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Theories and Concepts of an Increased Cost Adjustment (ICA\textsuperscript{o}) Formula for Optimum Cost Escalation Recovery

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Conceptual paper

ABSTRACT

Purpose – Rising construction input costs have an adverse impact with regard to optimum cost reimbursement to contractors where contracts allow for increased cost adjustments on some basis. This paper has a two-fold aim, namely to establish the shortcomings of increased cost adjustment methods and to introduce an alternative method. Methodology/Scope – The literature on the shortcomings of existing increased cost adjustment methods was reviewed. The ICA formula was developed based upon a set of assumptions derived from a comprehensive breakdown of contract costs. Findings – After the development of the ICA formula, an illustrative case study comparing the ICA formula over other methods was done. The adjusted amount using the ICA formula was between the amounts obtained using the traditional method and the Haylett formula, hence the optimality of the ICA formula with regard to cost recovery. Research limitations – Given that this paper solely establishes theoretical concepts of the ICA formula. No field work was done, only an illustrative case study was done. Practical implications - The study recommends the use of ICA formula as an alternative method for valuation of fluctuating contracts given its suitability within the current macroeconomic situation. Value/Originality - The study contributes to the existing body of knowledge of both practitioners and academia. It is a scientific demonstration that theoretically and practically recognises the uniqueness of each construction contract with regards to increased cost adjustment. It is anticipated that the adoption of the ICA formula as an alternative method for price adjustment will result in balanced cost recovery/reimbursement between the client and the contractor.

Keywords: ICA formula, increased cost adjustment methods, shortcomings, South Africa.

1. INTRODUCTION

The construction industry has been challenged with the rise of construction delivery costs which in some cases do not tally with the budgeted ones owing to the continuous and unpredictable change of the macroeconomic environment. Given such a situation, contractual clauses have been formulated to cater for optimum recovery of cost escalations. Subsequently, various increased cost adjustment methods have been developed and reviewed from time to time.

Until the late sixties, the inflation rate was low and contractors were prepared to accept the risk of the rise of building costs and made due allowance for this in their tenders \cite{1}. As a consequence of the world oil crisis in the seventies, prices started rising in unpredictable manner \cite{1}. Fixed price contracts were no longer suitable for such an economic environment since contractors were at risk with regard to recovery of profit due to cost escalation. Contracts were then subject to a cost-escalation provision in which a contractor was compensated for all increases in costs since the base date of tendering \cite{1}. Since then, several methods for cost recovery have been tried and these include traditional method and consumer price index (CPI) based formulae. However each of these methods have shortcomings with regards to optimum cost recovery.

The traditional method of ascertaining the amount of price fluctuation requires the contractor at the time of tender, to provide a list of the principal materials, plant and labour to be used in the contract and the unit price for those materials on which bill rates were based \cite{2}. The traditional method is referred to as a partial fluctuation reimbursement because the amount of increase recovered is much less than the total amount by which costs have really increased/varied \cite{3}.

CPI based formulae include Osborne and Haylett formulae for building works, the Engineering formula for civil works and Baxter formula for civil contracts that are expected to be in excess of 24 months duration. Known also as full reimbursement methods, CPI based formulae were introduced in United Kingdom in the 1970s as an alternative to the traditional method to fully reimburse the contractor for losses incurred due to price fluctuation \cite{2}. However, the BLS\cite{3} neither encourages nor discourages the use of price adjustment

\begin{itemize}
\item \textsuperscript{1} Bureau of Labour Statistics in the United States of America that compiles consumer price indices
\end{itemize}
measures in contractual agreements. While this paper will provide a critical overview of CPI based formulae with regards to increased cost recovery; further discussions will be confined to the Haylett formula which is currently predominantly used in South African building contracts. Subsequently the theories and concepts of development of another formula to overcome such shortcomings will be provided.

2. PROBLEMS WITH CPI BASED FORMULAE

The CPAP\(^2\) (Contract Price Adjustment Provisions) also colloquially referred to as the Haylett formula was introduced in 1976 as a formula method of compensation or reimbursing for price fluctuation in labour costs, material prices, plant and equipment, and fuel \(^3\). CPAP \(^4\) stipulates that the purpose of the formula was to provide for the needs of contractors who required a clear-cut, agreed recovery formula method to avoid dissension and disputes with employers and subcontractors and provide a reasonable reimbursement of unusual price fluctuations. This formula is based on the Consumer Price Indices \(^5\) published by the Central Bureau of Statistics. The CPI number measures relative price changes from one time period to another. The problem with the CPI is that it may overestimate or under estimate the market conditions as at how prices have risen. When the formula is used, no attempt is made to calculate the actual amount of loss involved; consequently, the sums recoverable by the formula method will differ from these recoverable under traditional method and will be usually greater \(^6\). Trickey \(^7\) contended that by relying on an incorrect index could give very misleading results. Since no audit of the amount of cost increase is done for each individual item, one would wonder whether clients pay the real losses incurred. CPAP \(^8\) clearly states that the formula can not precisely reflect the actual cost fluctuations on any particular piece of work or contract. De Vynck \(^9\) noted that the proportions and indices applied are indicative of average price movements and do not represent any particular contract. The Haylett formula provides roughly 85% constant which is subject to adjustment. De Vynck \(^9\) contended that as 15% non-adjustable portion eliminates profit recovery, this could be penalizing the contractor for profits not really earned.

In low inflation environment, CPI formulae may operate satisfactory. De Vynck \(^9\) believed that the stability of the South Africa’s macroeconomic situation could see the disappearance of the index because it was possible to predict the future price fluctuations in building materials. Unfortunately, the macroeconomic environment never stabilises. Unfortunately, at present no study has been carried out to ascertain at which level the increase of the CPI would be problematic with regard to increased cost adjustment neither will be the scope of this paper. This study increases the awareness of the problems of application of methods used for increased cost adjustment relative to macroeconomic environment. It opens debate with stakeholders along the matter of increase cost adjustment and stimulates a need for advanced research studies.

3. METHODOLOGY

The philosophy of the adjustment of the increased cost is reliant on three arguments, namely

- Each contract is unique, thus the increased cost adjustment should take this into account.
- The allowable profit margin on a contract is calculated on a percentage basis at tender; therefore, the percentage obtained at the end of the contract should be relatively closer to the allowable.
- The contract sum breakdown reveals that its components are affected in different ways in terms of losses of the contractor’s profit margin.

An ICA formula was developed taking reference to the above mentioned arguments. A comprehensive contract sum breakdown was done and subsequent theoretical concepts were formulated. The combination of concepts resulted in a sound formula. An illustrative case study of a construction contract comparing methods for increased cost adjustment was drawn.

4. THEORETICAL CONCEPTS OF THE ICA FORMULA

**Generic idea**

The idea of developing an ICA formula was born after the author sojourned in Zimbabwe, a country that beat the world record in price escalations in the 1\(^\text{st}\) decade of the 21\(^\text{st}\) century. For example, the CPI for civil engineering plant was reported to increase from 247,096.7 in October 2003 to 387,964.20 in October 2004 with an average CPI increase of 11739 per month \(^5\). In 2003, the author was working in the estimating department of a construction contracting company in Zimbabwe. Towards the end of the year, he was transferred to the quantity surveying department; eventually, working on a contract he was involved at tendering. The author was eager to see how the anticipated profit at tender was going to be achieved during the construction stage. At each monthly contract valuation, the computation of allowable costs against the actual costs showed the current profit margin diminishing far below the expected. A further observation

\(^2\) Manual guide for price adjustment provided by the Joint Building Contracts Committee in South Africa

\(^3\) Although the compilation of the statistics is still undertaken by the Central Bureau of Statistics, the publication of the indices in now undertaken by JBCC on a subscription basis [1]
revealed that the amount of increased cost exceeded far beyond the basic amount. This situation hypothesised the lack of proper recovery of increased cost. An initial research was done from 2004 to 2005 which revealed that contractors were not reimbursed their losses owing the shortcomings of increased cost methods along with the development of the ICA formula. The original ICA formula proposed that each construction contract fell under one of 51 options. At this advanced stage, this paper further establishes theoretical concepts for the ICA formula that provides infinite options.

Building up the ICA formula

The ICA targets the reconciliation of the decline in profit margin of the contractor with the original allowable. The ICA formula uses the actual costs on a particular project and prompts an appropriate percentage of adjustment \( m \) at each interim contract valuation. The ICA formula is developed upon ceteris paribus assumptions by providing a contract sum breakdown as follows:

1. Direct works/costs \( X \)
2. Preliminaries and General (P&G) \( +Y \)
3. Contractor’s sum \( S \)
4. Prime Cost sum \( +Z \)
5. Sub-total contract sum \( M \)
6. Contingencies sum \( +O \)
7. Total contract sum \( N \)

Other parameters to be taken into consideration are as follows:
1. Cumulative basic price amount \( B \)
2. Cumulative net increased cost \( I \)
3. Administration fees (%) \( a \)
4. Allowable profit (%) \( p \)

Assumption I - Contractor’s sum: Direct works \( X \) of versus P&G \( Y \)

“The higher the direct works proportion, the lower the P&G proportion, as a result a greater amount is recovered on increased cost adjustment thus the contractor’s profit is slightly affected and vice versa.”

In fact, the contractor recovers the increased cost on most of the direct works items by means of a percentage adjustment while the increased cost on preliminaries and generals is not recoverable since it is not subject to adjustment. An illustration showing how a contractor is reimbursed much amount for increased cost where the direct works proportion is higher than where it is lower is shown in a case study drawn in Table 1. As shown in Table 1, two contracts A and B have the same original contract amount of R600,000. They start and end at the same time, but they have different cost proportions. Assume a net cost increase of 50% of the original cost which affects both the direct works and preliminaries and generals; then the net increased cost amounts at R300,000 for both contracts A and B. Since there is no provision for adjustment for preliminaries and generals, only the increase on direct works is adjusted. The contractor recovers (R13,375) on project A which has a higher direct works proportion (89%) than on project B (R8,750) which has a lower direct works proportion (58%). Consequently, less profit is recovered on project B than on project A.

<table>
<thead>
<tr>
<th>Contractor’s sum</th>
<th>CONTRACT A</th>
<th>CONTRACT B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amount</td>
<td>Proportions</td>
</tr>
<tr>
<td>Direct works ( X )</td>
<td>535,000</td>
<td>89%</td>
</tr>
<tr>
<td>P&amp;G ( Y )</td>
<td>65,000</td>
<td>11%</td>
</tr>
<tr>
<td>Total</td>
<td>600,000.00</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Amount</td>
<td>Proportions</td>
</tr>
<tr>
<td>Direct works ( X )</td>
<td>350,000</td>
<td>58%</td>
</tr>
<tr>
<td>P&amp;G ( Y )</td>
<td>250,000</td>
<td>42%</td>
</tr>
<tr>
<td>Total</td>
<td>600,000</td>
<td>100%</td>
</tr>
</tbody>
</table>

In order to reconcile such a decline in profit, we have to develop a marginal expression \( f \) which decreases when the direct cost proportion is higher and increases when the direct cost proportion is lower. Table 2 shows a systematic development of the marginal expression \( f \) where \( x = \frac{X}{S} \) and \( y = \frac{Y}{S} \). The

\( x \) and \( y \) are the proportions of direct works and preliminaries and generals respectively. The direct works proportion \( x \) is the proportion of direct works to total contract sum \( S \) and the preliminaries and generals proportion \( y \) is the proportion of preliminaries and generals to total contract sum \( S \).
marginal expression $f$ was simply and purely developed from the imagination with the sole objective of getting an expression that has an increasing/decreasing feature. The objective is achieved by the multiplying the product of $x$ and $y$ by either their difference or their sum throughout three domains. The value of $x$ or $y$ dictates which domain one has to choose for a particular project.

**Conditions**

a. $x + y = 1$ (The sum of direct works and preliminaries and generals proportions equals 100%.)

b. $x \neq 0 \& y \neq 0$ (The contractor’s sum components: direct works and preliminaries and generals are always different from zero)

c. $x > y$ (It is assumed that the direct works proportion is always greater than preliminaries and generals proportion.)

d. $0.55 \leq x \leq 0.95$ and $0.05 \leq y \leq 0.45$

**Domain 1**

For $0.80 \leq x \leq 0.95$ and $0.20 \geq y \geq 0.05$

$$f = xy(x-y) = x^2y - xy^2$$

By substituting $x$ by $S_X$ and $y$ by $S_Y$:

$$f = \frac{X^2Y - XY^2}{S^3}$$

**Domain 2**

For $0.80 \geq x \geq 0.70$ and $0.20 \leq y \leq 0.30$

$$f = 0.6xy$$

By substituting $x$ by $S_X$ and $y$ by $S_Y$:

$$f = \frac{0.6XY}{S^3}$$

**Domain 3**

For $0.55 \leq x \leq 0.70$ and $0.45 \geq y \geq 0.30$

$$f = xy [(x+y)-(x-y)] = x^2y + xy^2 - x^2y + xy^2 = 2xy^2$$

By substituting $x$ by $S_X$ and $y$ by $S_Y$:

$$f = \frac{2XY^2}{S^3}$$

**Table 2 Building-up a marginal expression f**

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>0.95</td>
<td>0.05</td>
<td>0.0475</td>
<td>0.90</td>
<td></td>
<td>0.04275</td>
<td>0.04275</td>
<td></td>
<td></td>
<td>Domain 1</td>
</tr>
<tr>
<td>Y</td>
<td>0.90</td>
<td>0.10</td>
<td>0.0900</td>
<td>0.80</td>
<td></td>
<td>0.07200</td>
<td>0.07200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.85</td>
<td>0.15</td>
<td>0.1275</td>
<td>0.70</td>
<td></td>
<td>0.08925</td>
<td>0.08925</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>xy</td>
<td>0.80</td>
<td>0.20</td>
<td>0.1600</td>
<td>0.60</td>
<td></td>
<td>0.09600</td>
<td>0.09600</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>x-y</td>
<td>0.75</td>
<td>0.25</td>
<td>0.1875</td>
<td>0.60</td>
<td></td>
<td>0.11250</td>
<td>0.11250</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(x+y)-(x-y)</td>
<td>0.70</td>
<td>0.30</td>
<td>0.2100</td>
<td>0.60</td>
<td></td>
<td>0.12600</td>
<td>0.12600</td>
<td>0.12600</td>
<td>0.12600</td>
<td>Domain 2</td>
</tr>
<tr>
<td></td>
<td>0.65</td>
<td>0.35</td>
<td>0.2275</td>
<td>0.70</td>
<td></td>
<td>0.15925</td>
<td>0.15925</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.60</td>
<td>0.40</td>
<td>0.2400</td>
<td>0.80</td>
<td></td>
<td>0.19200</td>
<td>0.19200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.55</td>
<td>0.45</td>
<td>0.2475</td>
<td>0.90</td>
<td></td>
<td>0.22275</td>
<td>0.22275</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1 provides the graphic representation of a marginal expression $f$ versus contractor’s cost proportions $x$ and $y$. The graph is interpreted as follows: The graph was designed with Microsoft excel scatter chart. The proportions of direct works and preliminaries and generals have been intentionally combined in the same Cartesian plan. The bottom x-axis represents the values of preliminaries and generals cost proportions while the top x-axis represents the values of the direct costs proportions plotted in reverse. Y-axis represents the values of the marginal expression $f$ which are calculated in Table 2.

Note that y and x that appear on the graph should not be confused with the nomenclature of cost proportions $x$ and $y$ suggested by the authors during the building-up of the ICA formula. The linear regression equations for straight lines help to predict a value of a dependent variable (here, value of the marginal expression $f$) given the value of independent variable (here, direct works or preliminaries and generals cost proportions). R-squared measures the goodness of fit of a regression to data. But, the regression equations
and $R^2$ are beyond the scope of this paper. The researchers preferred to keep the introduction to ICA formula in generic form.

![Figure 1 Contractor's cost proportions versus marginal expression $f$](image)

**Assumption II - Contract sum $M$: Contractor's sum $S$ versus Prime costs $Z$**

“The higher the contractor's sum, the lower the prime cost sum; consequently little amount is obtained from PC sum and vice versa”.

**Table 3 Illustration of cost recovery from PC according to the proportion of Contract sum versus prime costs**

<table>
<thead>
<tr>
<th>Contract sum $M$</th>
<th>Amount</th>
<th>Proportions</th>
<th>Attendance &amp; profit amount (5%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor's sum $S$</td>
<td>535,000</td>
<td>89%</td>
<td>-</td>
</tr>
<tr>
<td>Prime costs $Z$</td>
<td>65,000</td>
<td>11%</td>
<td>2,955</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>600,000.00</strong></td>
<td><strong>100%</strong></td>
<td><strong>2,955</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Contract sum $M$</th>
<th>Amount</th>
<th>Proportions</th>
<th>Attendance &amp; profit amount (5%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor's sum $S$</td>
<td>65,000</td>
<td>11%</td>
<td>-</td>
</tr>
<tr>
<td>Prime costs $Z$</td>
<td>535,000</td>
<td>89%</td>
<td>24,318</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>600,000</strong></td>
<td><strong>100%</strong></td>
<td><strong>24,318</strong></td>
</tr>
</tbody>
</table>

As shown in Table 3, two contracts A and B have the same contract amount of R600,000 but with different contractor's sum and prime cost proportions. The contractor had allowed 5% attendance and profit on the prime cost amount. It is obvious that where the prime cost proportion is higher (89%) the contractor gets much money (R24,318) than where the prime cost proportion (11%) is lower. It is assumed that where the contractor's sum is lower, the contractor uses less of his resources for example, administration cost while revenues from management fees are higher.

- A marginal probability is allocated as follows: $S \div M$

**Assumption III - Price fluctuation: Cumulative Increased costs $I$ versus Cumulative Basic price amount $B$**

“The more the prices fluctuate, the more the profit is affected and vice versa”.
A marginal probability is allocated as follows: \[ \frac{I}{B}, \] where \( I \): cumulative net increased cost and \( B \): cumulative basic price amount.

**Assumption IV - Allowable profit margin**

"Each contract has an allowable profit margin".

The profit margin expressed as a percentage "\( p \)" is allocated to each contract.

**Assumption V - Administration fees: Increased/decreased cost**

"There are costs incurred during the price adjustment exercise".

An administration fee expressed as a percentage "\( a \)" is provided.

The combination of the above assumptions generates the formula as shown in Table 4. Note that under the concepts of the ICA formula, only a percentage for administration fee is multiplied by the net decreased value then the obtained amount is credited to the contractor’s fluctuation account.

**Distinctive features of ICA formula over other methods**

- The ICA formula audits every single item while CPI formulae group works into categories.
- The ICA formula adjusts price increase using the actual calculated net increased costs while CPI formulae do not attempt to calculate the actual amount of loss involved.
- With the ICA formula, the increased cost adjustment percentage varies continuously according to the level of the cost increase over the basic amount. But the traditional method provides only a single percentage of adjustment to be used throughout the contract.

**Table 4 Recapitulative of ICA formula building-up**

<table>
<thead>
<tr>
<th>Assumptions</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>ICA FORMULA</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOMAIN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The combination of 5 assumptions amounts to a formula that ascertains a margin ( m ) expressed as a percentage required for increased cost adjustment at each interim contract valuation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Form of ICA formula for contract with prime cost sums</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Form of ICA formula for contract with no prime cost sums</td>
</tr>
<tr>
<td>1) 0.80 ≤ x ≤ 0.95 and 0.05 ≤ y ≤ 0.20</td>
<td>( \frac{X^2 - XY}{S} )</td>
<td>( \frac{S}{M} )</td>
<td>( \frac{l}{B} )</td>
<td>( p )</td>
<td>( a )</td>
<td>( m = a + \frac{pI(X^2Y - XY^2)}{MBS^2} )</td>
</tr>
<tr>
<td>2) 0.70 ≤ x ≤ 0.80 and 0.20 ≤ y ≤ 0.30</td>
<td>( \frac{0.6XY}{S^2} )</td>
<td>( \frac{S}{M} )</td>
<td>( \frac{l}{B} )</td>
<td>( p )</td>
<td>( a )</td>
<td>( m = a + \frac{0.6pIY}{MBS} )</td>
</tr>
<tr>
<td>3) 0.55 ≤ x ≤ 0.70 and 0.30 ≤ y ≤ 0.45</td>
<td>( \frac{2XY^2}{S^3} )</td>
<td>( \frac{S}{M} )</td>
<td>( \frac{l}{B} )</td>
<td>( p )</td>
<td>( a )</td>
<td>( m = a + \frac{2pIY^2}{MBS^2} )</td>
</tr>
</tbody>
</table>

5. FINDINGS AND DISCUSSIONS

Illustrative comparison between increased cost adjustment methods

At this stage of further improvement of the ICA formula, the researchers find it necessary to draw an illustrative case study to compare the cash flows obtained using different methods. The traditional method, Haylett formula and the ICA formula will be compared. Table 5 illustrates the cost breakdown of a fluctuating contract to be carried out in five months. Assume the direct cost proportion \( x \) of 87% and the preliminaries proportion \( y \) of 13%. The contractor had allowed 10% profit margin \( p \) on the contract. The cost increase on the net direct cost was subject to adjustment due to increased cost. One has to note that the contractor’s
internal figures which reflect the profit margin and allowable costs are not disclosed to the public. Only external figures are disclosed to the public. The findings of comparison of increased cost adjustment methods are shown in Table 6 and Figure 2. Methods include the traditional method, ICA and Haylett formulae.

Table 5 Monthly cash flows

<table>
<thead>
<tr>
<th>Period</th>
<th>Projected monthly expenditure</th>
<th>Internal</th>
<th>External</th>
<th>Cost increase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Net Direct cost + P&amp;Gs</td>
<td>Anticipated Profit ( p ) (10%)</td>
<td>Net Direct cost ( B ) (87%)</td>
<td>Net P&amp;Gs (13%)</td>
</tr>
<tr>
<td>Month 1</td>
<td>40,000</td>
<td>36,364</td>
<td>3,636</td>
<td>31,636</td>
</tr>
<tr>
<td>Month 2</td>
<td>80,000</td>
<td>72,727</td>
<td>7,273</td>
<td>63,273</td>
</tr>
<tr>
<td>Month 3</td>
<td>60,000</td>
<td>54,545</td>
<td>5,455</td>
<td>47,455</td>
</tr>
<tr>
<td>Month 4</td>
<td>40,000</td>
<td>36,364</td>
<td>3,636</td>
<td>31,636</td>
</tr>
<tr>
<td>Month 5</td>
<td>30,000</td>
<td>27,273</td>
<td>2,727</td>
<td>23,273</td>
</tr>
<tr>
<td>Total</td>
<td>250,000</td>
<td>227,273</td>
<td>22,727</td>
<td>197,727</td>
</tr>
</tbody>
</table>

**Traditional method**

Five percent was used for adjustment of the net increased cost. The adjusted amount in column G is obtained by multiplying 5% to the net increase in column F. The total amount claimed is obtained by summing up the total sum for the projected external valuation in column E, the net cost increase in column F and calculated adjusted amount in column G. For example the total claimed amount in the second month is calculated as follows:

Total cumulative amount in the second month = R120,000+R27,000+(R27,000*0.05)=R148,350

**ICA formula**

For a contract with no prime cost sums with direct cost proportion of 0.87, the ICA formula option falling under domain 1 was adopted to calculate the percentage \( m \) of increased cost adjustment.

\[ m = a + \frac{p(X^2Y - XY^2)}{BS^3}, \]

where \( a \) is the administration fee of 5%, \( p \) is the allowable profit of 10% at tender, \( l \) is the net increased cost at month of valuation, \( X \) is the original total direct cost sum, \( Y \) is original total preliminaries sum, \( B \) is the basic price amount in the month of valuation and \( S \) is the original total contractor’s sum. The value of \( I, X, Y, B \) and \( S \) are found in respective columns F, C, D, B and E. For example the percentage \( m \) of adjustment in the third month is calculated as follows:

\[ m = 5 + \frac{10 \times 32000(2175001 \times 325000 - 2175001 \times 325000)}{14362 \times 250000^3} = 5.19\% \]

The total amount claimed is obtained by summing up the total sum for the projected external valuation amount in column E, the net increased cost in column F and calculated adjusted amount in column G. The total cumulative amount in the third month equals to R180,000+R32,000+(R27,000*0.5188)= R213,660.

**Haylett formula**

CPAP [6] calculates the amount of adjustment as follows:

\[ A = 0.85V \left( \frac{X_e}{X_o} - 1 \right), \]

where \( A \) is the amount of adjustment, 0.85 is a constant which provides for a 15% non-adjustable element, \( V \) is the work value of the index applicable to such work group and valuation period, \( X_e \) is the value of the index applicable to such work group and valuation period and \( X_o \) is the value of the index applicable to such work group for the base month.

Since this is an illustrative case, we will calculate the ad hoc index by means of the net costs of this particular project. Basically, the index number for a given good for a given period is calculated as follows: Calculate the difference between the actual price of a good and its price at the beginning of period over the price at the beginning of the period multiplied by 100.

For example the index at the end of the fourth month is calculated as follows:

Actual price is equal to the direct cost (R174,000) in column B plus the net increase cost (R39,000) in column F which totals to R213,000 in column L. Index equals to 213,000 in column L minus R174,000 in
column L over R174,000 multiplied by 100 plus 100 a base index number in column M which represents a base period. The index number in the 4th month is 122.

The amount of adjustment in the 4th month is calculated as follows:

\[ A = 0.85V \left( \frac{X_e}{X_0} - 1 \right) \]

Since no attempt is made to calculate how much prices have gone up, the value \( V \) of executed works in the 4th month is R220,000.

\[ A = 0.85 \times 220000 \times \left( \frac{122}{100} - 1 \right) = 41914 \]

The total amount in the 4th month is R220,000 + R41914 = R261,914

Figure 2 Comparison between methods of increased cost adjustment

By comparing the monthly cash flow between the existing methods for increased cost adjustment against the ICA formula, monthly cash flow is in between the traditional method and Haylett formula. This is an indication that the ICA formula may provide an optimum recovery for increased cost adjustment.

Table 6 Cumulative cash flows

<table>
<thead>
<tr>
<th>Months</th>
<th>Direct costs</th>
<th>Projected cash flow external</th>
<th>Net increase</th>
<th>Trad. Method</th>
<th>ICA formula</th>
<th>Haylett formula</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Direct costs</td>
<td>P&amp;Gs</td>
<td>Tot</td>
<td>Adj</td>
<td>Cash flow</td>
<td>Adj %</td>
</tr>
<tr>
<td>A</td>
<td>31,636</td>
<td>34,800</td>
<td>5,200</td>
<td>40,000</td>
<td>15,000</td>
<td>750</td>
</tr>
<tr>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>31,636</td>
<td>34,800</td>
<td>5,200</td>
<td>40,000</td>
<td>15,000</td>
<td>750</td>
</tr>
<tr>
<td>2</td>
<td>94,909</td>
<td>104,400</td>
<td>15,600</td>
<td>120,000</td>
<td>27,000</td>
<td>1,350</td>
</tr>
<tr>
<td>3</td>
<td>142,364</td>
<td>156,600</td>
<td>23,400</td>
<td>180,000</td>
<td>32,000</td>
<td>1,600</td>
</tr>
<tr>
<td>4</td>
<td>174,000</td>
<td>191,400</td>
<td>28,600</td>
<td>220,000</td>
<td>39,000</td>
<td>1,950</td>
</tr>
<tr>
<td>5</td>
<td>197,729</td>
<td>217,500</td>
<td>32,500</td>
<td>250,000</td>
<td>48,000</td>
<td>2,400</td>
</tr>
<tr>
<td>Tot</td>
<td>197,729</td>
<td>217,500</td>
<td>32,500</td>
<td>250,000</td>
<td>48,000</td>
<td>8,050</td>
</tr>
</tbody>
</table>
6. CONCLUSIONS
The study consisted at identifying the shortcomings of the existing increased cost adjustment methods in terms of their non-suitability for use in a highly inflationary economic environment and develops the ICA formula as an attempt for a remedial solution. The literature uncovered the shortcomings of the existing increased cost adjustment methods. In particular, it was revealed that the CPI based formulae either overstated or understated the market conditions.

The ICA formula was then developed in order to reconcile the shortcomings found in existing increased cost adjustment methods. The ICA building-up was based on three major concepts including the uniqueness of each construction contract, the allowable profit margin that should be realized at the end of the contract and a comprehensive breakdown of a contract sum in a way the contractor’s profit was affected. An illustrative case study compared the cash flows of a contract using the ICA formula against other methods. It was shown that the amount obtained through ICA formula was in-between the traditional method and the Haylett formula. Hence the ICA formula has the potential for optimum cost recovery considering both the client and the contractor. When a traditional method is used, it puts a financial burden to the contractor and the recovery using the Haylett formula puts a financial burden to the client.

7. MERITS, LIMITATIONS AND RECOMMENDATIONS
While the application of CPI based formulae requires indices compiled with an external agency, ICA has an advantage of using the really cost incurred on a particular contract. Given the current market price fluctuations, the adoption of the ICA formula as an alternative method for increased cost adjustment will provide an optimum cost recovery, hence the equitable share of the financial responsibilities between both the client and the contractor. Since the inflation and the continuous increase in construction input cost is becoming a global challenge to the construction industry, there is a need for the construction industry stakeholders to pursue theories provided under the ICA concepts.

Further studies are necessary to determine at which level of price increase the existing increased cost adjustment methods commence to generate problems. Further studies to establish various applications of the ICA formula such as for example this formula to be used as a guideline tool or cost prediction model to ascertain the required mark-up for adjustment of increased costs where disputes arise in this regard.

8. REFERENCES