



## Research article

## Public work contract laws on project delivery systems and their nexus with project efficiency: evidence from Ethiopia

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## ABSTRACT

Time, money, and quality are the three basic criteria for measuring construction project efficiency. The Ethiopian construction sector in general and public work projects, in particular, are believed to suffer from inefficiencies despite their quantitative growth in recent years. Previous researches have made attempts to explore factors determining the efficiency of the sector such as the low capacity of contractors (both financial and equipment, shortage of skilled human resource on technical, managerial, and entrepreneurial skills, etc...), the poor performances of the supply chain, inflation in the economy and so on. However, process and system-based challenges of the sector resulting from the existing legal frameworks governing the sector such as the modes of delivery of projects (modes of contracting) have not been a subject of extensive study. In this study, doctrinal and non-doctrinal legal research methods are employed to explore project delivery system(s) recognized in Ethiopia's public work contract laws and appraise their efficiency in terms of ensuring prompt completion of public construction projects. The doctrinal aspect of the research exposed that, despite an implied recognition of Design-Build (DB) and its variant forms of project delivery system, the country's public work contract laws set up Design-Bid-Build (DBB) as a default mode of contracting. Besides, the result from a survey questionnaire of 158 respondents which was computed by using Research Package for Social Sciences (SPSS) to generate the Relative Importance Index (RII) of each mode of contracting corroborated by primary data derived from the completion and status report of 40 road and 9 building projects, shows that even though construction project time overrun (delay) often happens in both routes of contracting, the magnitude of such inefficiency is greater in public projects of DBB than DB delivery mode.

## 1. Introduction

The construction industry is one among numerous sectors of an economy that make significant contributions to the socio-economic development of a country. It directly affects the economy of a country by providing huge employment opportunities to unskilled, semi-skilled, and skilled sections of the community of a country and indirectly through exploiting goods and services produced by other subsectors (Berk and Bicen 2017). The construction industry also fuels the economy of a country as a result of its strong multiplier effect through a complex system of linkages with other sectors, and therefore, the growth of all the economic sub-sectors such as modern agriculture, manufacturing, and the like is inconceivable without the construction industry. To regulate this important but complex and multifaceted sector of an economy and determine the rights and liabilities of stakeholders in construction projects, countries put in place different laws and regulatory institutions.

Efficient completion of a construction project among other things highly requires a synergetic operation of its stakeholders who take different but complementary tasks such as planning, design, procurement, financing, and construction, and so on.

A technical terminology in the field of engineering (which is also equally used in construction law) which refers to the respective responsibilities of project stakeholders is called Construction Project Delivery System (PDS), method, or mode. The term appears to be a misnomer in the minds of a lawyer who never practiced construction law as it gives a wrong impression that it is related to the completion of a construction project than a process that has to be determined upon commencement of the project. Simply stated, PDS is a mode of contracting construction projects. It can be defined as "a *comprehensive process by which construction project responsibilities are contractually assigned to its stakeholders*" (Kwan et al., 2014). It defines the structure of the relationships of the parties, the roles and responsibilities of the parties, and

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the general sequence of activities required to deliver the project (Moore, 2000). Based on the preceding definitions forwarded by different researchers, it is possible to deduce that a PDS refers to a contractual form of working relationship that defines the roles and responsibilities of different stakeholders involved in a construction project from the time of planning up to completion.

According to some writers, when project owners (for cost, time, and quality, etc... justifications) engage themselves to undertake the project, it is called "force account PDS" (Wibishet, 2012). According to these writers, "force account" is a project delivery method where there is neither a solicitation nor a contract between parties performing design and construction (Mearig, 2017). Under this delivery method, the owner serves as the contractor and uses labor from its own forces or direct-hired to supplement its forces to complete the work.

It does not, of course, follow that "force account PDS" inevitably leads to the reduction of cost and time or results in the construction of superior quality fixed facilities. Consequently, the same factors of efficiency which justified force account PDS legitimize outsourcing. Outsourcing happens when the project owner contracts with some other project stakeholder regarding the intended construction work. The contractually established relationship of the project owner with different stakeholders may take the form of Design-Bid-Build (DBB); Design-Build (DB); Construction Management (CM); Design-Build-Operate (DBO); Design-Build-Operate-Maintain (DBOM); Design-Build-Finance-Operate (DBFO); Build-Own-Operate (BOO); and Build-Own-Operate-Transfer (BOOT). Since public work projects in Ethiopia are often implemented under DBB and DB modes of contracting, the scope of this paper is confined only to the two PDSs.

DBB (Traditional Method) mode of contracting has been the standard choice for many years especially in the public sector in which an agency will use in-house staff (or use consultants) to prepare fully completed plans and specifications that are then incorporated into a bid package (Trauner Consulting Services, Inc. 2007). It is considered a traditional method of contracting because this PDS is the most commonly used across countries in the world. The process is initiated by the owner's recognition of a need or an opportunity for construction and then contracts with a design professional to transform the owner's general concept ultimately into a complete set of plans and specifications for the entire project from project site preparation to finish (Smith et al., 2009). The prepared plans and specifications are then used to solicit bids from general contractors, who rely on the scope of the work defined by the plans and specifications as the basis for their pricing, and then solicit sub-contractors (Pakkala, 2002). Typically, in a public organization, the bid or the proposal is in an open competition for "low price" which means that the contractor which wins the award is legally bound to produce the project at the lowest price the owner agrees to pay, within a defined schedule and minimum level of standard care (Pakkala, 2002).

Scholars established several advantages of DBB, for instance, DBB applies to a wide range of projects as it is well established and easily understood (Smith et al., 2009). Besides, DBB provides clearly defined roles for all parties, and most importantly, as construction features are typically fully specified, DBB provides agencies with significant control over the end product (however, this may come at the expense of increased agency-inspection efforts) (Levy, 2006).

This project delivery mode is also known for certain disadvantages. For example, scholars in the field argue that the initial low bid which DBB form of contracting is believed to offer for the client might not result in the ultimate lowest cost or final best value (Levy, 2006). The scholars also raise that; designers may have limited knowledge of the true cost and scheduling ramifications of design decisions in the DBB form of contracting. Besides, as a public agency bears design adequacy risk, this situation often tends to create an adversarial relationship among the contracting parties, rather than foster a cooperative atmosphere in which issues can be resolved efficiently and effectively (Levy, 2006).

DB (Innovative System) particularly differs from DBB due to its single-source liability which is at the heart of this mode of contracting.

Therefore, it can simply be stated that DB is a project delivery method in which the owner (client) selects an organization that will complete both the design and construction under one agreement (Pakkala, 2002). Regardless of the form chosen by the contractor (who is also called design-builder), the single most important step in DB is to arrive at a mutually understood and agreed definition of the project with the owner. Therefore, DB blends a contract of professional service for design and work in a single contract document between the client and the design contractor.

As a result of single-point responsibility for design and construction, DB is believed to be advantageous in terms of accelerated completion of the project (Smith et al., 2009). It is also accepted that it plays a significant role in cost containment by minimizing the owner's exposure to design errors and omissions and thereby promoting schedule and cost certainty (Smith et al., 2009). However, DB is criticized for higher initial costs which result from the involvement of few competitors and increased risk on the part of the contractor. It is also argued that, as DB reduces the traditional checks and balances, quality may be subordinated by cost or schedule considerations (Smith et al., 2009).

## 2. Research problem

The construction industry has important contributions to the Ethiopian economy, as demonstrated by its share in the GDP. According to *African Economic Outlook (2017)* during the past decade, robust public and private expenditure on infrastructure has catalyzed the country's rapid economic growth. According to the same report, the country has consistently invested 30% of the GDP into Gross Fixed Capital Formation since 2010 and as a result, the country has emerged as one of the fastest-growing economies in the continent of Africa. The *African Economic Outlook (2017)* further reported that by the same year the market value of the construction sector was estimated at more than US\$7bn which accounts for 15.9% of the GDP at the current price.

Notwithstanding its relative increase in output in the past few years, the efficiency of the construction industry of the country as a whole measured by one of conventional project success criteria of 'timely completion' is argued to be very poor (Solomon 2015). Previous researches established that factors of construction project inefficiencies in Ethiopia include the low capacity of contractors (in terms of capital both financial and equipment, shortage of skilled human resource in technical, managerial, and entrepreneurial skills, etc...), the poor performances of the supply chain, inflation in the general economy and the like. However, these factors alone cannot fully capture the inefficiency of the sector; process and system-based challenges of the sector resulting from the existing legal frameworks need to be investigated. One of the factors which emanate from the existing legal framework governing public construction works that are highly intertwined with construction projects' efficiency is the mode of contracting. To successfully address the aforementioned research problem, the research raises and attempts to sequentially address two related issues. Primarily, the research attempts to explore the kind(s) of PDS(s) recognized under the laws applicable to public work contracts in Ethiopia. Secondly, it determines which mode of contracting is highly prone to construction project time overrun.

## 3. Purpose and significance

A construction project is a process of a temporary alliance of different firms brought together over a project life span. As the process is very complex, it demands the participation of different parties responsible to undertake different tasks at different levels of the project. This paper is an attempt to unravel PDS through an in-depth study and analysis of different construction laws of Ethiopia to inform project owners to determine the proper PDS that will help to effectively organize stakeholders in the project tasks and carry out a project within a definite time frame. The paper also aims at providing additional evidence to the raging

debate on PDS vis-à-vis construction project efficiency through a case study of Ethiopia's public work contracts.

#### 4. The nexus between PDS and time overrun: review of literatures

When a public organ invests public funds to procure goods or services, the procurement rules prescribe value for money as a core principle. In procuring works, the same procurement principle applies which means that a government agency shall invest public funds in a way that ensures its efficient use (Proclamation number 649/2009, Art.5). Therefore it follows that, when a public organ procures works, it has to ahead of time determine the most efficient PDS which will make sure timely completion of the works as delayed completion has an obvious cost implication. In the following paragraphs, we will discuss the research findings incorporated in different published works on the nexus between project delivery systems and time overrun.

When we thoroughly examine existing works of literature on factors determining the efficiency of construction projects, most researchers often choose to follow a piecemeal approach of comparing micro determinants of construction project efficiency than giving attention to broad factors like mode of contracting within which other determinants of efficiency can be considered. For instance, [Sitwala and Jan \(2020\)](#), on their work on time and cost overruns on large projects in South Africa argued, lack of project-specific experience by the project team, external and organizational decisions in the past, community resistance, and pressure on the project team and scope change drive from stakeholders are the root causes of cost and time overrun of projects. [Johnson and Babu \(2018\)](#) in their research on time and cost overrun of the UAE construction industry on the other hand found out that design variation, unrealistic schedules, public agency's administrative delays, inaccurate time estimation by consultants, and client change orders are the top five causes of construction project delays. Other researchers such as [Maqsoom et al. \(2019\)](#) emphasize firm size and experience as causes of project time overrun. Some other researchers on the other hand consonant with this research paper take a deductive approach and underscore the nexus between modes of construction project procurement and time overrun in public work contracts.

[Whittington and Dowall \(2006–2009\)](#), researched "Transaction-Cost Economic Analysis of Institutional Change toward Design-Build Contracts for Public Transportation" in California. The research is a transaction-cost economic analysis of recently completed transportation projects, informing a comparative evaluation of the institutional change in public contracting from DBB to DB project delivery system. On its key findings, the research revealed that public construction projects are completed in a relatively short time duration when a DB contracting method is implemented but also concluded a project which takes a longer completion period does not necessarily cost much. This finding seems to ignore the loss of income incurred by the public agency when a project which should have been completed in time and put into its economic purpose (delayed yield), increase in the price of the work and complications with lenders, defective cash flow and loss of employer's goodwill ([Lukas, 2015](#)).

In another research, [Darren Hale et al. \(2009\)](#) compared the performance DB and DBB PDSs in terms of time and cost in the USA by taking a case study of similarly designed building projects. The research statistically compared project duration and project time growth and found out that DB projects were proven to be superior to DBB projects. Similarly, [Shretha et al. \(2018\)](#) conducted another research in the USA which compared the two PDSs in terms of time overrun and cost. The research employed data of 25 large highway projects representing over 6 billion USD capital expenditure. The statistical analysis which compared the delivery speed per lane mile of the high projects showed that DB projects outperformed DBB projects.

[Park et al. \(2015\)](#) also researched comparing project performance of the two PDSs in large size public apartment housing projects in

Korea. The research considered several efficiency factors for comparison. Concerning construction duration and construction duration growth, the finding of the research showed that DB projects' construction duration is shortened by 12 days per floor which significantly shortens the completion period of a project as compared to DBB projects.

On the other hand, [Abu Chakra and Ashi \(2019\)](#) compared the efficiency of the two PDSs in Lebanon in terms of seven performance indicators. The result of the research which compared the two project delivery system showed that DBB projects, especially public projects in the country have lower schedule growth because in this mode of project procurement professional team members of the client public organ are enrolled in the planning stage to define the scope of the work which helps the contractor to go into the job quickly with adequate prior knowledge of the expectation of the client.

[Kwan et al. \(2014\)](#) on the other hand conducted their research on understanding the sustainable outcome of project delivery methods in the built environment. Accordingly, to analyze the effectiveness of PDS, the researchers made a case analysis of two public work projects implemented under the same PDS in California. The finding from the case study revealed that the project outcomes varied significantly in terms of cost, schedule, scope compliance, quality, and stakeholders' expectations. The researchers asserted that applying an integrated project delivery method is not a substitute for a high-performance team; producing concise, clear, code compliance, and corrected set of construction drawings is a prerequisite for project success regardless of the project delivery system.

Generally speaking, even though the above-discussed works of literature generally favor DB in terms of ensuring time certainty than DBB, this evidence must be corroborated by primary data to assertively declare this mode of project delivery proves a comparative advantage of shortening project duration.

#### 5. Research method

Legal research is traditionally considered to be doctrinal. Doctrinal legal research (Research in Law) is concerned with the formulation of legal doctrines through the analysis of legal rules ([Chynoweth, 2008](#)). The existence of legal doctrines made it easier for practitioners in deciding which rule to apply in a particular situation. Legal Positivism portrayed the legal process as a routine application of laws to sets of facts as laws are described as a set of coherent rules, which are clear-cut, predictable or foreseeable, and readily available. Therefore, save for limited cases of bad judges, every reasonable judge will be able to apply them to the proper factual situations. As a result of this assumption, the law was perceived as an impermeable discipline, and legal research was conducted in the framework of pure legal doctrines ([Eli M. Salzberger, 2009](#)).

This traditional doctrinal legal research approach has been a subject of serious suspicion by other built environment researchers who struggled to recognize its outputs as a credible research contribution as it does refer to methodological approach common to other fields of studies ([Chynoweth 2008](#)). In many academic legal publications, research design and accounts of methods used are not discussed in detail and usually, validity issues are ignored altogether ([Langbroek et al., 2017](#)). This emanates from the normative nature of legal rules which are meant to dictate how individuals ought to behave rather than attempting to either explain or predict or even to understand human behavior which requires the collection and analysis of empirical data which is the norm in social and natural sciences ([Jain 1975](#)). Lately, however, parallel to doctrinal legal research, researchers of the discipline are employing a non-doctrinal research method that employs methods taken from other disciplines to either qualitatively or quantitatively investigate about the law ([Ibrahim et al., 2017](#)).

This research combines doctrinal and non-doctrinal legal research. Through doctrinal research, different Ethiopian construction laws

applicable to public work contracts have been analyzed and the kind(s) of project delivery system(s) incorporated in the laws are explored. The legal documents which are the subject of doctrinal analysis include [The Civil Code of the Empire of Ethiopia Proc. No. 165/1960](#), [The Commercial Code of the Empire of Ethiopia Proc. No. 166/1960](#), [Ethiopian Building Proclamation No. 624/2009](#); [Ethiopian Building Regulations No.243/2011](#), [The Ethiopian Federal Government Procurement and Property Administration Proc.No.686/2010](#), [Commercial Registration, and Business Licensing Proc. No. 980/2016](#), and the 2011 PPA (Public Procurement Agency) Conditions of Contract for Works; issued by Federal Government Property Administration and Public Procurement Agency.

Besides, a semi-structured questionnaire was prepared to assess the perception of construction professionals on the nexus between PDS and time overrun. The quantitative data obtained by questionnaire survey was computed by using Software Package for Social Sciences (SPSS) to rank the two PDSs based on their Relative Importance Index (RII). Moreover, to further substantiate the result obtained from the questionnaire survey, a case study of 40 randomly selected road and 9 building projects was made to derive a credible research finding by triangulating results obtained from these sources.

## 6. The result from doctrinal analysis of Ethiopian laws

The construction industry in Ethiopia is regulated by various legislative enactments which can be categorized into two domains; namely, civil construction laws, and public construction laws ([Hagos 2009](#)). Civil construction laws apply where a person (either natural or artificial) often named the client enters into a construction contract with a contractor, while the latter involves a public department that intends to have a construction work carried out on behalf of the public for the public interest ([Hagos 2009](#)). The civil code of the empire of Ethiopia 1960, under Article 3244 (1) defines a contract of public works as "... a contract whereby a person, the contractor binds himself in favor of an administrative authority to construct, maintain or repair a public work in consideration of a price". The civil code, however, does not further explain what is meant by "public works". However, the [Ethiopian Federal Public Procurement and Property Administration Proc. No. 649/2009](#) under article 2 (3) defines works as:-

*"...all work associated with the construction, reconstruction, upgrading demolition, repair or renovation of a building, road, or structure, as well as services incidental to works, if the value of those services does not exceed that of the works themselves and includes build-own-operate, build-own-operate-transfer, and build-operate-transfer contracts"*.

The cumulative reading of the definition of public works in the provisions of the Civil Code and the Public Procurement and Property Administration Proclamation splits up the work aspect of construction from its service aspect (which refers to design). The phrase which states "...services incidental to work..." plainly asserts that the provision delineates a service contract from a contract of work. Therefore, the contractor in public work contracts is under obligation to undertake what has been defined as works excluding design (save for minor design works which the contractor needs to incidentally undertake in the course of executing the work). The design aspect of the project shall be a subject of a separate contract of intellectual service which the public entity concludes with separate parties who are called architects or designers ([Ethiopian Civil Code 1960, Art. 2632 ff](#)). Designing might have a very broad meaning but it refers to the preparation of design drawings, design details, specifications, bills of quantity, and design calculations or the determination of a particular method of doing a construction work ([Construction Design and Management Regulations' 2015](#)). Therefore, as per the provisions of the civil code on public work contracts, the responsibility of the contractor is to execute the construction work as per the design drawings, details, and specifications furnished to him by the employer.

Another crucial legislation that has to be referred to is Federal Public Procurement and Property Administration Proc. No. 649/2009. In the earlier paragraphs, we have stated the definition of "works" as enshrined in the proclamation. The proclamation separately defines "consultancy service" under Art. 2(d) as "...a service of an intellectual and advisory nature provided by the consultants using their professional skills to study, design and organize specific projects, advise clients, conduct training and transfer knowledge". From the reading of these two definitional provisions, it is possible to state that, the proclamation was promulgated with the assumption that a public work contract for the design of the project and construction of the same need to be separately concluded. Even though the proclamation under Art. 2(c) incidentally hints at the possibility of adopting Build Own Operate (BOO) and Build Own Operate Transfer (BOOT) forms of PDS, it is plausible to argue that the general essence of the proclamation is meant to set up DBB as a default mode of contracting in public work contracts. However, as BOO and BOOT are variations to the DB project delivery system, it is possible to argue that their implied recognition as an alternative mode of contracting by the proclamation is equal to an implied recognition of DB as an additional procurement route for public work contracts in Ethiopia.

Other relevant legal regimes that need to cumulatively be studied on PDS are; the [Commercial Registration and Business Licensing Proc. No. 980/2016](#), Definition of Powers and Duties of the Executive Organs of the Federal Democratic Republic of Ethiopia Proc. No. 916/2015 and [Ethiopian Building Pro. No. 624/2009](#). As per the provisions of [Commercial Registration and Business Licensing Proc. No. 980/2016](#), before issuing a business license, the applicant must satisfy the requirements of professional competence and get a certificate of professional competence from the relevant government office (Arts. 2(30), 4(10), 42). In construction works, the relevant authority which testifies professional competence and offers a certificate of professional competence is the Ministry of Construction (Proc. No. 916/2015, Art. 27 (1) (d)). Concurrent with the above-mentioned legal regimes, [Ethiopian Building Pro. No. 624/2009](#) establishes that the licensing and registration for design or consultancy and construction are separate. Art. 2 (4) employs the term "registered professional" to designate a natural or juridical person who is issued with a certificate as a design or construction professional or construction consultant by the relevant body (Ministry of Construction), while it uses the term "registered contractor" to refer to a juridical person who is registered and issued with a work permit by the Ministry of Construction as a contractor ([Ethiopian Building Pro. No. 624/2009](#), Art. 2 (4&5)). Therefore, it is possible to conclude that, the above-mentioned legal regimes seem to have been crafted to establish DBB as for the default public works procurement system. The laws do not establish a system of licensing and registering a construction professional or firm both as a designer and consultant, and contractor at the same time.

When it comes to standard conditions of contracts used for public contracts in Ethiopia, we find the Standard Conditions of Contracts prepared by the Federal Public Procurement and Property Administration Agency (PPA) which is legally mandated to regulate federal public procurements under the provisions of [The Ethiopian Federal Government Procurement and Property Administration Pro. No. 649/2009](#). The PPA Standard Conditions of Contracts for the Procurement of Works 2011 and the accompanying standard bid documents are used for non-complex works by Federal Government organs save for instances where the project fund is obtained through bilateral or multilateral agreements in which case foreign donors may require the use of their bidding documents ([Ketema 2014](#)). The PPA Standard Condition of Contract is applicable only for DBB projects implemented by government agencies. Even though the DB method of procurement is being implemented in many government projects such as complex high-story non-residential buildings, hydropower, rail, and highway projects, the country has not yet adopted a locally developed standard condition of contract to be used for this procurement route. This fact transpires that the construction industry and its regulatory regimes are highly influenced by the DBB form of project procurement.



### 7. Result of the questionnaire survey

As shown earlier, the researchers distributed 250 semi-structured questionnaires to different professionals of civil engineering background out of which, 239 were recollected. However, 81 of the questionnaires were rejected most importantly because part of the respondents did not prove practical experience in both modes of contracting while the others gave inconsistent responses to several of the related questions. Finally, 158 questionnaires were sorted out for analysis and the results of the questionnaire survey are presented here below.

As shown in Table 1 above, the background information of participants of the survey questionnaire is described in terms of their academic level, work experience, and professional qualification. Based on academic level, greater numbers of the respondents are first degree (BSc) graduates (63.4) while the least number of professionals are diploma holders (1.8%). Based on years of professional experience, substantial numbers of the respondents (more than 86%) have more than 5 years of professional experience while the remaining percentage represents respondents who have less than 5 years of experience. Based on their professional qualification, the respondents are office engineers, site engineers, project managers, designers and consultants, client project engineers, lawyers and so on. Out of these professionals, designers and consultants represent the highest percentage (43.7%) while client project engineers, lawyers and other professionals constitute the least percentage (3.5%). The research participants who completed the questionnaires are self-employed professionals and employees of government agencies and private construction firms. The institutions include but not limited to, Ethiopian Road Authority, Commercial Bank of Ethiopia, etho telecom, Jimma University, Ethiopian Construction Design and Supervision Corks Corporation, Ethiopian Construction Works Corporation, Ministry of Construction, Zemen Bank, Hibert Bank, Metaferia Consulting Engineers Private Limited Company (PLC), Civil Works Consulting Engineers PLC, DANA & Associates Engineering Consultants PLC, Net Consult Consulting Engineers and Architects P.L.C, LIDET Consulting Engineers PLC, Afro-Tsiyon Construction PLC, Geom Luigi Varnero Construction Share Company and so on.

#### 7.1. Nexus between PDS and construction project time overrun

Respondents were generally asked if a particular PDS can be considered as a determinant factor of construction project efficiency in terms of time. They are instructed to give an affirmative or negative response or to state "I am not sure" if they are not well aware of the matter. Accordingly, the data shows, while 88% of the respondents answered in the affirmative, the remaining 12% answered in the negative. Respondents who gave negative responses were asked to state factors which in their opinion have significant relation with construction

project time overrun. Their response identified three factors; capacity of the contractor (financial, material, and human resource), proficiency of the supervision team, and specific characteristics (properties) of a project.

Following the above general responses, participants of the research were also asked to compare the two PDSs in terms of their relation with construction project time overrun. The comparison was done by asking the respondents to scale the two PDSs from 1 to 5 where 1 represents no relation (nexus), 2 represents negligible relation (nexus), 3 represents a marginal relation (nexus) while 4 and 5 respectively represent moderate and major relation (nexus).

The data analysis on the nexus between each of the project delivery systems to time overrun was done by SPSS for computing Relative Importance Index (RII) where the scores assigned to the two PDSs by the respondents were entered and hence the responses from the 158 questionnaires were subjected to statistical inquiry for further interpretation. The contribution of each of the PDS to overall time overrun was examined and the ranking of the PDSs in terms of their nexus with project delay as perceived by the respondents was computed using the equation below and the results of the analysis are presented in Table 2 and Table 3.

$$RII = \frac{\sum W}{A \times N} \quad (0 \leq RII \leq 1)$$

Where

W = Weight given to each factor by the respondent on a scale of 1–5 with one implying the least and five the highest.

A = Highest weight (i.e., 5 in this case)

N = the total number of respondents

Table 2 presents the RII result by classifying the participants of the questionnaire survey into their respective years of professional experience in the construction industry while Table two is the aggregate RII result without diluting the research participants into their professional experience. We opted to do so to reduce the risk of reaching a biased conclusion as the participants' response on the nexus between a particular PDS and project delay may differ depending on their practical experience in these two PDSs.

Under Table 2, the research participants whose work experience is less than 5 years ranked DB first and DBB second with RII = 0.472727 and RII = 0.445455 respectively. Participants of the research with 5–10 years of work experience ranked DBB first and DB second with RII = 0.981481 and RII = 0.359259 respectively. Respondents with job experience between 10 to 15 years also ranked DBB first and DB second with RII = 0.973684 and RII = 0.478947 respectively. The last category of participants whose work experience is over 15 years ranked DBB first and DB second with RII = 0.922727 and RII = 0.713636 respectively. Under

Table 1. Population characteristics.

SN	Respondent's Demography	Qualifications	# of Respondents	Percentage
1	Based on an academic level	Diploma	3	1.8%
		First degree (BSc)	100	63.4%
		Second Degree (MSc)	55	34.6%
		Third Degree (Ph.D.)	None	None
2	Based on years of work experience	0–5 years	22	13.79
		5–10 years	54	34.18%
		10–15 years	39	24.45%
		Over 15 years	43	27.58%
3	Based on professional qualification	Office Engineers	33	20.8%
		Site Engineers	19	11.6%
		Project Managers	34	21.3%
		Designers and consultants	69	43.7%
		Client project Engineers and others	6	3.5%

**Table 2.** RII computed based on the response of participant's with different years of work experience.

Experience	PDS	Number of Response					#of Respondents	RII	Rank
		Very low	Low	Medium	High	Very high			
Below 5 years	DBB	4	5	8	5	0	22	0.445455	2
	DB	0	5	11	6	0	22	0.472727	1
5–10 years	DBB	0	0	11	25	18	54	0.981481	1
	DB	10	36	5	0	3	54	0.359259	2
10–15 years	DBB	0	0	9	20	9	38	0.973684	1
	DB	3	23	6	6	0	38	0.478947	2
More than 15 years	DBB	3	3	8	22	8	44	0.922727	1
	DB	6	14	5	14	5	44	0.713636	2

**Table 3.** The aggregate RII.

PDS	Number of Response					#of Respondents	RII	Rank
	Very low	Low	Medium	High	Very high			
DBB	7	8	36	72	35	158	0.888608	1
DB	19	78	27	26	8	158	0.502532	2

Table 3 the rank shows DBB first and DB second with RII = 0.888608 and RII = 0.502532 respectively.

Therefore, as we can see from the overall relative importance index from the different categories of respondents, except for those respondents with the lowest year of experience, the rest determined that DBB is significantly related to construction project delay. For those respondents whose job experience is the lowest, even though the RII difference between the two PDSs is very marginal, they believed that DB is more prone to time overrun than DBB. Even though our basic aim in this research is only to show the relative contribution of the two modes of contracting to construction time overrun based on their RII, it would also be more helpful to make meaning out of these decimals and what they mean in terms of their importance level (significance value). According to Akadiri (2011), five importance levels are transformed from RII values: high (H) ( $0.8 \leq RI \leq 1$ ), high medium (H-M) ( $0.6 \leq RI \leq 0.8$ ), medium (M) ( $0.4 \leq RI \leq 0.6$ ), medium-low (M-L) ( $0.2 \leq RI \leq 0.4$ ) and low (L) ( $0 \leq RI \leq 0.2$ ). Accordingly, the RI indices computed based on the response of the participants with the lowest years of experience fall within the medium-low range for both modes of contracting. On the other hand, the RI indices of DBB as per the perception of all other respondents fall within the high range category which transpires that the DBB mode of contracting is highly prone to time overrun as compared to DB. But this does not mean that the DB mode of contracting perfectly ensures timely completion of a construction project. The response of the most senior research participants shows that the nexus between DB and time overrun falls under the medium-high range with RII = 0.713636. The aggregate RII of DB presented under Table 3 also is equal to 0.502532 and falls within the medium range and that of DBB is equal to 0.888608 which falls within a high significance range.

Generally, the result presented above reveals that while the response of research participants having more than five years of professional experience consistently favor DB as a more time-efficient mode of contracting, the response of the least experienced respondents on the other hand with a marginal difference in RII value favors DBB instead of DB. On the other hand, even though those participants with more than 15 years of professional experience generally agree on the fact that DBB is less time-efficient as compared to DB, their perception of DB as an innovative mode of contracting is not as strong as the second and the third group of professionals. Therefore, it is possible to conclude that the result of the questionnaire survey strengthens the finding of previous researches analyzed in the literature review. However, we still need to support this finding with additional evidence from case studies to make the finding

more credible. In the following part of the paper, we will examine the time overrun of different public projects undertaken in the two delivery modes.

## 8. The result from road projects data

The road projects which are made part of this study are randomly selected and an attempt has been made to include data from North, South, East, West, and Central regions construction projects management directorates of Ethiopian Road Authority. The data constitutes the information of completed and ongoing road projects. The ongoing projects are further classified into those the contract period of which (either original or revised) have expired and projects whose original period of completion is yet to expire.

Table 4 revealed that out of the sixteen DBB road projects, only one was completed within the original contract period. The remaining projects which represent 93.75% were delayed. Besides, except for three of the projects, the remaining 13 projects on average required a 60% extension of time (EOT). The scenario is not different when we examine projects whose original period of completion extends till 2020 as summarized in the following table.

Table 5 summarizes the status of nine DBB road projects with the original contract period extending to 2020. On average, 74.88% of the contract period of the projects has already lapsed but the average project status of the road projects is limited only to 51% which makes the average slippage of the schedule of the projects to be 23.88%. Therefore, it is possible to conclude that, except for the project mentioned in numbers 4 and 5 which only suffer from 2.14% and 1.71% of slippage in schedule respectively, it is inevitable that the remaining projects will substantially be delayed.

Table 6 presents the status of 15 DB road projects within the original contract period and percentage EOT. Out of the 15 projects, while 5 projects (33.33%) are on time, 9 projects representing 60% were not completed within the original contract period. The remaining one project has a contract duration up to 2020 but, this project suffers a 25.45% slippage of schedule which explains that delay of the project is almost inevitable. Besides, out of the 15 sample DB road projects, seven of them (46.6%) did not require an extension of time while the remaining projects on average required more than 72% extension of time.

Construction projects often face delays and based on the nature of the cause of delay, contractors will be granted EOT unless the parties fixed inflexible completion date in their contract which is a rare circumstance

**Table 4.** DBB road projects contract duration and project status in percentage.

No	Project Name	Initial Contract period	Completion (Yes/No)	Revised contract Period	EOT in %
1	Ageremariam – Yabelo	May 2011 to 10 May 2014	No	May 2011 to Nov. 2015	52.05%
2	Aposto-Wondo-Negele	Apr. 2009 to Apr.2012	No	Apr.2009 to Jun. 2014	85.84%
3	Arbaminch-Kemba-Sawla contract I	April. 2010 to Apr.2013	No	April. 2010 to Aug. 2016	110.95%
4	Arbaminch-Kemba-Sawla Lot II	Sep. 2011 to sep.2014	No	Sep. 2011 to July, 2017	94.52%
5	Arbereketi-Gelemso	May 2015 to May 2018	No	May 2015 to May 2019	33.33%
6	Ayra - Chanka	Jul. 2011 to Apr. 2014	No	Oct. 2011 to Dec. 2015	68.24%
7	Chanka- Dembidolo	Jul. 2011 to Apr. 2014	No	Oct. 2011 to Feb.2016	72.52%
8	Dansha-Abderafi- Maikadra	Dec. 2013 - Dec 2016	Yes	No changes	—
9	GedoBako-Nekemte	Jan. 2010 to Jan. 2014	No	Jan. 2010 to Jun. 2014	35.7%
10	Gelemso-Mechara-Micheta	Nov. 2015 to Nov. 2018	No	Nov. 2015 to Feb. 2019	8.21%
11	Kong – Begondi – Wombera	Jan. 2013 to Jan. 2016	No	Jan. 2013 to May 2019	110.95%
12	Mekenajo-Ayra	Jul. 2011 to Apr. 2014	No	Oct. 2011 to Jun. 2015	46.15%
13	Otolo-Sawla lot III	Sep. 2011 to Sep. 2014	No	Sep. 2011 to Nov.2016	72.14%
14	Sawla-Kako	Sep. 2011 to Mar. 2014	No	Sep.2011 to Sep.2014	19.78%
15	Sembo – Sholagebeya – Gorfo – Gindeber	Jan. 2010 to May 2013	No	Jan. 2010 to May 2016	100%
16	ShambuBako	Jul. 2016 to Jul. 2019	No	No changes	—

**Table 5.** Status of DBB road projects with original contract period extending to 2020.

No	Project Name	Original Completion Date	Project Status till the end of Jul. 2019	Lapsed contract period in %	Slippage of work
1	Afdera-Irebtu Junction-Ertale Junction-Ahmed Ela	May 2017 to May 2020	29.15%	72.15%	43%
2	Babile - Fik Lot I	May 2017 to May 2020	43.68%	74.34%	31%
3	Babile - Fik: Lot III	May 2017 to May 2020	52.78 %	72.4%	20%
4	Babile - Fik: Lot IV	May 30, 2017 May 2020	70.28%	72.14%	2.14%
5	Babile-Fik, Lot II	May 2017 to May 2020	43.68 %	72.4%	31 %
6	Chereti- Hagermekor	Apr. 2017 to Apr. 25, 2020	67.69%	73.97%	6.28%
7	Ertale Junction – Ahmeela	May 2017 to May 2021	34.12%	77.62%	43.12%
8	Fik-Hamero-Imi	May 2017 to May 2020	61.69%	72.95%	11.26%
9	Jigjiga-Gelelesh-Degahamedo-Segeg Con.1	May 2017 to May 2020	73.18%	74.89%	1.71%

**Table 6.** DB road projects contract duration and project status in percentage.

No	Project Name	Initial Contract period	Completion (Yes/No)	Revised Contract Period	EOT in %
1	Dallol-MusliBada	Jan.2016 to Jan.2019	No	No revision	—
2	Dejen-Felegebirhan	Aug. 2011 to Feb. 2015	No	Aug.2011 to Apr. 2018	90.03%
3	DichotoGalafi Junction – Elidar - Belho	Oct. 2015 to Jan. 2019	No	Oct. 2015 to Jul. 2019	15.29%
4	Dire Dawa – Dewelle	Oct. 2014 to Sep. 2017	No	Oct. 2014 to Nov. 2018	37.53%
5	F6 Junction – F4 Junction	Dec.2014 to Dec. 2017	On-time	No changes	—
6	Fendika-Ayma	Dec. 2012 to Jun. 2015	No	Dec. 2012 to Jun 2017	78.97%
7	Hargele-Dolobay-Dolo Odo	Sep. 2011 to Aug. 2013	22% ahead of time	No Changes	—
8	Jinka – Medir	Feb. 2016 to Feb.2018	No	Feb.2016 to Nov 2019	91.66%
9	Koka-Adulala- Debrezeit	Mar. 2015 to Mar. 2017	No	Oct. 2014 to Nov. 2018	29.31
10	May Tsebri-Dima – FiyelWuha-Abi Adi	Jun. 2014 to Jun. 2017	Ahead of Schedule	No changes	—
11	Moricho – Dimtu – Bitena – Sodo	Dec.2014 to Jun. 2017	No	Mar. 2015 – Jan. 2018	18.72%
12	Moricho- Dimtu-Bitena- Sodo	Dec. 2014to Aug. 2018	On time	No changes	—
13	Omo-F6 junction	Dec. 2014 to Dec 2017	Yes	No changes	—
14	Robe-Gassera	Nov. 2017 to Oct. 2020	25.45 slippage	No revision	—
15	Sawla-Maji	Aug. 2011to Aug.2014	No	Aug. 2011 to Jan. 2018	144%

**Table 7.** DBB projects status after EOT, time overrun, and/or slippage of work.

No	Project Name	Revised Contract Period	Date when the report was made	Project status at/after EOT	Time overrun after EOT	Slippage of work
1	Ageremariam – Yabelo	May 2011 to Nov. 2015	Oct. 2017	100%	6.28%	0%
2	Aposto-Wondo-Negele Con.1	Apr.2009 to Jun. 2014	Jun.2015	98.74%	8.10%	1.26
3	Arbaminch-Kemba-Sawla contract I	April.2010 to Aug. 2016	Jun. 2019	94.91%	47.23%	5.09%
4	Arbaminch-Kemba-Sawla Lot II	Sep. 2011 to July 2017	June 2017	90.10	0%	9.84%
5	Arbereketi-Gelemso	May 2015 to May 2019	Jul. 2019	66.23 %	4.45%	33.77
6	Ayra – Chanka	Jul.2011 to Dec. 2015	May 2017	100%	0%	0%
7	Chanka- Dembidolo	Jul.2011to Oct.2015	Oct. 2016	100%	17.19%	0%
8	Dansha - Abderafi – Maikadra	Dec. 2013 -Dec 2016	Apr. 2018	100%	0%	0%
9	GedoBako-Nekemte Con.2	Jan. 2010 to Jun. 2014	Aug.2014	99.4%	0%	0.6%
10	Gelemso-Mechara-Micheta	Nov. 2015 to Feb. 2019	Jul.2019	56.53%	12.65%	43.47
11	Kong – Begondi – Wombera	Jan. 2013 to May 2019	Jul. 2019	82%	2.6%	18%
12	Mekenajo-Ayra	Jul. 2011 to Dec. 2015	Jan.2016	100%	6.76%	0%
13	Otolo-Sawla lot III	Sep. 2011 to Nov.2016	Apr. 2017	98.31	7.95%	1.61
14	Sawla-Kako	Sep.2011 to Nov. 2014	Jan. 2016	89.84%	44.75%	10.16
15	Sembo – Sholagebeya – Gorfo – Gindeber	Jan. 2010 to May 2016	Dec. 2018	94.63%	40.78%	5.5%
16	Shambu- Bako	Jul. 2016 to Jul. 2019	Jul. 2019	84.33%	0%	16%

given the very nature of construction. However, a repetitive request by the contractor for EOT and failure to complete the project even after the expiry of the extension is a symptom of unhealthy project execution and management. The result shown in the following tables is a typical reflection of the same.

Table 7 presents the status of the sixteen DBB projects after the expiry of EOT and the time overrun till and after EOT and/or slippage of work. As it was shown previously under Table 3, the sixteen projects on average required 60% EOT, however, ten (62.5%)out of the sixteen projects were not completed even after the expiry of the extended contract duration. Besides, we can see that out of the sixteen DBB projects only three of them (18.75%) are completed within the extended contract period. The remaining projects which represent 81.25% on average have 22.37% of time overrun and 21.73% slippage of work.

When it comes to DB projects, Table 8 presents the data concerning the status of the projects' time overrun and/or slippage of work after the expiry of EOT.

A look at the figures in the table explains that many of the projects are substantially completed at or before the expiry of the extended schedule. As we have shown earlier under Table 5, EOT was not given for seven of the projects. The table further shows, five projects (33.33%) are

completed and yet the other four projects (26.66%) are also substantially completed on time only with an average of 1.54% of minimums remaining works. The remaining projects on average have 11.96% time overrun and 31.2% of slippage of work.

## 9. The result from building projects data

So far, we have shown results obtained from questionnaire surveys and road projects the result consistently shows that DB offers better efficiency in terms of timely completion of public work projects. In the next part of the paper, corroboratory evidence shall be presented from public building projects examined in this work.

Table 9 shows the status of the seven DBB building projects within the original contract period and the extension of time in percentage. According to the data, none of the projects were completed within the original contract period which forced the client to allow an extension of the contract period. The maximum period of extension granted was 228.25% while the minimum was 30%. On average, every project was granted an EOT of 129.12%.

As we can see from Table 10, except for the project mentioned under number four, the extended contract period of which did not expire at the

**Table 8.** DB projects status of after EOT, time overrun, and/or slippage of work.

No	Project Name	Revised Contract Period	Date when the report was made	Project status at the date of the report	Time overrun After EOT	Slippage of work
1	Dallol-MusliBada	Jan.2016 to Jan.2019	Jul. 2019	86.14	16.43%	13%
2	Dejen-Felegebirhan	Aug.2011 to Apr. 2018	Sep. 2018	94.6	7.5	5.4%
3	DichotoGalafi Junction - Elidar – Belho	Oct. 2015 to Jul. 2019	Jul. 2019	90.7%	0%	9.3%
4	Dire Dawa – Dewell	Oct. 2014 to Nov. 2018	Feb. 2019	97.38%	0%	2.62%
5	F6 Junction – F4 Junction	Dec.2014 to Dec. 2017	Nov. 2017	98.32	0%	0%
6	Fendika-Ayma	Dec. 2012 to Jun 2017	Jan 2018	100%	0%	0%
7	Hargele-Dolobay-DoloOdo	Sep. 2011 to Dec.2012	May 2016	100%	0%	0%
8	Jinka – Medir	Feb.2016 to Nov 2019	Jul. 2019	43%	0%	57%
9	Koka-Adulala- Debrezeit	Oct. 2014 to Nov. 2018	May 2018	99.53%	0%	0.47%
10	May Tsebri-Dima - FiyelWuha-AbiAdi	Jun. 2014 to Jun. 2017	May 2017	97%	0%	0%
11	Moricho – Dimtu – Bitena – Sodo	Mar. 2015 – Jan. 2018	Aug. 2018	99.27%	0%	0.83%
12	Moricho- Dimtu- Bitena- Sodo	Dec. 2014to Aug. 2018	Nov. 2018	99.7%	0%	0.83%
13	Omo-F6 junction	Dec. 2014 to Dec 2017	Nov. 2017	99.6%	0%	0%
14	Robe-Gassera	Nov. 2017 to Oct. 2020	Jul. 2019	32.81%	–	25.45%
15	Sawla-Maji	Aug. 2011 to Jan. 2018	Dec. 2018	89.66%	0%	10.34%



**Table 9.** Project status of DBB public building projects within the original contract period.

No	Project Name	Initial Contract period	Completed or not (yes/no)	Revised Contract period	EOT in %
1	Research Center and Conference Hall (main contract)	May 2010 to Dec. 2011	No	May 2010 to Jan. 2013	71.60%
2	Research Center and Conference Hall (supplementary contract)	Aug. 2016 to Feb. 2017	No	Aug. 2016 to Apr. 2017	30.52%
3	Hospitality and Tourism Institute	Dec. 2015 to Aug. 2017	No	Dec. 2015 to Jul. 2019	112%
4	Head Quarter Building	Oct. 2015 to Oct. 2017	No	Oct. 2015 to Oct. 2019	109%
5	Sports Courts Project	Jun. 2015 to Mar. 2016	No	Jun. 2015 to Feb. 2018	270%
6	Student canteen project	Jul. 2014 to Aug. 2015	No	Jul. 2014 to Jun. 2017	228.25%
7	Teaching and referral hospital	Aug. 2014 to Aug. 2016	No	Aug. 2014 to Jan. 2019	120%

time the data was collected, the remaining projects' extended contract period has expired but the projects were not completed. Especially project number 3 suffers a serious backlog of works as it was only 29% complete at the expiry of the revised contract period. The table also presents the time overrun and/or slippage of work of the projects. The longest time overrun (after the revised contract period) in percentage is 176.61% while the shortest is 2.11%. Therefore, on average, the projects were 89.36% late even after the revised contract period. To make the situation worse, except for two of the projects which are completed with 106.13% and 176.61% respective time overrun, the remaining projects still are left with outstanding works to be completed.

DB as a project delivery system in the road and building projects is a recent introduction in Ethiopia. Even though this PDS now is being vastly used in road projects, its application in building works is very much limited to few public projects (including mega projects). As a result, the researchers were able to identify only two ongoing building projects which are being built under this form of PDS. In the following final part of the paper, we will present the data of two grand DB projects which are being carried on by two giant public agencies; the Commercial Bank of Ethiopia and ethio-telecom. These two government agencies are building new buildings that are to be used as headquarters of the agencies in the capital Addis Ababa. The Commercial Bank of Ethiopia's new headquarter building project is 48 stories high-rise office tower with two law-rise building volumes which are being built with an amount of over 298 million US dollars. The ethio telecom's new headquarter project is being built with a budget of over 215 million US Dollars.

Table 11 presents the project schedule and status of the two DB buildings. The CBE Headquarter project required a revision of the contract period as a result of a supplementary agreement that modified the initial approved design of the project. Design variation resulted in additional work to the contractor who demanded the revision of the initial contract period. At the time when the report was collected, the total project time elapsed was 87.5 % while the project status was 89.73% which means that, the project was slightly ahead of schedule. When it comes to the new headquarter project of ethio telecom, the

contractor was not granted an additional contract period till the date this report was collected. The total time elapsed at the last date the project report was made was 75.34% while the project status was 73%. This shows that this project has a slight slippage of work at the time.

These two projects are among the most complex and intensive public projects which are being carried out by two public agencies of the government of Ethiopia. The projects compared with the previously discussed seven projects are much bigger in terms of size, complexity, and budget. However, it is found out that, they are being executed in a much better time efficiency than the DBB projects discussed earlier.

## 10. Discussion of the findings

If a project is not completed for whatever reason within the contract duration, we can say that there is a project time overrun/delay. As it was shown in the result section, some participants of the research linked time overrun basically with the capacity of the contractors. It can be assumed that a contractor's capacity might influence the timely execution of a project. However, when we see the contractors who are engaged in all road and building projects which are made case studies of this research, they are all licensed as Grade 1 (G1) contractors. Therefore, setting aside the practical difference in the capacity of the construction firms when they are compared to each other, legally speaking all G1 contractors are assumed to possess the minimum capacity to undertake these projects efficiently. Besides, it is also argued that foreign contractors have better capital, material, and human resource capacity than local contractors. A closer investigation of the project reports to some degree reveals that foreign construction companies have proven relatively better efficiency in terms of finalizing projects within the contract time. Nevertheless, the data also shows that many projects in which foreign construction firms are engaged have the same problem of time inefficiency while some projects which are undertaken by local contractors on the other hand are time efficient. That is one of the reasons which make the writers of this work start from the premise that factors like contractors' capacity, supply chain problems, inflation and the like cannot help in fully capturing the

**Table 10.** Project status after EOT, percentage of time overrun, and/or slippage of work.

No	Project Name	Revised Contract period	Date when the report was made	Project status at the date of the report	Time overrun After EOT	Slippage of work
1	Research Center and Conference Hall (main contract)	May 2010 to Jan. 2013	Nov. 2015	100%	106.13%	0%
2	Research Center and Conference Hall (supplementary contract)	Aug. 2016 to Apr. 2017	Jun. 2018	100%	176.61%	0%
3	Hospitality and Tourism Institute	Dec. 2015 to Jul. 2019	Jul. 2019	29.04%	2.11%	71%
4	Head Quarter Building	Oct. 2015 to Oct. 2019	Jul.2019	78.16%	0%	10%
5	Sports Courts Project	Jun. 2015 to Feb. 2018	Apr. 2019	111%	42%	Unknown
6	Student canteen project	Jul. 2014 to Jun. 2017	Jul.2019	95%	57.88%	5%
7	Teaching and referral hospital	Aug. 2014 to Jan. 2019	Oct. 2019	82.53%	20.41%	17.47%

**Table 11.** Contract time data of DB building projects.

No	Project Name	Original Contract period	Revised Contract period	Date when the report was made	Project status at the date of the report	Slippage of work
1	CBE Head Quarter	Jul. 2015-Jul. 2019	Jul.2015 to Jan. 2020	July 2019	89.72%	Ahead of time
2	ethio-telecom Headquarter	Aug.2016 to Nov. 2019	No revision	Feb. 2019	73%	2%

cause(s) of the inefficiency of the sector. Therefore, the researchers opted to emphasize and investigate the process and system-based challenges of the sector resulting from the existing legal frameworks governing the sector of which mode of contracting is one.

Accordingly, the literature review revealed that DB offers better efficiency in terms of timely completion of a project than DBB. Besides the RII of the two PDSs which was computed by SPSS based on a survey questionnaire of 158 respondents with different academic and professional experience further supports the result obtained from the literature review. The data from the selected case studies similarly confirmed that DB offers better time efficiency than DBB. The road project data showed that 81.25% of DBB projects on average have 22.37% of time overrun and 21.73% slippage of work calculated after the expiry of the revised contract period. The data on DB road projects on the other hand revealed that only 40% of the projects on average face 11.96% of time overrun and 31.2% slippage of work after the expiry of the revised contract period while the remaining DB projects constituting almost 60% are either fully or substantially completed within the original and revised contract period. This result was further strongly confirmed by the building projects data discussed under Tables 9, 10, and 11. Generally, the result consistently shows that Ethiopian public construction projects suffer time overrun both at the initial and revised contract periods irrespective of the mode of project delivery system, however, the magnitude of delay is greater in DBB than in DB mode of contracting. But what clicks our mind at this point is why the DBB route of contracting is less time-efficient than DB? Even though an attempt to provide a credible answer for this question demands further investigation, we would like to shed light on the possible common causes of project time overrun applicable to both modes of contracting and causes that are more frequent in DBB projects extracted from the project status reports examined in this research.

The most repeatedly mentioned causes of project delay in both routes of contracting are; adverse weather condition and other natural calamities like landslides and floods, late transfer of possession of project site, problems in removal of the right of way obstructions, public resistance especially in road projects in the eastern and western parts of the country, increase in the quantity of removal of unsuitable materials, increase in rock excavation, delay in the mobilization of resources, shortage of work crew, insufficient deployment of equipment, delay in thoroughly undertaking investigations for potential sources of construction materials, the volatility of the price of construction materials, shortage of construction materials and theft.

Some other factors of construction project delays are more frequent in the DBB mode of contracting if not exclusively applicable to it alone. They include but not limited to; overall design change or modification, late submission of design data by the employer or his representative, delay in approving design changes by the employer or his representative, variation orders which often are results of design modification, increasing the volume of work as a result of variation orders, the addition of supplementary contracts, late release by the public organ of interim payments, abandoning project sites claiming the work is substantially completed while the client alleges the existence of outstanding works, weak or reluctant supervision team, overlooking activities and lack of proper planning, lack of well-organized project management team, budget shortage and contractor's lack of technical and material capacity.

Therefore, it is possible to observe from the reports that, one of the glaring challenges to the timely completion of DBB projects is design-related problems which often are overlooked before the commencement of the projects. Since the design in the DBB route of contracting is

prepared by the employer or a third party, it would take time to make necessary modifications and pursue the project. Besides, design changes are very common in DBB projects after the commencement of work because of design errors or overlooked aspects of the design which often increase the volume of work. Likewise, since the customary mode of payment in DBB form of contract often is based on the quantity of work executed by the contractor (in several installments) as opposed to lump-sum payment which is the common form of payment in DB contracting, the lack of swiftness on the part of the public body to process and effect interim payments often forces the contractors to slow down the work. This is especially noticed from a thorough study of status and completion reports of public building projects discussed under Tables 9 and 10.

## 11. Conclusion

PDS is a legal and contractual issue succinctly regulated under the laws of different legal systems and local and international standard conditions of contracts. As every law is crafted to achieve one or more efficiency objectives, construction laws prescribing the application of a particular PDS also are driven by the same principle of efficiency. Laws are said to be efficient when their implementation results in achieving the goals that they are intended to (Tullock, 1980). The goals of the laws are fetched from the societal need for regulating a certain social, economic or political matter. Among other goals, the construction industry is meant to foster social and economic development through the execution of projects with a fixed period, budget, and required quality. The law prescribing a particular PDS has to therefore ensure these efficiency goals. Among the numerous PDSs applicable in the construction industry, this research examined DBB and DB PDSs intending to discuss their legal foundation and their nexus with construction project time overrun in public work contracts in Ethiopia.

The objective of the researchers was to triangulate the data obtained from different sources and provide evidence on the role of PDS in ensuring project efficiency. The triangulated shreds of evidence, therefore, prove that, in the context of Ethiopian public work projects, DB projects are found out to be more time-efficient than DBB projects. This conclusion, however, does not mean that the DBB is an inefficient mode of contracting and DB perfectly ensures efficiency. It is up to the client to determine which mode of contracting best suits the particular nature of its projects. Even though the DB form of contracting is now being implemented in the road and few mega projects, its implementation in public building projects in Ethiopia is very much limited. The writers of this research do not have the opinion that DB has to replace DBB in public work contracts, but we have the opinion that the very nature of DBB coupled with the inefficacy of public organs in managing construction projects takes part of the blame for the observed project inefficiency. Therefore, among other measures, modification of the laws of the country to incorporate different modes of contracting which can be chosen from based on the specific nature of every project and the development and gradual introduction to the system of standard conditions of contracts for public works that integrate the service and work aspect of the contract may help in mitigating the observed inefficiency.

As the final remark, even though this research is a case study of Ethiopia, the central theme that is covered by the research is yet an unsettled issue in construction law and management across different systems. The focus of mainstream researchers on the causes of construction project delay often involves factors that are related to the contractor, to the owner, to the contract, to the supply chain, and the like. These factors

have been a subject of intensive study but yet, construction project delay remains to be a prime challenge of the industry. System-related problems that are embedded in the laws which regulate the construction industry have not been satisfactorily dealt with in existing researches especially in the developing world where the construction sector is constrained by serious inefficiencies. We believe that this research shall provide an insight to developing country researchers to shift their focus and investigate and expose system-based challenges of the sector in their context. Besides, as the title of the research made clear, the work shall provide additional evidence to the existing knowledge on the relationship between project delivery systems and construction project time overrun.

## Declarations

### Author contribution statement

Sintayehu Demeke Kebede: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Tiewei Zhang: Conceived and designed the experiments; Wrote the paper.

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Data included in article/supplementary material/referenced in article.

### Declaration of interests statement

The authors declare no conflict of interest.

### Additional information

No additional information is available for this paper.

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## References

Abu Chakra, Hadi, Ashi, Amina, 2019. Comparative analysis of design-build and design bid build project delivery systems in Lebanon. *J. Indust. Eng. Int.* Available at <https://link.springer.com/article/10.1007%2Fs40092-019-00323-1> last visited Oct. 2019.

African Economic Outlook, 2017. Entrepreneurship and Industrialization. OACD Publishing, Paris. <https://doi.org/10.1787/aec-2017-en>.

Akadiri, O.P., 2011. Development of a Multi-Criteria Approach for the Selection of Sustainable Materials for Building Projects. PhD theses.

Berk, A., Bicen, S., 2017. Causality between the construction sector and GDP growth in emerging countries: the case of Turkey. *Athens J. Mediterranean Stud.* 4 (1), 19.

Chynoweth, P., 2008. Legal Research in the Built Environment: A Methodological Framework, 672. Research Institute for the Built and Human Environment, University of Salford.

Civil Code of the Empire of Ethiopia, 1960.

Commercial Registration and Business Licensing Proclamations' No. 980/2016

Darren, R., Hale, P.E., et al., 2009. Empirical comparison of design-build and design bid build project delivery methods. *J. Construct. Eng. Manag.* 579.

Designers: Roles and Responsibilities, Construction (Design and Management) Regulations, 2015. CDM 2015 available at. <http://www.hse.gov.uk/construction/cdm/2015/designers.htm>. last visited, Oct. 2019.

Ethiopian Building Proclamation No. 624/2009

Ethiopian Federal Government Procurement and Property Administration Proclamation' number 649/2009.

Hagos, Bahta T., 2009. Adjudication and arbitrability of public construction disputes. *Mizan Law Review* 1 3 (1).

Ibrahim, Ali S., et al., 2017. 'Legal research of doctrinal and non-doctrinal. *Int. J. Trend Res. Dev.* 4 (1), 494.

Jain, S.N., 1975. Doctrinal and non-doctrinal legal research. *J. Indian Law Inst.* 17 (4), 516.

Johnson, R.M., Babu, R.I.I., 2018. Time and cost overruns in the UAE construction industry: a critical analysis. *Int. J. Construct. Manag.*

Ketema, Keneissa, 2014. Salient Features of the PPA General Conditions of Contract for Works (unpublished).

Kwan, Fong C., et al., 2014. Understanding the Sustainable Outcome of Project Delivery Methods in the Built Environment. DOI1055/otmcj.2014.3.9 research paper, p. 1141.

Langbroek, P., et al., 2017. Methodology of legal research: challenges and opportunities. *Utrecht Law Review* 2 13 (3).

Levy, S.M., 2006. Design-Build Project Delivery: Managing the Building Process from Proposal through Construction. McGraw Hill professional.

Lukas, Klee, 2015. International Construction Contracts Law. JohnWiley & Sons, Ltd.

Maqsoom, A., Choudhry, R.M., Umer, M., Mehmood, T., 2019. Influencing factors indicating time delay in construction projects: impact of firm size and experience. *Int. J. Construct. Manag.*

Mearig, T., 2017. Project Delivery Method Handbook, second ed. state of Alaska Department of Education and Early Development, p. 32.

Moore, D., 2000. Selecting the best project delivery system. In: Paper Presented at Project Management Institute Annual Seminars & Symposium. Newtown Square, PA: Project Management Institute, Houston, TX available at. <https://www.pmi.org/learning/library/selecting-best-project-delivery-system-8910>. last accessed, Oct. 2019.

Pakkala, P., 2002. Innovative project delivery methods for infrastructure: an international perspective. *Finnish Road Enterprise* 11.

Park, Hye Sung, et al., 2015. Comparing project performances of design-build and design-bid-build methods for large size public apartment housing projects in Korea. *J. Asian Architect. Build Eng.* 14 (2), 327–328.

Salzberger, Eli M., 2009. The Economic Analysis of Law: the Dominant Methodology for Legal Research? Haifa Law review University of Haifa, p. 211.

Shretha, Parmen P., et al., 2018. Comparison between design build and design bid build transportation projects using lane mile data. In: Conference Paper, 7 available at. <https://www.researchgate.net/publication/324746169>> last visited. (Accessed October 2019).

Sitwala, S., Jan, W., 2020. Time and cost overruns on large projects: understanding the root cause. *J. Constr. Dev. Ctries. (JCDC)* 25 (1), 129–146.

Smith, et al., 2009. Common Sense Construction Law: A Practical Guide for Construction Professional', fourth ed.

Solomon, Desta S., 2015. The Management of Construction Processes in Developing Countries: A Case Study of Ethiopian Road Authority. Ph.D. thesis (unpublished).

Trauner Consulting Services, Inc., 2007. Construction Project Delivery Systems and Procurement Practices: Considerations, Alternatives, Advantages, and Disadvantages, p. 2. Available at. <https://pdf4pro.com/view/construction-project-delivery-systems-and-44e916.html>. last visited Nov.2019.

Tulloch, Gordon, 1980. Two kinds of legal efficiency' *Hofstra law review*, 8 (3), Article 8. Available at: <http://scholarlycommons.law.hofstra.edu/hlr/vol8/iss3/8>. last visited, Oct. 2019.

Whittington, J., Dowall, D., 2009. Transaction Cost Economic Analysis of Institutional Change toward Design-Build Contracts for Public Transportation. Institute of Urban and Regional Development University of California at Berkeley.

Wibishet, 2012. Procurement & contract delivery systems. In: National Workshop Magazine Organized by Ministry of Urban Development and Construction, pp. 2–13.