Sixth International Conference on Construction in the 21st Century (CITC-VI)
"Construction Challenges in the New Decade"
July 5-7 2011, Kuala Lumpur, Malaysia

Schedule Incentive / Penalty Provisions in Indian Construction Projects

Abid Hasan

Graduate Student,Construction Technology and Management, Indian Institute of Technology, Delhi,
India
abidhasan1@gmail.com

K N Jha

Assistant Professor, Department of Civil Engineering, Indian Institute of Technology, Delhi, India
knjha@civil.iitd.ac.in

Abstract

Incentive / penalty provisions are used in construction projects for various reasons which include improving the performance. The successful formulation and implementation of such provisions is dependent on a number of attributes which needs attention of client and contractor. A total of 25 attributes have been identified based on literature review and structured personal interview. The attributes have been evaluated based on the results of a questionnaire survey conducted among professionals working in Indian construction Industry. Five factors: *contractor's management*, *client's role and responsibilities*, *manpower and equipment*, *sound planning*, and *advanced scheduling and monitoring* have been extracted based on the results of factor analysis conducted on the responses of important attributes. The results would prove to be useful to clients as well as contractors in understanding and implementing the schedule incentive / penalty provisions in a better way to achieve timely completion of construction projects.

Keywords

Schedule; Incentive / Penalty; Early Completion; Factor Analysis

1. Introduction

Incentive / penalty provisions are used in construction projects nowadays to ensure timely completion of projects, to reduce the total cost and to meet certain standards of quality, safety or any other performance parameter. There are different forms of incentive / penalty (I/P) provisions in a contract depending on the objective for which the provisions are needed. For example: schedule I/P for early completion, safety I/P for safe execution, quality I/P for maintaining high quality standards and so on. The objective of schedule incentive / penalty schemes is to ensure the timely completion of construction projects and these are the most common form of incentive / penalty provisions being used in various projects. Given the substantial potential of these provisions towards early completion of construction projects, this study has been carried out in Indian construction industry in order to make these provisions more meaningful and effective. This research tries to identify the different attributes which are needed to be taken care of by both the client as well as the contractor for the successful formulation and implementation of schedule incentive / penalty provisions. Incentivization measures have been launched with success in the United States, United Kingdom, China and Australia (Chan and Chan, 2010). But in Indian construction industry, the use of incentive / penalty provisions is still not very popular and it is restricted to few large and important

projects only. Until now, no systematic research has been carried out to analyze the use of incentive/penalty provisions in Indian construction industry.

2. Literature Review

Incentives can be considered as an efficient tool for the client to balance costs and to meet performance and schedule requirements (Herten and Peeters, 1986). The researchers also demonstrated the use of incentive provisions in the multinational contracting environment. The motivational and incentive mechanisms play an important role in successful contracting (Bower et al., 2002) but it is important that incentives should be made measurable and objective, using relevant benchmarks. Further, contract incentive structures must be tailored to provide appropriate incentive to the contractor to meet the project cost, schedule, and quality objectives and correctly allocate risk. Schedule and safety performances are definitely improved by inclusion of positive incentive provisions however no evidence exists that negative incentives (penalty) used by them enhance project objectives like timely completion, better safety records etc.(Ibbs and Ashley, 1987). Construction contracts that include incentive/penalty provisions have larger budget overflows and more frequent change orders. But I/P contracts achieve "essential" and "final" completion faster than non-l/P contracts (Arditi et al., 1997).

Bonus-only schedule incentives should be used whenever a perceived benefit from above average schedule performance exists (Ibbs and Abu-Hijleh, 1989). Study of various contract clauses in Indian Construction Contracts suggests that use of penalty – only or penalty greater than incentive provisions is more common in Indian Construction Industry. Incentive contracts are frequently awarded at the 10% design stage and finalized when 40%-60% of the design is complete, subject to changes in scope (Stukhart, 1984). The author also concluded that it is essential that targets must be realistic estimates of actual costs, labor hours or schedules. There is a statistically significant agreement in owners' and contractors' perceptions regarding a number of critical issues, such as: calculation of project duration, the definition of "completion of the project," the importance of certain project objectives, the type of expedited work schedules used by contractors, and the frequency and magnitude of change orders in Incentive / Disincentive (I/D) contracts (Arditi and Yasamis, 1998). The project maximum days for incentive as well as the maximum incentive can be predicted for linear I/D contracts (Shr and Chen, 2004)

Some researchers have also worked on the application aspects of incentive / penalty provisions in specific types of construction projects. Use of incentive / disincentive provisions in highway construction or refurbishing contracts shows that I/D provisions enabled the completion time to be reduced by up to 50% (Jaraiedi et al., 1995). While the use of I/D provisions in industrial projects shows that if the contractor wants to win the incentive, he needs to be proactive, anticipate problem areas, and fix them before occurrence (Bubshait, 2003).

The methodology used by researchers in most of the literature presented above is questionnaire surveys and case studies. Most of these studies emphasize on the positive impact and benefits of using incentive / penalty in construction projects. In most of the work done in the past, the researchers have studied very limited aspects of schedule incentive / penalty provisions and the number of cases reflecting the uses and effects of schedule I/P is also very limited. The present research tries to put together all the important aspects of schedule incentive / penalty provisions right from its formulation stage up to the implementation stage.

3. Objective

The objective set for this study is to identify and evaluate the various attributes which ensure successful formulation and implementation of schedule incentive / penalty provisions in construction projects.

The study is restricted to Indian construction industry and the results reflect perception of experienced Indian construction industry professionals only.

4. Research Method

Due to non-availability of relevant published papers on Indian construction Industry, a questionnaire survey along with the structured interview with highly experienced professionals from construction industry was conducted to list out various attributes affecting timely completion of incentive / penalty projects. A total of 25 attributes affecting the schedule incentive / penalty project were identified (see Col 2 of Table 1). After the preparation of final questionnaire, the same was distributed among 120 highly experienced construction industry professionals working at various sites and offices. The response was taken on a five point Likert scale in which '1' represented 'strongly disagree' while '5' represented 'strongly agree'. A total of 72 responses were collected giving a response rate of 60%. The average of respondents was 16 years. The respondents included client, consultant and contractors. Some of the major companies which participated in this survey are – Larsen and Toubro Ltd. (ECC division), GMR, Parsons Brinckerhoff, Shapoorji Pallonji (SPCMG), Engineers India Limited (EIL), Northern railways, Central Public Works Department (CPWD), Lanco infratech limited, and Delhi Metro Rail Corporation (DMRC). The responses were stored and analyzed using SPSS software. The ranking of attributes based on their criticality was done on the basis of relative importance index (RII)-values of attributes. The RII is evaluated using the expression Σw / AxN, where w is the weight given to each attribute by the respondents and ranges from 1 to 5, A is the highest weight (i.e., 5 in this case), and N is the total number of respondents.

The attributes were arranged on their descending order of RII values and ranked. The highest RII indicates the most critical factor with rank 1 and the next indicating the next most critical factor with rank 2 and so on. The overall ranking was based on the total number of response (including client, consultant and contractors).

Using the RII, the rank orders of different attributes were obtained for all responses as well as separately for client, consultant and contractor responses. The high ranked attributes (Table 1) that are observed in four categories of responses: all response, client, consultant and contractor are discussed in the next section.

After ranking all the attributes on the basis of RII, the Spearman's rank correlation coefficient was calculated using the expression $R_S = 1 - 6\sum d^2 / \{n\,(n^2-1)\}$, where n is the number of pairs ranked and d is the difference between corresponding ranks.

Further, from the five point Likert scale used in the questionnaire, the mean scores of responses (l) for different project attributes were found out and the attributes with $\mu \geq 4.0$ were used for the data reduction purpose using factor analysis.

5. Important Attributes Affecting Timely Completion of Schedule Incentive / Penalty Projects

Schedule incentive / penalty provisions are frequently used in various projects of different size and nature. These provisions are now finding favor in Indian construction contracts due to their potential in completing projects on or before time, however, careful examination of data on completed projects reveal that many a time a contractor fails to achieve the predefined targets or milestones because they continue to treat an incentive / penalty project like any other ordinary project. Due to lack of adequate knowledge and understanding of incentive / penalty targets, quite often a contractor gets penalized for the late completion of a particular milestones or the entire project. Thus, need was felt to identify the most

important attributes which make these provisions effective and help a contractor in achieving various targets associated with them.

Table 1 – Attributes Affecting Schedule Incentive / Penalty Projects

S. No	Attributes affecting the timely completion of project in Schedule Incentive/Penalty Contracts	All response		Client		Consultant		Contractor	
		RII	Rank	RII	Rank	RII	Rank	RII	Rank
01	Availability of drawings and specifications on time	0.931	1	0.941	4	0.943	1	0.908	4
02	Well-thought-out checklists for each construction operation	0.931	2	0.948	2	0.924	3	0.917	2
03	Advanced scheduling techniques and Continuous monitoring	0.919	3	0.941	5	0.895	6	0.917	3
04	Look-ahead schedules covering next 1-2 weeks	0.917	4	0.941	6	0.933	2	0.875	9
05	Optimum resource utilization	0.903	5	0.963	1	0.829	14	0.900	5
06	I/P based on a combination of final and milestone assessments	0.894	6	0.881	17	0.905	5	0.900	6
07	Planning should accommodate external constraints/ Add contingencies to the project schedule	0.889	7	0.948	3	0.810	18	0.892	8
08	Clear work scope definition	0.883	8	0.926	9	0.867	8	0.850	12
09	Good Procurement Policy/ Material expediting system	0.883	9	0.867	19	0.848	9	0.933	1
10	Proactive Contractor	0.881	10	0.941	7	0.838	11	0.850	13
11	Take permits for unsafe / hazardous works beforehand	0.878	11	0.911	12	0.838	12	0.875	10
12	Careful selection of subcontractors	0.875	12	0.889	16	0.829	15	0.900	7
13	Effective labour management	0.872	13	0.919	10	0.838	13	0.850	14
14	Fast dispute /conflict resolution	0.869	14	0.919	11	0.819	16	0.858	11
15	Advanced equipment/ Construction methods	0.864	15	0.904	13	0.914	4	0.775	19
16	Determination of accurate duration of project	0.858	16	0.896	15	0.848	10	0.825	16
17	Recognition and consideration of job restraints	0.842	17	0.881	18	0.819	17	0.817	18
18	Efficient equipment maintenance plan	0.836	18	0.859	20	0.810	19	0.833	15
19	Feasibility study of crashing the project duration	0.825	19	0.933	8	0.686	23	0.825	17
20	Increased manpower and equipment	0.819	20	0.904	14	0.886	7	0.667	23
21	Early start of work	0.742	21	0.741	24	0.743	21	0.742	20
22	Multiple shifts at multiple places	0.731	22	0.756	22	0.762	20	0.675	22
23	I/P based on Final project completion date	0.683	23	0.756	23	0.562	24	0.708	21
24	A foreman should be assigned the responsibility of planning an activity in advance	0.661	24	0.778	21	0.695	22	0.500	25
25	Seven day work week	0.481	25	0.415	25	0.505	25	0.533	24

The all response column (columns 3 and 4 in Table 1) shows the most important factor to be *availability of drawings and specifications on time* with RII = 0.931, followed by *well-thought-out checklists for each construction operation, advanced scheduling techniques / continuous monitoring* , and *look-ahead schedules covering next 1-2 weeks* as indicated by their decreasing RII's.

The clients view (columns 5 and 6 in Table 1) o*ptimum resource utilization* as the most important attribute (RII = 0.963) followed by the *well-thought-out checklists for each construction operation* and a*dding contingencies to the project schedule*. Also owners realize *availability of drawings and specifications on time* as fourth most successful attribute.

The consultants (columns 7 and 8 in Table 1)also rank *availability of drawings and specifications on time* as the most important factor with a RII = 0.943, followed by *look-ahead schedules* covering next 1-2 weeks, *well-thought-out checklists for each construction operation* and *advanced equipment/ construction methods.*

The most important attribute in contractor's view (columns 9 and 10 in Table 1) is found to be the *good procurement policy/ material expediting system* (RII = 0.933) followed by *well-thought-out checklists* for each *construction operation* and continuous monitoring, and availability of drawings and specifications on time.

Availability of drawings and specifications on time has got high ranking in all the three categories (client, consultant and contractor) because late submission and approval of drawings is an important cause of delay of construction projects in India. It is also a major reason behind disputes arising due to late completion. If the design part is the responsibility of client then it is his duty to provide all the drawings to the contractor on time.

Well-thought-out checklist for each construction operation is an important factor which ensures smooth and timely execution of various construction activities. It takes a lot of experience to develop these checklists but once in practice they save a lot of time and improve the quality of work.

Despite the high ranking of *advanced scheduling techniques and continuous monitoring,* the use of advanced scheduling software has not gained enough popularity in Indian construction industry. Though in large projects project management software such as MS project and Primavera etc are in use for scheduling and monitoring operations, in most of the projects of small or medium size, the bar chart is still predominantly used for the scheduling and monitoring purposes.

A look-ahead schedule covering next 1-2 weeks was placed at the fourth position by the respondents. In order to achieve different milestones and overall completion of project on time, it is very important to plan and execute the entire project in small steps by making short term plans. By preparing 1-2 weeks advance schedule, all the necessary resources can be arranged well before time for each and every activity.

The Spearman's rank correlation coefficient was calculated for all the possible combination of respondent i.e. client-consultant, client-contractor and consultant-contractor using the expression mentioned earlier. The nearer the value of Rs is to either +1 or -1 the stronger is likely to be the mathematical correlation between the data sets and the more likely it is that the result is significant if there is in fact a relationship between the two variables correlated. The values of Spearman's rank correlation coefficient are 0.575, 0.652 and 0.607 for client-consultant, client-contractor and consultant-contractor respectively and they indicate strong positive correlation among all the three pairs. As suggested by (Nolan, 1994), the calculated values of Spearman's coefficient were compared with the critical value at 99% level. Since the R_s correlation coefficients are greater than the critical value i.e. 0.511, they are accepted.

6. Factors Determining the Success of a Schedule Incentive / Penalty Project

Factor analysis has been performed on the 20 attributes which have $\mu \geq 4.0$. Factor analysis is a powerful method of statistical analysis that aims at providing greater insight of relationship among numerous correlated, but seemingly unrelated, variables in terms of a relatively few underlying factor variant. Factor analysis is performed for responses of all respondents as well as separately for owner and contractor responses. While the all response set has given some meaningful interpretations, the variables emerging in various factors under isolated response sets of contractor and owner have been found out to be jumbled and not leading to any meaningful interpretation. Hence the analysis and subsequent discussion is restricted to factor analysis of all responses. Since the factors extracted using principle component

analysis are orthogonal and contain a large number of overlapping attributes across various factors it is not amenable to interpret. Thus, oblique rotation using varimax rotation is employed for the analysis. The total number of factors has been decided on the basis of both Eigen values (>1) and Scree plot. These factors explain a total of about 68% of the variance. Details of factor analysis are presented in Table 2 and the factors are briefly described below:-

6.1 Contractor's Management

This factor has six attributes, which reflect policy of the prime contractor for achieving schedule targets. The first and third attributes show the overall management of available resources and labour by the contractor whereas the second attribute focuses on the procurement policy followed by the contractor. In a complex project having large number of activities, timely and well-planned procurement of specified materials is a necessary part for the timely execution of project. It is also important to consider various job constrains beforehand so that they can be incorporated while preparing the base plan as reflected by the third attribute. The fifth attribute shows the importance of subcontractors in a project where a part of work has to be sub contracted. Choosing a wrong subcontractor may jeopardize the overall completion date of the project. The last attribute points out the behaviour or attitude of contractor in any problematic situation. A proactive contractor anticipates problem areas, understands them thoroughly and takes initiatives to rectify those problems before time. This factor explains a variance of 16.399%.

Table 2 - Factor Profile of Important Attributes Affecting Schedule I / P Provisions

S. No	Factor name and attribute description	Factor Loading	Variance Explained
1.0	*Contractor's management*		
1.1	Optimum resource utilization	0.655	16.399%
1.2	Good Procurement Policy/ Material expediting system	0.652	
1.3	Recognition and consideration of job restraints	0.643	
1.4	Effective labour management	0.635	
1.5	Careful selection of subcontractors	0.575	
1.6	Proactive Contractor	0.532	
2.0	*Client's role and contribution*		
2.1	I/P based on a combination of final and milestone assessments	0.842	15.467%
2.2	Clear work scope definition	0.832	
2.3	Determination of accurate duration of project	0.809	
2.4	Ensure availability of drawings and specifications on time	0.758	
3.0	*Manpower and equipment*		
3.1	Use of advanced equipment/ Construction methods	0.890	14.084%
3.2	Increased manpower and equipment	0.711	
3.3	Efficient equipment maintenance plan	0.683	
4.0	*Sound Planning*		
4.1	Prepare Look-ahead schedules covering next 1-2 weeks	0.705	12.498%
4.2	Planning should accommodate external constraints/ Add contingencies to the project schedule	0.705	
4.3	Fast dispute /conflict resolution	0.658	
4.4	Take permits for unsafe / hazardous works beforehand	0.613	
4.5	Prepare well-thought-out checklists for each construction operation	0.514	
5.0	*Advanced scheduling and monitoring*		
5.1	Feasibility study of crashing the project duration	0.757	9.472%

5.2	Use of advanced scheduling techniques / continuous monitoring	0.738	

6.2 Client's Role and Responsibilities

This factor explains the role of client in the successful formulation and implementation of incentive / penalty provisions. The first attribute shows that the schedule targets should be a combination of milestones and overall completion rather than the latter alone. The second and third attributes point towards the careful assessment of the project duration and work scope by the client. While the last attribute in this factor shows the importance of timely delivery of drawings and specifications during the execution of project. If the design part is client's responsibility then he should ensure their availability to the contractor as per the agreed dates. These attributes together make the client free from any liability if the completion of project gets delayed. This factor explains a variance of 15.467%.

6.3 Manpower and Equipment

This factor explains a variance of 14.084%. The first and second attribute focus on using adequate number of advanced equipments. The manpower and equipment should be increased as per the demand of the project. The third attribute shows the importance of an effective equipment maintenance plan which reduced the number of breakdowns and improves the productivity as well.

6.4 Sound Planning

This factor contains five attributes and explains a variance of 12.498%. The first and last attributes show the importance of short term planning while the second and fourth attributes define the two important features of long term or base plan. A project involving cutting of trees, discontinuation of public services, deep excavation, welding etc usually require permit from the competent authorities and this process may take few weeks. So it is important to take care of these activities well before their time of execution.

6.5 Advanced Scheduling and Monitoring

This factor explains variance of 9.472% and has two attributes. The second attribute under this factor explains the role of using advanced scheduling and monitoring tools like MSP, Primavera etc in the projects involving hundreds of activities. Scheduling software is very efficient tool if used properly and can provide great help in tracking the actual progress of project against the planned progress. The attribute under this factor focuses on crashing of the project duration in order to achieve contractual milestones. There may be some activities which are not possible to crash, so it becomes necessary to rearrange them and redraw the network diagram.

7. Summary and Concluding Remarks

Using Schedule Incentive / Penalty provisions is a win-win situation for both the client and the contractor if it is used in a right manner. On one hand it gives the client an opportunity to start earning the revenue by early completion of the project while on the other hand it gives the contractor a chance to increase its profit by earning the incentives. Even in non-commercial projects which are not likely to generate money upon early completion, using incentive / penalty provisions shield the client against price escalation during the reduced portion of total project life.

It is necessary for the client to incorporate these provisions in a proper contractual form depending upon the size and nature of the project. Their award should be based upon a combination of completion of uniformly distributed milestones as well as the entire project. It is also the client's responsibility to deliver various drawings and other deliverables as specified in the contract on time.

The contractor needs to treat a schedule incentive / penalty in a different manner compared to a normal project. He needs to thoroughly plan all the activities, ensure timely availability of manpower and equipment, and ensure the timely procurement of materials specially those requiring large lead time. Along with the detailed planning, it is also very important to prepare the 1-2 weeks look-ahead schedule. Monitoring and updating the project on a regular basis using advanced scheduling software is equally important. The selection of subcontractors should be done in a careful way because a bad subcontractor executing some critical portion of the project may jeopardize the success of entire project.

Apart from the work reported here, the authors have conducted cases studies of real life projects case where schedule incentive / penalty provisions are being used. A similar study is also in progress to analyze the safety incentive / penalty provisions in Indian construction projects. Further research includes study of reasons behind the limited use of incentive / penalty provisions in Indian construction industry.

8. References

Arditi, D., and Yasamis, F. (1998). "Incentive/Disincentive contracts: perceptions of owners and contractors". *Journal of Construction Engineering and Management*, Vol. 124, No. 5, pp 361-373.

Arditi et al. (1997). "Incentive/disincentive provisions in highway contracts". *Journal of Construction Engineering and Management,* Vol. 123, No. 3, pp 302-307.

Bower et al. (2002). "Incentive Mechanisms for Project Success". *Journal of Management in Engineering*, Vol. 18, No. 1, pp 37-43.

Bubshait, A.A. (2003). "Incentive/disincentive contracts and its effects on industrial projects". *International Journal of Project Management*, Vol. 21, pp 63–70.

Chan, W.M., and Chan, P.C.(2010). "Empirical Study of the Risks and Difficulties in Implementing Guaranteed Maximum Price and Target Cost Contracts in Construction". *Journal of Construction Engineering and Management,* Vol. 136, No. 5, pp 495-507.

Herten, H. J., and Peeters, W.A.R. (1986). "Incentive contracting as a project management tool". *Project Management: Butterworth & Co (Publishers) Ltd*, pp 34-39.

Ibbs, C.W., and Abu-Hijleh, S.F.(1989). "Schedule based Construction Incentives". *Journal of Construction Engineering and Management,* Vol. 115, No. 3, pp 430-443.

Ibbs, C.W., and Ashley, D.B.(1987). "Impact of various construction contract clauses". *Journal of Construction Engineering and Management*, Vol.113, No.3, pp 501-521.

Jaraiedi et al. (1995). "Incentive/Disincentive guidelines for highway construction contracts". *Journal of Construction Engineering and Management*, Vol. 121, No. 1, pp 112-120.

Shr, J.F., and Chen, W.T. (2004). "Setting Maximum Incentive for Incentive/Disincentive Contracts for Highway Projects". *Journal of Construction Engineering and Management*, Vol.130, No.1, pp 84-93.

Stukhart, G. (1984). "Contractual Incentives". *Journal of Construction Engineering and Management*, Vol. 110, No. 1, pp 34-42.

Nolan, B. (1994). *Data analysis- an Introduction,* Polity press.