APPLICABILITY OF ICTAD PRICE FLUCTUATION FORMULA FOR GOVERNMENT FUNDED INTELLIGENT BUILDING PROJECTS

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ABSTRACT

In high inflationary situations, government fiscal policies etc., have an effect on price fluctuations in Intelligent Building (IB) projects which are funded by the Government. It can increase the cost of material, plant and labour, while increasing the risks that both the contractors and the clients have to face. The use of the ICTAD price fluctuation formula in construction projects of more than three months duration, especially those of the Government, will help to recover these unforeseen costs at least to a certain extent. The formula however has its own inherent constraints. The objective of this research is to identify these constraints and suggest solutions to overcome them.

An expert survey and a case study were done towards achieving the main objective. The case studies comprised a document review and semi structured interviews. Code-based content analysis was used to identify the significant conclusions that could be made from the semi-structured interviews. The QSR. NVivo computer software was used to simplify the content analysis.

The results emphasised that in the case of IB projects of the Government, there is a difference between the actual price fluctuations and the corresponding figures obtained using Institute of Training and Development (ICTAD) price fluctuation formula as the formula had its own limitations. Therefore there is a need to modify the way the 'cost adjustment' factor is determined in IB projects of the Government. By using reliable price indices while taking steps to improve the currently available norms, it will be possible to make available to future IB projects a better operating framework.

Keywords: *ICTAD Price Fluctuation Formula; Intelligent Building (IB); Price Fluctuation.*

1. INTRODUCTION

The price fluctuations of a project being unavoidable and difficult to forecast, they are important to the project and also make the undertaking of the project risky (Subasinghe, 2009). According to Ashworth (1999), fluctuation which depends on the provisions in a contract, is the allowance made for the cost increases caused by inflation irrespective as to whether the contractor has to be compensated or not Several formulae such as those developed by the Federation International Des Ingenieurs Conseils (FIDIC), NEDO, Osborne, Baxter and the Institute for Construction Training and Development (ICTAD) are being used in the construction industry to reimburse price fluctuations (Harshana, 2013). In Sri Lanka, two methods are being used for computing these price fluctuations, i.e traditional method and the formula method (Liyanage, 2005). Ranathunge (2010) pointed out that the calculation of fluctuations through the formula method is simpler and less time consuming when compared to calculating same using the traditional method.

The formula method has been approved by the Government for compensating price fluctuations and its use ihas been made mandatory for public sector projects (Jayalath, 2013). Sub Clause 5.4.2 of the Procurement Guidelines related to Goods and Works published by the National Procurement Agency (2006) states that in any contract for works the duration of which exceeds three months, the price variation formulae for the Sri Lankan Rupee component shall be included in the bidding document and the contract agreement.

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Subsequent to the end of the war, the Government has been increasingly investing in the building construction sector and it can be seen that a significant proportion of this investment is on Intelligent Buildings (IB) (Central Bank Sri Lanka, 2012). Intelligent Building Construction is a collection of several new construction techniques which have advantages over traditional methods (Santos, 2011). So and Chan (1999) stated that in these intelligent buildings, computerized systems perform specific and isolated tasks while being integrated with other systems. According to the current rules and regulations specified for IB projects of the Government, the ICTAD price fluctuation formula although it has its own short comings, has to be used to calculate price changes. This formula however has not been adjusted or revised to suit the construction techniques that have been developed of late. In this context it is essential to analyse the impact and the risk of using the current ICTAD price fluctuation formula in Intelligent Building projects of the Government so as to identify the ways of minimising these negative effects. Therefore, this research has adhered to clear and concise literature review on price fluctuation recovery methods and the significant of government IB projects. Thereafter, data collection methods such as interviews and case study were carried out in identifying the issues when applying ICTAD formula in IB projects. Ultimately the aim of this research has been accomplished by identifying the constraints of using the formula in IB projects of the Government and at proposing solutions to overcome them in order to use them in an efficient and effective manner in government IB projects.

2. LITERATURE SYNTHESIS

Fluctuations are granted to contractors as compensation in accordance with conditions laid out in the relevant contracts when there is an increase in building costs (Harshana, 2013). These cost increases will differ depending on the extent of inflation (Ashworth and Hogg, 2002). Liyanage (2005) stated that the so increased costs have a significant effect especially on large scale projects of very long duration. Subasinghe (2009) also stated that price fluctuations, being unavoidable and difficult to forecast, will have a significant impact on a project and that the parties to the contract could not be made liable to these price fluctuations. Therefore it can be stated that price fluctuations contribute significantly to the risks that have to be faced by the construction industry.

2.1. CAUSES OF PRICE FLUCTUATIONS

Sendooran (2005) defined that prices can increase for several reasons such as the increase of oil prices in the world market and changes in technology and inflation. However depending on the conditions and the methods of construction used in the projects concerned, the reasons for fluctuation could vary. According to Hanna and Blair (1993), market conditions, inflation, actions on the part of the Government, taxes and political influence are the fundamental reasons for these fluctuations.

2.2. PRICE FLUCTUATION FOR DIFFERENT TYPES OF CONTRACTS

There are two types of contracts related to construction projects as indicated in Figure 1. i.e. contracts with fixed prices and those in which price fluctuations are allowed (Subasinghe, 2009).

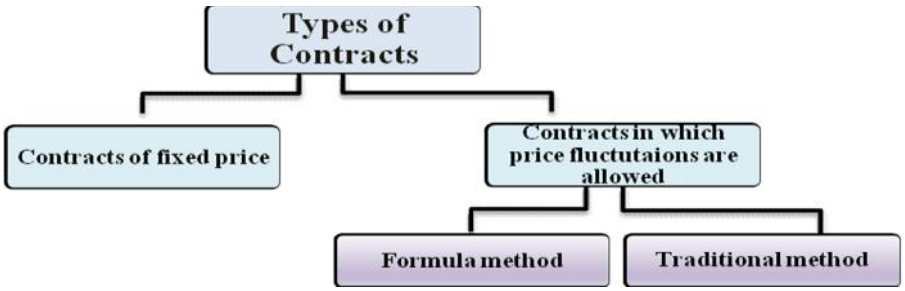

Figure 1: Different Types of Contracts

Suraweera (2001) emphasised that depending on the contractual clauses provided in the relevant agreements, price fluctuations could either be recoverable or non-recoverable. According to Cook (1991), in fixed price type contracts the costs of material and labour are not considered as those that could get affected by fluctuations. Hence, price fluctuation clauses are not provided for in this type of contracts with both parties having to agree on a fixed contract sum and in case of price fluctuations there will be no contract sum adjustments (Ramus, 1981). Subasinghe (2009), identified that these types of contracts can make it very risky for the contractor to undertake the project since he will have to take full responsibility for all costs. On the other hand, according to Ramus and Birchall (1996), contracts in which price fluctuations are allowed are identified as contracts containing provisions for reimbursement of increases of labour costs and material prices as well as statutory costs. A price fluctuation formula is made available in these projects to calculate costs due to price fluctuations and provide guidance on cost changes (Anon, 2009). Price fluctuation clauses in the standard forms of contract are described below.

2.3. PRICE FLUCTUATION CLAUSES IN STANDARD FORMS OF CONTRACT

Price fluctuation clauses are included in Standard Forms of Contracts such as the FIDIC Standard Form of Contract, ICTAD Standard Bidding Document and Procurement Guidelines (Subasinghe, 2009). Sub Clause 70.1 of the Fourth Edition of the 1987 Red Book - FIDIC Conditions of Contracts, deals with the fluctuations in the labour and material costs or in any other factors that affect the cost of construction. It is difficult to ascertain the fluctuations purely based on information provided in these standard forms unless there is official control of the rates of wages in the country where labour is employed. Clauses 38, 39 and 40 of the 1980 Edition of the Joint Contracts Tribunal (JCT) Standard revised in 1989 provide provision for price fluctuations. These provisions focus on limited fluctuations (firm price), full fluctuations and on the price adjustment formula and Brook (2004) stated that no increase has been allowed therein for overheads and profits, site supervision, site establishment costs, plant and temporary work. Clause 13.7 of the ICTAD (2007), deals with price fluctuations as adjustments for changes in cost. ICTAD (2007) states that the amounts computed from the formula given in this Clause for changes in the cost of labour, material, plant and other inputs to the works, shall be added to or deducted from the payment to the contractor. In the Procurement Guidelines published by the National Procurement Agency it is stated that in the price adjustment of any contract for works the duration of which exceeds three months, the price variation formula for the Sri Lankan rupee component shall be included in the bidding document and in the contract agreement. The price variation formula developed by the ICTAD has to be used in such cases even though there can also be other recovery methods.

2.4. PRICE FLUCTUATION RECOVERY METHODS PRACTICED BY THE CONSTRUCTION INDUSTRY

Liyanage (2005) concludes that to compensate the parties to a contract for fluctuations, there are two main methods of calculating the price fluctuations, i.e traditional method through which the contractor will be paid for the actual costs incurred and the formula method through which the contractor will be compensated for the price fluctuations depending on the value of work done. Turner (cited Subasinghe 2009) stated that the traditional method is to make an adjustment for the contractor's expenditure relating to fluctuations taking the prime cost as the basis. According to Suraweera (2001), the formula method will calculate a sum or sums which will compensate the parties to the contract for losses incurred by them due to an increase or decrease in costs (Suraweera, 2001). There could be a slight difference between what is recoverable using the formula method and what is recoverable using the traditional method. The formula method does not calculate the actual amount of losses incurred (Ramus, 1981). Most contractors who use the formula method to compute fluctuations agree that the amount recovered is a reasonable recovery of the increased costs (The Chartered Institute of Building [CIB], 1997).

2.5. ICTAD PRICE FLUCTUATION FORMULA

This formula has been developed for the contracts whose contract value exceeds Rs. 10 Million and is applicable for adjustments for changes in local costs. De Mel (2008) stated that the ICTAD formula has been developed using several assumptions which minimise the complexity of the formula and make the formula easy to use.

$$F = \frac{0.966\,(V - V_{na})}{100} \sum_{\text{All Inputs}} \frac{P_x\,(I_{xc} - I_{xb})}{I_{xb}} \qquad \text{(Eq. 01)}$$

V = Valuation of work done for period
V_{na} = Non-adjustable elements
P_x = Input percentage
I_{xb} = Base index for input X, publish by ICTAD
I_{xc} = Current index for input X, publish by ICTAD

Subasinghe (2009) demonstrated that even though there are several price fluctuation methods, the ICTAD formula is the most prominent and beneficial method practiced in most of the traditional projects and IB projects in Sri Lanka. Among them IB projects are important due to their unique and special features.

2.6. INTELLIGENT BUILDINGS

The IB aims at rearranging and enriching the capabilities of independent building management and communication systems through well planned and coherent building concepts (Croome, 2004). It has become a viable and a justifiable alternative for the evaluation of a cost of a building against its life cycle benefits. According to Chapman (2004), special features of IB projects are;

- Maximum transparency and communication among subsystems
- Electrical design features that are tailored to suit the Intelligent Building concept
- Flexible and modular High Voltage Air Conditioning (HVAC) systems
- Availability of high-speed fibre optic communication networks for carrying data and video
- Individually controlled HVAC terminal units which could be controlled by the occupants themselves

2.7. ASSESSMENT OF RESEARCH GAP THROUGH THE LITERATURE SYNTHESIS

Considerable research has been conducted worldwide on price fluctuation in construction projects. However only very little research has been done for the use of the ICTAD price fluctuation formula used only in Sri Lanka, that too in relation only to traditional construction projects. Therefore this research is aimed at identifying issues that arise when the ICTAD price adjustment formula is used in the Intelligent Building projects of the Government and makes suggestions to overcome the identified issues.

3. RESEARCH METHODOLOGY

Creswell (2003) concluded that a suitable research approach has to be selected to deal with any research problem. The Qualitative research approach was used in the research to arrive at the conclusions. The background study in this particular research revealed a research gap as there were no available studies on the accurate application of the fluctuation formula to the IB projects. A comprehensive literature survey was initially conducted to determine the concept of price fluctuation and price fluctuation recovery methods related to intelligent buildings.

The selection of an appropriate data collection method is the main element of a research. Due to their significance, an expert survey and a case study were identified to find solutions for the issues that were identified. Kumar (2011) indicated that, the basic purpose of an expert survey is to support interview outcomes by identifying key factors and case studies in the relevant areas. Data collection was done through an expert survey. Yin (2003) stated that, an empirical inquiry would investigate a contemporary phenomenon in the context of a real-life situation where the boundaries between each other are not clear and that it would obtain evidence from multiple sources.

A preliminary interview survey was carried out among industry experts who were very familiar with the ICTAD price fluctuation formula and IB projects so that a comprehensive guideline could be developed to conduct case study interviews. The empirical study was conducted using a case study research

approach. The unit of analysis for the case studies was IB projects, and the research was carried out both at individual and organisational levels. The number of case studies was limited to two and they were examined mainly through semi structured and face-to-face interviews. Eight interviews were conducted and the NVIvo 2010 software was used for analysing the data collected. The data collected by reviewing documents on monthly fluctuations pertaining to each case was analysed using statistical data analysis methods with a view to producing a more realistic outcome. Table 1 is provided with a details of respondents of the interview.

Table 1: Details of Interviewees

Interviews Code	Designation	Years of Experiences	Organisation Category
Respondent A	Chief Quantity Surveyor	23	Consultancy
Respondent B	Chief Quantity Surveyor	14	Consultancy
Respondent C	Assistant Director	21	Regulator
Respondent D	Senior Quantity Surveyor	18	Contractor
Respondent E	Construction Managers	13	Consultancy
Respondent F	Chief Quantity Surveyor	11	Contractor
Respondent G	Senior Quantity Surveyor	16	Consultancy
Respondent H	Project Manager	13	Contractor
Respondent I	Senior Quantity Surveyor	14	Consultancy
Respondent J	Project Manager	16	Contractor

4. ANALYSIS AND RESEARCH FINDINGS

There is a precise and a clear outcome from the analysis of the research findings. Intelligent building projects have special features exclusive to them. They have maximum interaction among their different systems and during their construction phase material is purchased in bulk. Moreover most of the IB projects in the state sector, a s emphasised by Respondent B, are carried out in accordance with Board of Investment (BOI) regulations of the Government. A special feature of the IB projects of the Government is the fact that it is mandatory to apply the ICTAD formula in their implementation. These projects take a long time for completion as the buildings concerned are designed to have automated systems. IB projects as explained by Respondent A, use new technologies to provide building services. According to this respondent, Intelligent Buildings can think and do functions by themselves implying that hey contain fully automated functions programmed according to a special schedule which enables them to function independent of others. All these features were revealed during the expert survey and some of the buildings selected for case studies had these special features. Figure 2 illustrates the special features of IB projects.

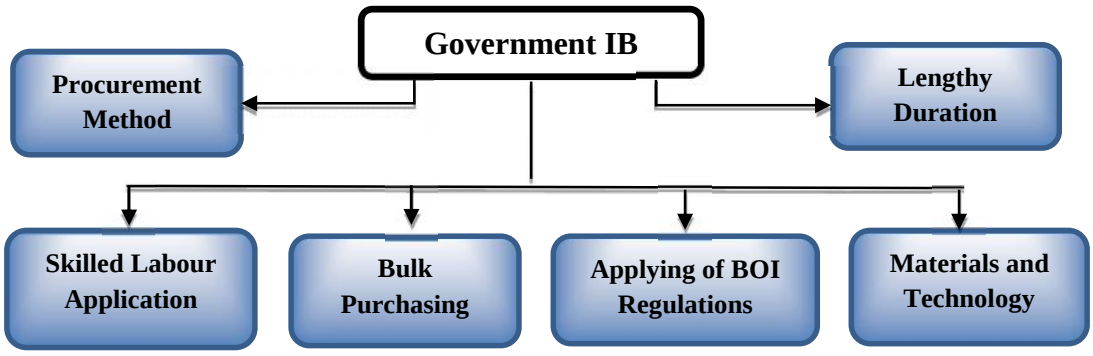

Figure 2: Special Features of IB Projects

The survey also revealed the following assumptions which had been used in developing the ICTAD formula:

- Inputs are uniformly distributed through the projects
- Indices used are same irrespective of the location of the building in the country
- Foreign exchange conversion rates do not fluctuate
- Interim statements will be submitted by contractors every month

Since this research mainly focused on the applicability of ICTAD formula to Intelligent Buildings of the Government, the practicability of applying this formula can be determined through the research. In IB projects, there can be several mechanical, electrical and plumbing (MEP) items such as BMS, lifts, electrical distribution systems, systems, the cost of which would amount to a considerable percentage of the total contract sum. i.e. 30%-40%. The ICTAD formula will not be able to recover the price fluctuations related to these systems as most of these costly items are not considered in calculations because of the non-availability of the relevant indices. Thus this formula will not help either the client or the contractor to make accurate calculations when there are special features. It may at times even be beneficial only to one party. Further, the calculation of input percentage has become a complex and a tedious process due to the unavailability of appropriate and updated Building Schedule of Rates (BSR) norms and sometimes this leads to conflicts between the contractor and the client. The Interviewee D specifically emphasised that in the case of certain types of material, there is no source from which the particular categories to which these material belong could be identified making it difficult to submit claims. He further said that input percentages have to be prepared for a group of Bills of Quantities (BOQ) items and that input quantities are determined by using norms. The other limitations are the non-consideration of parity rate fluctuations and market trends of indices, high taxes on imported material, inaccurate assumptions, etc.

In order to study the relevance of the findings of the expert survey to a practical situation, an in-depth analysis of two selected cases was done. The two case studies revealed that there is a difference between the actual fluctuation and the fluctuation computed using the formula. The following formula was used to compare the two fluctuations:

$$Amount\ of\ actual\ price\ fluctuation = \frac{100}{90}\sum_{i=1}^{n} Q_i\,{}^{a}{}_{i} \qquad \text{(Eq. 02)}$$

Q = Quantity of Input
λ_i = Price difference of Input *i*

Using this formula, thirteen Interim Payment Certificates (IPCs) of Case A and Case B were analysed to verify whether there had been any difference between the amount of actual price fluctuation and the amount compensated using the ICTAD formula. Table 2 provides the details of the two cases selected for the study.

Table 2: Details of Two Cases

Project	Case A	Case B
Project Cost (Rs.)	2.6 billion	4.2 billion
Project Duration	40 months	36 months
Type	Administrative complex	Administrative complex
Stories	12 stories	13 stories
Net Floor Area	46000 m^2	40000m^2
Location	Baththaramulla	Colombo 01

Table 3 provides a summary of the analysis of these differences relating to case A.

Table 3: Difference Between Actual Fluctuation and Fluctuation Computed Using the Formula

IPC (Case A)	Work Done According to IPC	Amount of Actual Fluctuation	Amount Paid as Fluctuation	Amount Payable to the Contactor as Fluctuation	Amount Over Paid as Fluctuation	Fluctuation Difference
1	19,016,569.04	747,734.29	890,159.87	890,159.87	142,425.58	0
2	37,107,568.52	1,250,848.60	2,156,635.52	2,156,635.52	905,786.92	0
3	34,614,720.11	1,272,891.90	1,871,899.85	1,871,899.85	599,007.95	0
4	17,100,543.52	994,930.36	1,715,397.17	1,715,397.17	720,466.81	0
5	28,112,589.01	1,481,047.16	1,791,033.78	1,722,147.86	309,986.62	68,885.91
6	27,671,812.57	1,273,011.70	1,818,588.14	1,653,261.95	545,576.44	165,326.19
7	30,721,629.98	1,291,955.33	2,417,206.74	2,083,798.91	1,125,251.41	333,407.83
8	45,418,610.40	1,642,867.06	2,859,805.63	3,042,346.41	1,216,938.57	(182,540.78)
9	27,171,224.88	1,107,024.20	2,178,337.94	1,785,522.90	1,071,313.74	392,815.04
10	11,732,672.18	777,643.66	1,346,989.92	1,388,649.40	569,346.25	(41,659.48)
11	5,370,096.04	364,253.42	540,861.14	551,899.12	176,607.72	(11,037.98)
12	79,465,390.65	2,891,446.03	5,782,892.06	5,354,529.69	2,891,446.03	428,362.37
13	41,492,255.75	1,715,883.38	2,917,001.74	2,859,805.63	1,201,118.36	57,196.11
Total	**404,995,682.6**	**16,811,537.09**	**28,286,809.50**	**27,076,054.29**	**11,475,272.4**	**1,210,755.2**

The fluctuation calculated using the ICTAD formula is taken as the amount that is payable to the contractor. The difference between the actual fluctuation and the calculated fluctuation is considered as fluctuation over paid. Fluctuation difference which is indicated in the last column indicates the difference between the payable amount and the actual amount paid.

By referring to Table 2, it can be clearly seen that there is a difference between the actual fluctuation and the fluctuation paid to the contractor. To illustrate this situation in detail, the percentage of this fluctuation as against the work done is calculated and shown in Table 4.

Table 4: Percentages of Fluctuation in Case A

IPC	Actual Fluctuation %	Fluctuation Paid to the Contactor%	Fluctuation Over Paid %
1	0.04	0.05	0.01
2	0.03	0.06	0.02
3	0.17	0.01	-0.05
….	….	….	….
….	….	….	….
12	0.04	0.15	0.12
13	0.04	0.07	0.03
Project	**0.09**	**0.15**	**0.06**

According to Table 3, the actual fluctuation in Case A is 9% of the total work done. However, the client has paid to the contractor 15% as fluctuation cost against the total work done. It is therefore clear that the client has overpaid 6% of the total work done because of the limitations of the ICTAD formula when applied to IB projects of the Government. The findings of a similar analysis done for Case B are graphically shown in Figure 3.

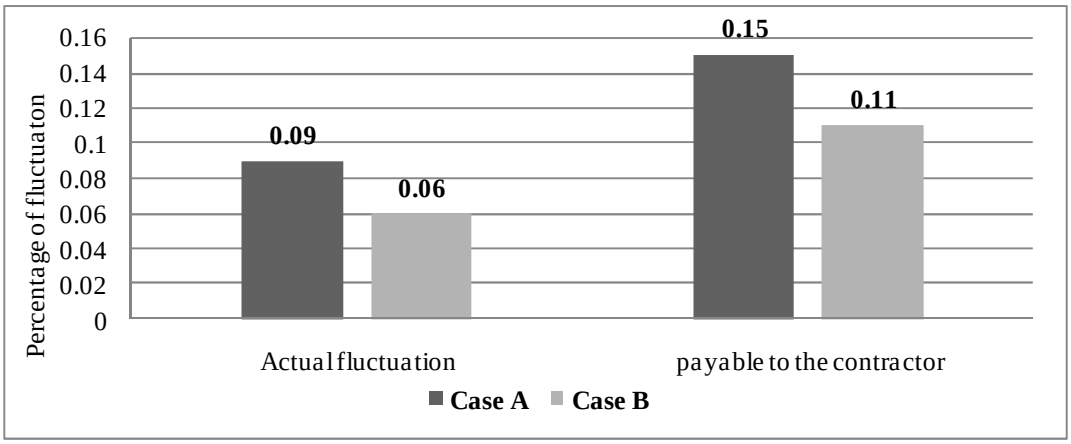

Figure 3: Difference between Actual Fluctuation and Formula Fluctuation in Case A and Case B

Table 3 and Figure 3 clearly indicate that here have been overpaid amounts in both cases which was 6% in Case A and 5% in Case B. This over paid amounts called Fluctuation Differences in Table 3 and Figure 3 are due to following factors:

- Base and current indices being not properly applied in accordance with instructions provided in the ICTAD publication - ICTAD formula method for adjustment to contract price due to fluctuation in prices.
- Most of the actual prices of material and relevant price variations being not included in the cost of work actually done.
- Cost of items related to provisional sums being not deducted from the cost of work done which benefits the contractor when compensated through the ICTAD formula.

The findings enabled to identify the suggestions that can be made to mitigate the effects of the limitations of ICATD price fluctuation formula while emphasising the importance of identifying factors that can be used to revise the formula to suit IB projects. According to interviewees, new indices related to special material and MEP items used in IB projects have to be determined as these components contribute considerably to the cost of these projects. Since, in the literature review Chapman (2004) has emphasised that IB projects are very much concern on advanced services installations and that indicates that advanced and new types of materials are being used at sites. Whereas, in ICTAD formula fluctuation restricted to several inputs like material, plant and equipment and labour published from the bulletin (Suraweera, 2001). Hence it is important to have these indices as otherwise the results obtained using the formula may not be accurate and in developing these indices due consideration has to be given to demographical factors. In the past , these indices would have been developed based on prices that were available in and around Colombo and presuming that they are same in other areas of the country as well, which is not reasonable as the type of resources obtainable and available in those areas could be different.

Furthermore, the cost adjustable factor needs to be changed from 15% to 30% and the coefficient factor from 0.966 to 0.855 respectively since in IB projects the cost adjustable factor is around 30%. Since according to Samareweera (2008), inaccurate assumption like equal distribution of inputs though out the contract duration is used to calculate the fluctuation easily. Therefore, the necessity of the appropriate adjustment to the formula comes to the stage. Furthermore, enhancement of current available norms and develop missing norms to calculate the input percentages correctly is also an important suggestion. At present outdated BSR norms are used and some of the required norms are not available at all. Apart from that, in IB projects Chapman (2004) has highlighted that, number of various new materials, specialised skilled labours and well equipped plants are used. Therefore, there should be more focus on the enhancement of currently available norms and updating the BSR according to the requirement in IB projects. Thereby an efficient evaluation and calculation of price fluctuation can be done for the IB projects in Sri Lanka, in order to carry out the pre-construction process in a reliable manner and to provide a better output for the government as well.

5. CONCLUSIONS AND RECOMMENDATIONS

IB projects are special when compared to traditional building projects as they have distinctive features. They use modern technologies, innovative material, and different procurement systems and at times continue for months and years. Therefore, there is a strong probability in price escalations of labour, material and equipment during the implementation of the project. The ICATD formula has several significant drawbacks when it is used to calculate price escalation in IB projects of the Government, as it does not suit the modern construction methodologies. Therefore, this study was aimed at identifying the limitations of the ICTAD formula when it is applied to IB projects of the Government and to presenting suggestions to overcome those limitations.

In order to accomplish the aim of the research, a mixed approach was adopted by collecting primary data from semi structured interviews and from a close ended case study survey. A documentary survey was conducted to obtain secondary data from documents that have already been published. The analysis of this data revealed that both the traditional method and the formula method deal with price fluctuations and that at times the contractors are overpaid for price fluctuations as there are deviations from the ICTAD formula when price fluctuations are computed. The limitations of the formula method were also identified and improvements to it were suggested by highlighting some of the areas which are not clear. Therefore it is necessary to change the ICTAD formula to 0.855 and a proper method of calculation has to be proposed to calculate the quantity of work done during the respective valuation period. Price indices are one of the most important factors to be considered in calculating fluctuations according to the ICTAD formula method. These indices have to be therefore prepared as accurately as possible. The main drawback of the indices is that they have been prepared on a national basis without giving due consideration to the possibility that there could be regional variations thus resulting in inaccuracies in the calculated fluctuations. Therefore, in order to ensure a fairly accurate calculation of the fluctuations, the ICTAD will have to focus on preparing indices district wise as location indices. As it is very essential for the industry to have a better understanding of the ICTAD formula, it is also necessary to conduct training programs for the members of the industry who are involved in calculating price fluctuations. These steps will enable the proper use of price fluctuation formula leading eventually to better practices in the construction industry.

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