RESEARCH OF THE BEST TIMING FOR GOVERNMENT'S TERMINATION OF FREEWAY REPAIR WORK CONTRACT

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ABSTRACT: Normally, monetary penalties for breach of agreement will be stipulated in the contract. The contractor parties, who fail to fulfill the agreement, are required to pay the other parties a certain amount or proportion of money as a fine. However, it is worth our study - whether or not the scope of monetary penalty implementation and bases for determination of a fine will cover the losses of social and administrative costs incurred by the interruption of the contract. This research is about the best timing for government to cancel the freeway repair work contracts. Under the goal of the maximum social welfare, the limitation of government spending for the social and administrative costs invoked by interruption of contracts will have to be considered to attain the best timing of contracts' suspension or deferment. According to the factors of social and administrative costs, the best time point is calculated to reduce the loss of the aforesaid costs, which can also be used as theoretical basis for the future road-widening construction at home.

Key words：Bid, Highway, Time Cost, Contract

1. INTRODUCTION

1.1 Motives of research

In recent years, with the rapid economic growth, the rise of people's living standards, the increase of citizens' income and the growing ownership of vehicles, the highways have been overly burdened by increasingly heavy traffic. What's worse is that the overloaded big-size transportation vehicles have shortened the service life of the road surface. The damage to and the aging of the road surface become increasingly severe, for the use of roads in good condition, shorter cycle of road surface's repair work become inevitable.

During the repair work and the expansive construction, especially for the construction work on the freeways with heavy traffic, to keep the traffic moving at the same time, it is very often to reduce the width of vehicle lanes or close some of the lanes. The repair work and the expansive construction of public highways involve a broad range and are complicated, which would also consume great social and administrative costs. Because of the characteristics of highly professionalism, unique features, being easily affected by weather and environment plus the long working period and high risks, the implementation of construction contracts often contain uncertain factors.

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This research is about the best timing for government to cancel the freeway repair work contracts. Under the goal of the maximum social welfare, the limitation of government spending for the social and administrative costs invoked by interruption of contracts will have to be considered to attain the best timing of contracts' suspension or deferment. According to the factors of social and administrative costs, the best time point is calculated to reduce the loss of the aforesaid costs, which can also be used as theoretical basis for the future road-widening construction at home.

1.2 Research Objective

The purposes of the research can be summarized as below:

a. Build a predicting model for government's best timing to terminate freeway repair work contract. Serve as references for construction contractors to ensure the fulfillment of the contracts and avoid the

loss of social and administrative costs.

b. Establish a predicting model of the best timing for government to cancel freeway repair work contract. Provide the organizing authorities with references for contractors' contracts' implementation for the future road-widening projects and the best timing of contract termination.

1.3 Research Scope

This research explores the best timing of government's termination of freeway repair work contracts, further to set up a predicting model for the optimal timing of the contract cancellation leading to the saving of social and administrative costs. Also, this research can be used as theoretical basis for the future road-widening projects at home.

1.4 Research Methods

Methods of the research are as below:

a. Secondary data analysis:

The relevant important papers and literatures are collected for the study of unit time value, daily road user cost, social cost, administrative cost and the categories of construction contracts.

b. Through operation study to achieve the best solution

1.5 Research Flowchart

Flow of the research and steps are described as below:

1. On-site investigation and data collection and analysis: On-site inspection of freeway repair work and widening construction, collection of construction data and analysis of traffic flow.

2. Calculation of freeway's unit time value and the loss of social and administrative costs.

3. Build a mathematical model to predict government's best timing of termination of freeway repair work contracts.

2. LITERATURE REVIEW

2.1 Relevant literatures about contract implementation

In the course of contract implementation, "the Taiwan Governmental Purchase Law" serves as the highest guidelines. However the related rules set by the organizing authorities within their respective power should also be abided by. Should there be any disputes about the contract; the related rules must be abided by if there is any. If there are not any clear rules to follow in the contract, legal precedents or litigation should be considered. For an effective management of contract implementation, the contents that may provide direct help to the research are summarized as the below Table 1:

Table 1. Summary of contract-related literatures

Literature title	Author, year	Contents worth of reference
Research of the Public Construction Management Efficiency of Taipei City	Lee, De-zhong, 1989, National Taiwan Technology Institute	The conceptual analysis of public construction planning and policy-making theories and methods, budget progress and implementation efficiency evaluation
Handling of Public Construction Disputes Edition #2	Engineering Commission, Administrative Yuan, 1997	Conceptual explanation of dispute settlements process and dispute cases
The Related Laws and Practices of Public Construction Purchase Finance	Yo, Kuo-qin, Chinese Integrate Development Institute, 1998	Explanation of purchase practices and relevant regulations
Public Construction Law and Related Regulations	Lu, Rong-hai, Wei-Li Co., Ltd.,1998	Explanation of legal aspects of the contract fulfillment
Standard Work Regulations and General Rules	National Industry Bureau, 1998	Explanation of general related regulations
Study of Construction Disputes and the Resolution Modes	Public Construction Commission, Executive Yuan, 1997	Provide case examples for construction disputes and resolution modes worth of reference
Study of Construction Contract Termination and Cancellation	Huang, Shi-meng, Chen, Kung-cheng, Modern Construction Issue219 and 220, 1998	Explore the differences of contract termination and cancellation to achieve a clear concept
Law of Construction Personnel Contract and Practices	Wang, Buo-jien, Yong-Rang Culture Publishing Co., Ltd., 1998	Familiarize with the law of domestic construction contract, civil code and special administrative rules
The Management Mechanism of Contractors' Deferment of Public Construction Contract	Li, De-Chang, Public Construction Commission, Executive Yuan, 2001	Study and explanation of management mechanism for contractors' deferment of public construction
Study of the Handling Mechanism of Contractors' Deferment of Public	Liu, Chung-Yian, Taiwan Technology University, 2002	Introduction of the handling mechanism for the delay of public construction

Construction		
Governmental Purchase Law	Public Construction Commission, Executive Yuan, 2002	Conceptual explanation of governmental purchase law and the way to assess the discredited contractors

3. DELAY COST EVALUATION

3.1 Unit time value and daily road user cost:

Herbsman and Chen Wei-tong consider that the unit time value of construction refers to "the unit time deferment cost of contractors by delaying the construction [1]. Unit time value includes direct and indirect costs. Direct costs are inclusive of the temporary equipment, movement costs and substitute solutions; whereas indirect costs are composed of the work spending and general expenses. General expenses cover the potential interest loss and the difficulties encountered by contractors, which are the costs hard to be quantified. To the contractors of freeway repair work, the unit time value means "Daily Road User Cost, DRUC"[2,3,4]. As for the road construction, DRUC consists of travel time, travel distance, fuel consumption and so forth. For instance, in 1991, the transportation department in Kansas, the United States, conducted a study of the DRUC of a freeway as below[1]:

(a) Basic data of roads

- Yearly Average Daily Traffic (AADT): 20,000 cars/day
- AADT of trucks: 1,600 cars/day
- AADT of small passenger cars: 18,400 cars/day
- Cost of extra driving distance for a small passenger car: $0.22 dollars/mile/car ($0.14 dollars/km/car)
- Cost of extra driving distance for trucks: $0.71 dollars/mile/car ($0.44 dollars/km/car)
- Increased cost for truck driver's salary for extra driving distance: $10.50 dollars/hr/car
- Length of the roads sealed off for construction: 10 miles (16 km); speed limit: 55 miles/hr (88 km/hr)
- Length of the substitute roads: 21 miles (34 km) speed limit: 55 miles/hr (88 km/hr)
- There are two pause places for traffic control on each substitute road, one place with traffic light control

(b) Calculation of direct cost:

(1) calculation of the direct cost for small passenger cars

(21-10) miles x 18,400 cars/day x $0.22 dollars/mile/car = $44,528 dollars/day

(2) calculation of the direct cost for trucks

(21-10) miles x 1,600 cars/day x $0.71 dollars/mils/car = $12,496 dollars/day

(3) calculation of total direct cost

$44,528 dollars/day + $12,496 dollars/day = $57,024 dollars/day

(c) Calculation of cost for time discrepancies:

(1) Driving time for 10 miles at speed of 55 miles/hr = 0.1818 hr

(2) Driving time for 21 miles at speed of 55 mils/hr = 0.3812 hr

(3) 2 minutes' waiting time for traffic lights = 0.033 hr

(4) 2 minutes' waiting for traffic control + 2 minutes' delay for waiting = 0.066 hr

(5) time discrepancy = 0.3812hr + 0.033hr + 0.066hr – 0.1818hr = 0.2984 hr

(6) cost of time discrepancy = 0.2984hr x 1,600 cars/day x $10.50 dollars/hr/car

= $5,013.12 dollars/day

(d) Daily Road User Cost (DRUC):

DRUC = direct cost + time discrepancy cost

DRUC = $57,024 dollars/day + $5,013.12 dollars/day = $62,037.12 dollars/day

Although the calculation of Daily Road User Cost (DRUC) by the freeway bureau in many states in the Unite States has become a routine for years, there is still a lack of a standard calculation method for DRUC due to the involvement of lots of costs not possible to be quantified plus many direct and indirect costs not able to be taken into account. Take the damage of major freeway construction in California during the big earthquake for example, the calculation of DRUC by the transportation department of California was $2000,000 dollars/day (approx. NTD 6,400,000), a calculation result based only on direct costs [1].

3.2 The basic characteristics of vehicles

When using a macro view to describe the characteristics of the vehicles on the move, three descriptive elements - Flow (Q), Speed (V) and Density (K) are defined as below:

(a) Flow (Q)

The number of vehicles passing the cross section of a lane or multiple lanes within a unit time. The unit of Flow (Q) is cars/hr or cars/hr/lane

(b) .Speed(V)

There are two kinds of vehicle speeds: Time-Mean Speed and Space-Mean Speed.

Time-Mean Speed is the average speed of all vehicles. The mathematical expression is as blow:

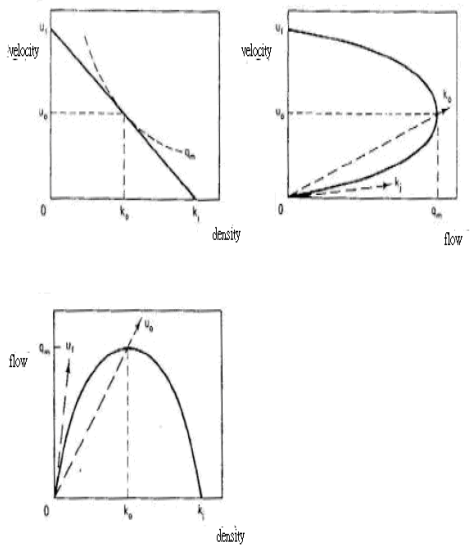
$$V_t = \frac{\sum U_i}{n} \qquad \text{....(1)}$$

Vt = Time-Mean Speed

Ui = the Spot Speed of Vehicle i

N = number of vehicles

Space-Mean Speed can also be called Average Travel Speed, which means the ratio of the travel distance to the travel time. The mathematical expression is as below:



$$V_s = \frac{D}{\left(\sum t_i / n\right)} = \frac{n}{\sum \left(1/U_i\right)} \qquad (2)$$

Vs = Space-Mean Speed
D = travel distance
Ti = travel time

The definitions for the rest variables are the same as (2)

As the use of time-Mean Speed in volume analysis is limited, therefore Space-Mean Speed (Vs) is adopted in this research.

（c）. Density (K)

The definition of density (K): the number of vehicles in one lane or multiple lanes in unit length. The unit of density is cars/km or cars/km/lane. The relations between flow (Q), density (K) and speed (V) can be expressed as below:

$$Q = K \times V \qquad (3)$$

Equality (3) shows that the vehicle flow (Q) is decided by vehicle density (K) and vehicle speed (V). In fact, speed (V) varies with density (K), i.e. Speed (V) can be expressed by the function of density (K). In the above equality, density (K) is independent variable; while vehicle flow (Q) and speed (V) are dependent variables. When the measurement is conducted, vehicle flow (Q) and speed (V) can easily be acquired. Therefore, vehicle density (K) is normally acquired through vehicle flow (Q) and speed (V).

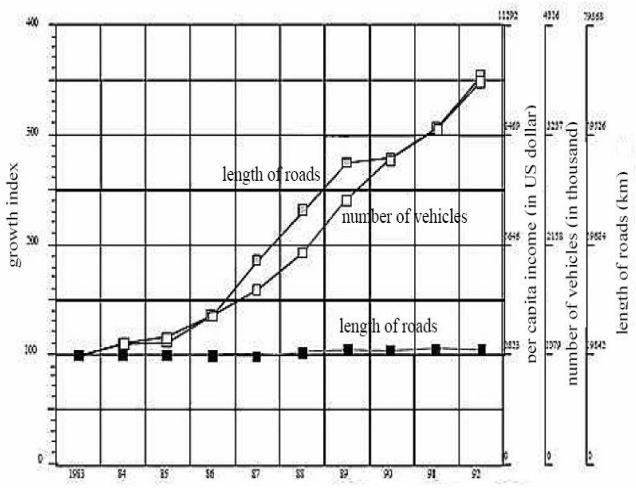


Figure1. the growth curve of per capita income, number of vehicles and the length of roads in Taiwan area.

4. MODEL FRAMEWORK

The basic assumption is that the accumulated disincentive plus the cost resulting from the suspension should not exceed the performance bond. Because the performance bond is fixed, before the performance bond cannot cover the losses from the disincentive plus the cost resulting from the suspension, the owner should terminate the contract to avoid more losses.

The stage to develop the model framework is as follows:

（a）To develop the incentive/disincentive equation（see in fig. 2）

（b） To develop the accumulated incentive/ disincentive equation（see in fig.3）

（c） To decide the Lag from the Terminate Contract Time to Restart Time（see in fig. 4）

（d）Based on the assumption hat the accumulated disincentive plus the cost resulting from the suspension should not exceed the performance bond to build the model（see in fig.5）

Pb > = Ad+C+Bc =(Tct – Ct)*D+L*D+Bc
Tct =< (Pb+Ct*D-L*D-Bc)/D

Pb：Performance Bond
Ct：Contract Time
Tct：Terminate Contract Time。
Rt：Restart Time
D：Disincentive
Ad：Accumulated Disincentive
Bc：Bidding Cost
L：Lag from the Tct to Rt；L=Rt-Tct
C：Compensation for the lag loss

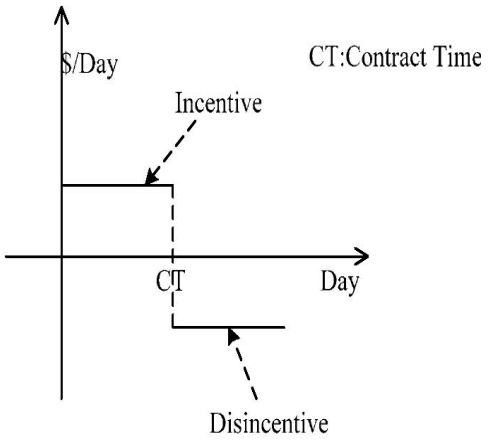


Figure2. Incentive/Disincentive Rate

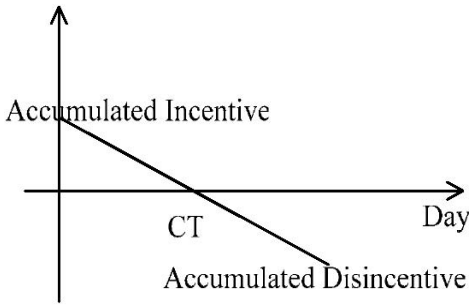


Figure3. Accumulated ncentive/Disincentive

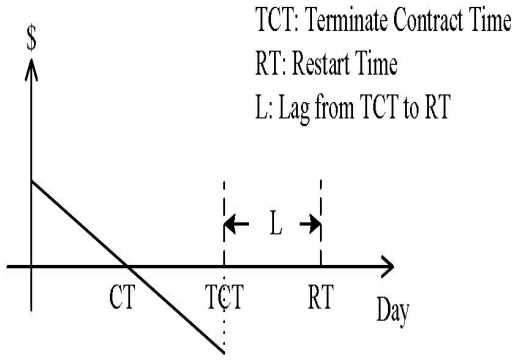


Figure 4. Terminate Contract Time

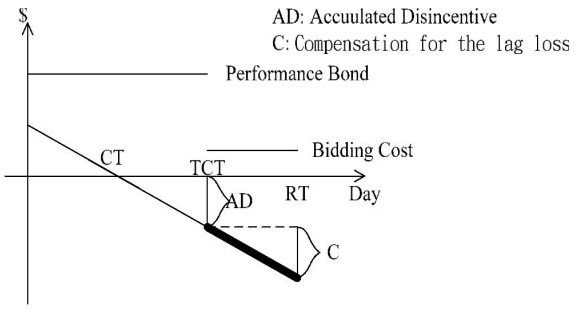


Figure 5. Accumulated Disincentive

5. CONCLUSION AND ATTRIBUTION

This study has established a framework of the Best Timing for Government's Termination of Freeway Repair Work Contract. In the future research, more case studies need to examine this model framework.

This research is within the currently most popular scope of law and economics. At what time and according to what should be cancellation of contracts, which belongs to the legal area, be activated? The research is based on the consideration of social economy in the hope that legal economy can be introduced into the area of construction contract management research. The repair work of freeways has great influence on the general public. Unfortunately, neither the purchase law nor the rules set by the Public Construction Commission take into account the cost of time during the construction period and the loss of social and administrative costs caused by breach of contract. This research provides quantitative models, which will help improve the contract management for the present freeway repair work.

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