Title of the thesis:

"**Assessment on the Effectiveness of Design-Build Versus Design-Bid-Build Project Delivery Method in Federal Road Construction Projects.**"

Name: Mekonnen Asaminew

Place: Addis Ababa, Ethiopia

Signature: _____

This thesis has been submitted for examination with my approval as university advisor:

Name: Wubishet Jekale (Dr.-Eng)

Signature: _____

Date: _____