Construction cost index: a case study in Malaysia

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Abstract. Construction Cost Index (CCI) is introduced to enhance cost forecasting in construction projects. However, the effectiveness and its application in the developing countries are limited. Therefore, a case study is conducted in Malaysia to investigate the effectiveness of CCI in developing country. In order to achieve the aim, the objectives of the study are to identify the CCI implementation factors, challenges of CCI that hindering its implementation and to justify its applicability in developing countries. Quantitative approach is selected for data collection. 1000 sets of questionnaires were distributed to the construction industry stakeholders. Principal Component Analysis (PCA) and Structural Equation Modelling (SEM) were employed to analyse the collected data. It is found that encouragement from local government plays a vital role in CCI concept. Meanwhile, the reliability and validity of CCI remain as the major CCI implementation challenges in the industry. From the SEM, a causal relationship framework of CCI implementation factors and CCI functions is developed. The framework is important to serve as an implementation guideline for the stakeholders. This study is significant to provide an insight overview of CCI to the stakeholders to enhance cost estimating efficiency.

1. Introduction
The construction industry in Malaysia continues to cost estimation is one of the key considerations in the construction project life cycle which plays an important role in driving a project success [1]. Therefore, estimation accuracy is essential in budget preparation to fulfil the perspective of the stakeholders. However, construction cost estimation is the key problems in construction project. This is due to the high uncertainty of construction cost change dynamically.
over the time [2]. In order to eliminate and reduce cost estimation problems, Construction Cost Index (CCI) is introduced to serve as an effective solution on the problems occurs relate to the cost. CCI had been widely used by the developed countries, such as United States and European Union (EU) [4]. In United States (US), the national average CCI has been continuously reviewed and published monthly. The CCI provided are developed after weighted the aggregate index of average construction prices in 20 cities. Other than CCI, industry practitioners also constantly review on the other indices such as Building Cost Index (BCI), Skill and Common Labour Cost index (LCI), Material Cost Index (MCI) and etc. The constant reviewing of CCI helps industry personnel, such as contractors in better cost estimation and budget preparation in order to secure winning bids [5]. Moreover, CCI represents the general cost changes in a country construction industry as the components costs have a direct control and weighted to the overall cost index (Paul and Mathew, 2012). Disparate with US, Eurostat does not have the data of CCI in particular countries such as Ireland, Poland, Belgium, Croatia and etc. [4]. Despite, there is lack of study on the effectiveness of CCI in developing countries. Therefore, Malaysia as one of the developing country introducing CCI is needed to be reviewed on CCI effectiveness and its implementation. CCI is introduced in Malaysia on December 2003 by Construction Industry Development Board (CIDB) Malaysia.

The implementation of CCI is entailed in Malaysia to serve as an indicator on the construction cost measurement [7]. Hence, the application of CCI is expected to provide assist to the developers and contractors. CCI is able to offer accurate cost estimation in construction projects which able to improve the cost estimation in the industry. Besides, the awareness of construction personnel to implement CCI is able to boost the cost performances. In Malaysia, cost overrun is a significant problem exists in the industry. Through the study in year 2010, there are more than 50% of public sectors and more than 63% of private sectors were found completed their projects beyond their estimated budgets. The major factors that result in cost overrun are the inaccurate or poor estimation of original cost, fluctuation in the price of materials, poor financial control, construction cost underestimation and etc [1]. Moreover, the issues of over estimating and under estimating of the project cost causing erroneous bids remain untreated. As such, the inconsistent bidding price affecting the difficulties of contractors in tendering for projects in Malaysia. Hence, the accuracy of cost estimated is curial to be ensured in order to certify the improvement in budget preparation. Government authority, CIDB expects to reduce the norms through implementing CCI in the industry projects [8].

However, the cost performances of construction projects in Malaysia are still in an inferior condition after 10 years CCI introduced. This is mainly due to the low level of awareness and knowledge of construction personnel on the application and effectiveness of CCI. As an investigation into the developing country, on the manner, the level of CCI implementation in Malaysia and its usefulness needed to be validated and clarified. As such, it is crucial to identify the implementation level of CCI and its effectiveness in construction projects. Subsequently, the key factors which restricting or influencing the CCI implement also determined. The effectiveness and successfulness of CCI assist and practises in construction projects in developed countries are validated by previous researchers. However there is a needed to come out an investigation of the effectiveness and situation of CCI in developing countries. Hence, this study is significant to provide a view of CCI from developing country perspective on this matter. The developing countries, such as Malaysia construction industry needs for this innovative cost management and cost estimation tool. Therefore, utilised of CCI throughout the construction projects is believed to effectively enhance the entire cost performance in the industry projects through increase the awareness of construction personnel on CCI implementation and its efficacy.
2. CCI in European and Malaysia

The CCI is introduced into Malaysian construction industry since year 2003. CCI indices are updated and published in the CIDB webpage entitled “National Construction Cost Centre (N3C)” monthly. While, the N3C is mainly focuses in Building Material Cost Index (BMCI) with the purposes to “provide consultancy and advisory services with respect to the construction industry” and “initiate and maintain a construction industry information system” [8]. CCI is intended to show the cost needed by contractors to accomplish the whole construction stage. Three main inputs to all construction works are typically building materials and products cost, labour cost, and construction equipment hire cost [11]. Moreover, the components affecting CCI are grouped in financial, economic, stock market and energy (Zhang, 2007). However, this does not signify that they are core components to carry out the calculation of CCI.

Eurostat reviews that the contents to calculate CCI are building materials cost (BMCI), labour cost (LCI), machinery cost (MCI), transportation, energy and others [12]. They also mentioned that materials and labour cost index are the most important components in CCI. However, CIDB has developed a new CCI calculation in Malaysia. The components of CCI in Malaysia are building materials cost and products cost, labour cost, and machinery cost [13] [14]. CIDB [8] stated that more than 60% of building construction cost is related to building materials. This is because transportation cost is usually implanted in material cost in Malaysia. Besides, the cost of energy is mostly embedded in machineries, materials and overhead costs [15]. The new energy used in the European countries is not suitable and apply in Malaysia such as wind energy, dynamic energy and solar energy. Consequently, the Malaysian CCI is only consists of building materials cost, labour cost and machinery cost

\[
CCI = BMCI + LCI + MCI + \text{Transportation} + \text{Energy} + \text{other}
\]  
(Eurostat, 2016)  

\[
CCI = BMCI + LCI + MCI
\]  
(Zakaria, 2004)

On the other hand, the allocation of percentages among component of CCI for those developed countries and Malaysia are dissimilar. First and foremost, the labour cost index believed occupied a lesser percentages in United States compare to Malaysia. The increase use of new technologies and mechanisation in construction projects might reduce the need of unskilled workers in the sites [16]. Therefore, machinery costs are thought to be higher in the project life-cycle compare to labour cost in those developed countries. However, Malaysian construction industry is more rely on large number of workers to carry out the construction stages [8]. The huge number of foreign workers imported to Malaysia construction industry causing Malaysia’s CCI is more to labour cost and materials cost index rather than machinery cost. Despite, the labour cost index is suspected to be reduced due to the high percentage increase of workers levy for foreign construction labours.

Reported by Cheng [17], the construction materials cost should be free from Good and Services Tax (GST) in Malaysia. However, the basic materials such as brick, cements, and tiles which classified in First Schedule Good are not subject to sales tax but the others materials which classified as Second Schedules Goods are charged in sales tax [17]. In order to stabilise the building material costs, Malaysia Government has taken out several efforts. The government has taken the first step on making proper planning on Government development projects. Through the consideration of the other private sector construction activities in the development planning, sudden surges of demand in building materials can be avoided. Next, the Competition Act 2010 (Act 712) is enforced to help in maintains the materials prices [12]. With the co-operation of government and CIDB, the construction prices are controlled and the benefits of construction parties are secured.
Malaysian construction industry is continually affected by the dynamic economic. Malaysia report in December 2014, the transportation cost is expected to increase due to the increases of oil prices and manpower shortage. Other than these, the construction project cost is expected to increase due to GST implementation in April 2015 [18]. However, this expectation in increase of oil prices is wiped out with the dramatically fall in crude oil price in the world market and also spook investors in Malaysia [19]. These show the uncontrollable and unpredictable of the economic and domestic cost factors, which always significantly affects the construction projects and projects’ budget. Therefore, the cost performances and management in the construction projects are aim to enhanced with the cooperation and assist of utilizing CCI. Nevertheless, possible difficulty of CCI implementation is the barriers between the east and west Malaysia. The unsynchronized policy and market treading prices between two regions create the barriers in implementing specific industry new technologies [20].

3. Factor affecting CCI implementation

The factor affecting the implementation of CCI is recognized as in Table 1. The factors are categorized into six (6) categories, namely Economic Condition (EC), Effectiveness and Efficiency (EE), Reliability and Validity (RV), Project Nature (PN), Governance (GV) and Knowledge (KN). These categorise are generated based on the characteristics of the factors affecting the implementation of the CCI.

Economic condition is referring to micro and macroeconomic conditions which directly influence the construction material price. CCI represent the real-time market prices and cost expansion in the industry. The uncontrolled prices variation in the market has resulted in poor financial performances for those unaware practitioners [21]. The typical example is the increment of reinforcement price in South East Asia in 2008-2009 which resulted in cost overrun in several projects.

Effectiveness and efficiency of cost performances is one of the important criteria to be measure the success of a project [22]. Effectiveness and efficiency is measured according to time, cost and quality. In terms of CCI, cost effectiveness, time efficiency, integration of CCI in cost estimating and documentations factors are interrelated. Moreover, effectiveness and efficiency also considered the ability of the CCI in reflecting the specification changes. This is mainly due to design and documentation factors (DDF) ascribed as one of the major problem causing the change of construction cost performances and finally affect the overall construction cost in Malaysia [1] [23] [24]

| Category               | Factors                                         | Sources                          |
|------------------------|-------------------------------------------------|----------------------------------|
| Economic Condition     | Micro and Macro Economy                         | [28]                             |
|                        | Fluctuation                                      | [1] [21] [29]                   |
|                        | Inflation                                        | [5] [29] [30] [31]              |
| Effectiveness and Efficiency | Cost Effectiveness and Time Efficiency     | [22]                             |
|                        | Proper Integration of CCI in cost estimation    | [12]                             |
|                        | Design and Documentation Factors (DDF)          | [1] [23] [24]                   |
| Reliability and Validity | Data Accuracy                                    | [14] [27]                       |
|                        | Reliability and Validity of CCI                 | [23] [32]                       |
|                        | Availability and Accessibility                  | [2]                              |
| Project Nature         | Geographical Region                              | [4]                              |
|                        | Context of Projects                              | [1]                              |
| Governance             | Encouragement of Government                      | [21] [28] [33]                  |
|                        | Regulations and Policies Changes                 | [21] [28]                       |
| Knowledge              | Training                                        | [32] [34]                       |
|                        | Awareness                                       | [32] [34]                       |
|                        | Skills and Experiences of User                   | [8] [27] [32]                   |
Reliability and validity of data refers to the degree of believability on the measured approach that indicates the instrument quality \([25]\) \([26]\). The reliability and validity of CCI relies on contracts valuation and price alignment basis \([26]\).

Project nature is referring to the characteristics of the project. CCI is influence by the geographical region, type of project and availability of materials. Taking Malaysia as case study, Malaysia is formed by Peninsular Malaysia and Borneo Island. CCI in Borneo Island will be slightly higher due to additional transportation. Moreover, the labour cost index in that region is higher than Peninsular Malaysia as there are limited skill workers as well as limited construction technology.

The implementation of CCI is greatly affected by the government policy. This is happened in Malaysia that CCI has been introduced for decades, but the implementation of CCI is at minimal level. This is interrelated to knowledge where Malaysians are not aware of the benefits of CCI. Meanwhile, there are limited resources and training provided to the practitioners in utilizing CCI.

4. Methodology
Research design generates the basis for the entire study works. The selections of research design facilitate the sufficiency and efficiency of the study on acquiescent maximum information needed. Therefore, this study was conducted vitally in quantitative manner with the utilisation of questionnaire survey. The questionnaire was prepared according to the implementation of CCI in Malaysia and factors affecting it which discussed in the literature study. Pilot study was conducted in the preceding of distribution the questionnaire to ensure its workability and reliability.

| Table 2. Questionnaire distribution |
|------------------------------------|
| **Distributed Questionnaire** | **Sets** |
| Contractor | 250 |
| Cost Consultant | 250 |
| Developer | 250 |
| Local Authority | 250 |
| Total Distributed | 1000 |
| Total Received | 426 |
| Valid Questionnaires | 390 |

1000 questionnaires were dispersed to the respondents as shown at Table 2, 250 sets each to contractors, cost consultants, developers and local authorities. Sampling size required for this study is 384 sets for the industry players based on 95% confidence level, 5% sampling error. 426 sets were collected, 390 sets questionnaire were valid, encountered 39.0% of response rate are acceptable respond \([35]\). The factors are further validated through semi structured interview with local authority, construction personnel and practitioners. The collected data subsequently evaluate in descriptive analysis.

Two Principal Component Analysis (PCA) are conducted from the data collected from questionnaires to achieve the aim of this study. First PCA test is carried out to define the overview of factors affecting CCI implementation in Malaysia. The second PCA test is conducted to test the affecting factors of CCI according to the project stakeholders’ interests. The purpose to run PCA test on different stakeholders is to identify their different interests of cost estimation in CCI criteria.

Other than this, one-way ANOVA test is carried out to test the implementation level of CCI in Malaysian construction industry and the relationship among CCI implementation level and
different stakeholders. Thus, hypotheses are developed in this test. The hypotheses are developed as follow:

First issue : Level of knowledge on CCI
Null hypothesis $H_{10}$ : Industry personnel are aware on the CCI introduction.
- Contractors are aware on CCI introduction.
- Cost consultants are aware on CCI introduction.
- Developers are aware on CCI introduction.
Alternative hypothesis $H_{11}$ : Industry Personnel are not aware on the CCI introduction.
- Contractors are not aware on CCI introduction.
- Cost consultants are not aware on CCI introduction.
- Developers are not aware on CCI introduction.

Second issue : Implementation of CCI in the construction projects
Null hypothesis $H_{20}$ : CCI is implemented in the previous construction projects.
- CCI is implemented in contractors’ previous projects.
- CCI is implemented in cost consultants’ previous projects.
- CCI is implemented in developers’ previous projects.
Alternative hypothesis $H_{21}$ : CCI is not implemented in the previous construction projects.
- CCI is not implemented in contractors’ previous projects.
- CCI is not implemented in cost consultants’ previous projects.
- CCI is not implemented in developers’ previous projects.

5. Data analysis and discussion

Figure 1. Respondent rate on different stakeholders

Figure 1 shows the response rate of the respondents. Contractors recorded the highest percentage of 45%, meanwhile developer and local authority recorded the lowest 17%. The overall response rate is at 39%.

Cronbach’s Alpha ($\alpha$) is conducted for internal consistency test. The coefficient is recorded as 0.937, recorded a high internal consistency of the questionnaire. The high coefficient might due to high numbers of collected samples. This can be seen form the Kaiser-Meyer-Olkin (KMO) and Bartlett’s Test which recorded 0.891. This indicated that those factors are significant to be used in the analysis [37].

The first Principal Component Analysis (PCA) is conducted on the factors to determine and regroup the major factors affecting CCI implementation in Malaysia through Varimax rotation. The key factors are regrouped into six (6) component factors as shown in Table 3 and named as the CCI publication interval, cost efficiency, reliability and validity, time saving, government encouragement, and awareness. The cutoff 0.7 factor loading is made to indicate an adequate
degree of significance of the factors in this study [38]. According to the factor loading obtained, the encouragement of government is the most critical factor which affect the CCI implementation with factor loading 0.903. This result shows that the encouragement and introduction of CCI by local government is very important to implement new tools or new technologies in construction industry. The importance of the factors are followed by the ability of CCI on enhancing and save time on cost estimation (0.859, 0.811) and the willingness of practitioners on learning CCI (0.832). This result shows the trend of construction industry in applying new tools or technologies in the projects. CCI can only be widely apply in Malaysian construction projects when its benefits and ability are proved. The current construction industry is willing to learn new tools when it able to enhance and much improve the construction projects and better return in monetary investment, as same as another new technology, Building Information Modelling (BIM) [39].

Table 3. Principal Component Analysis regrouping

| Factors Regrouping                        | Factor Loading |
|-------------------------------------------|----------------|
| CCI Publication Interval                   |                |
| CCI provided tally with market time by time.| 830            |
| Time interval on publishing CCI is sufficient.| 870            |
| CCI is Up-to-date                          | 831            |
| Construction cost can be determined easily by review historical cost indices provided by CIDB. | 747            |
| Cost Efficiency                            |                |
| CCI provides latest monetary inflation on construction cost. | 733            |
| CCI improve estimation on project bidding prices. | 732            |
| CCI provide accurate current material prices, labour wages and machinery prices. | 756            |
| Use of CCI can forecast future uncertainty prices factors. | 725            |
| CCI increase cost efficiency in projects.  | 787            |
| CCI can affect construction cost estimation. | 811            |
| Reliability and Validity                   |                |
| CCI provide prices of unique items.        | 748            |
| CCI provides import materials prices.       | 735            |
| Reliability and validity of CCI is critical factors on its implementation. | 810            |
| Time Saving                                |                |
| Use of CCI because of the drawing change frequently time by time. | 739            |
| CCI save time on project cost estimation.   | 859            |
| Government Encouragement                   |                |
| CCI hard to implement due to complexity of cost performances in the projects. | 866            |
| Government does not enforce CCI or provide policies to encourage the use of CCI. | 903            |
| Awareness                                  |                |
| CCI is noticed by construction personals since it introduced in Malaysia. | 743            |
| CCI not suitable to be used in construction projects. | 704            |
| Construction personal are willing to learn on using CCI. | 832            |

Subsequently, second Principal Component Analysis (PCA) is conducted to identify the factors affecting the implementation of CCI in Malaysia based on different stakeholders’ interest as shown in Table 4. Based on the result obtained, contractors believed that the implementation of CCI is required to be considered from multiple sectors. The reliability of CCI, accessibility of the data, accuracy of CCI is deemed to be the consideration of contractors in the implementation. This is mainly due to contractors are more interested in the accuracy and estimating speed of the
CCI in winning the tender. This result is aligned with the study of Rahman that accuracy and time are the key issues in driving the project success [29].

Table 4. Stakeholders Principal Component Analysis in factors affecting the CCI implementation

| Contractor | Factors                                                                 | Factor Loading | Ranking |
|------------|--------------------------------------------------------------------------|----------------|---------|
|            | CCI provides accurate current material prices, labour wages and machinery prices. | 0.890          | 1       |
|            | CCI provides needed import materials prices.                              | 0.855          | 2       |
|            | CCI is easy to access by users.                                           | 0.854          | 3       |
|            | CCI provides the prices of unique items.                                  | 0.832          | 4       |
|            | CCI provides the latest market prices.                                    | 0.818          | 5       |
| Developer  | CCI save the time for project cost estimation.                            | 0.986          | 1       |
|            | Use of CCI provides better cost control and cost management during construction. | 0.983          | 2       |
|            | CCI provides accurate current material prices, labour wages and machinery prices. | 0.979          | 3       |
|            | CCI is easy to access by users.                                           | 0.973          | 4       |
|            | Government policies to cancelled building materials controlled prices cause CCI to be use to obtain latest market fluctuation prices. | 0.967          | 5       |
| Cost Consultant | Use of CCI increases the accuracy of project bidding price estimation. | 0.950          | 1       |
|            | CCI provides needed import materials prices.                              | 0.910          | 2       |
|            | CCI provides latest monetary inflation on construction costs.             | 0.898          | 3       |
|            | CCI is noticed by construction personnel since it introduce to Malaysia.  | 0.889          | 4       |
|            | CCI bring effective and efficiency on the project.                        | 0.877          | 5       |
| Authority  | Use of CCI increases the cost efficiency in construction projects.        | 0.985          | 1       |
|            | CCI provided by CIDB cover all the states in Malaysia.                    | 0.979          | 2       |
|            | Construction cost can determine easily by reviewing historical cost indices data provided by CIDB. | 0.977          | 3       |
|            | Use of CCI enables to save construction cost.                            | 0.974          | 4       |
|            | CCI contributes time efficiency to the entire construction project.       | 0.962          | 5       |

However, developers are interested on how CCI is able to assist in the project management related issues. The effectiveness of CCI in enhancing the project works, in term of improve cost management and control, and save time for cost estimation are the most important factors driving them to utilise CCI. Basically, the success of a project criteria are based on the iron triangle of project management by saving the cost and time with provide adequate quality [40].

Cost consultants is looking at the accuracy and CCI reliability. Cost consultants expected to obtain the latest monetary inflation and fluctuation of market conditions from the CCI. The accuracy of CCI plays an important role in ensuring accurate budget preparation and cost planning.

Local authorities are interested in the benefits of CCI and to provide awareness and publication of CCI to the industry. Thus, CIDB is expecting that CCI can be implemented widely to promote accuracy, efficiency in estimating and control material prices in the country.

As a summary, the construction personals are looking on the effectiveness of CCI to enhance projects prices and cost. Therefore, the ability of CCI to improve project’s cost estimation and management is crucial. However, the skills and experiences to utilize the CCI are not concerned
by industry practitioners. Through the validation by interview, the industry personnel are willing to learn and practise on CCI when the effectiveness and reliability of CCI in Malaysia are proved and developed. However, the existing of different cost index in each construction company increases the difficulty on the CCI implementation in nationwide.

ANOVA test is conducted to correlate the CCI knowledge of different stakeholders as shown in Table 5.

Table 5. ANOVA test on the construction personnel knowledge on CCI

| Issues                                      | Firm    | Mean   | F     | Sig   |
|---------------------------------------------|---------|--------|-------|-------|
| Knowledge on CCI                           | Contractor | 2.5306 | 15.019| .000  |
|                                             | Developer  | 3.3333 |       |       |
|                                             | Consultant | 3.8696 |       |       |
| Usage of CCI published by CIDB              | Contractor | 3.7143 | 2.890 | .004  |
|                                             | Developer  | 3.8333 |       |       |
|                                             | Consultant | 3.9565 |       |       |
| Average cost overrun in past project        | Contractor | 2.0408 | 4.832 | .003  |
|                                             | Developer  | 2.6667 |       |       |
|                                             | Consultant | 2.1304 |       |       |

From the Table 5, knowledge on CCI, usage of CCI published by CIDB and average cost overrun in past project shown a significant confidence level, \( p < 0.001 \) and \( p < 0.005 \).

Based on result obtained, not all construction personnel are aware of CCI. Developers and cost consultants are more aware on CCI introduction compare cost consultants. This might be due to developers and cost consultants are more sensitive in financial budgeting and risk for cost overrun, are more focus on the accuracy of the entire project cost performances [10] [41]. For cost consultants, CCI is not important and reliable in their professional opinions as most of the company having their own cost data. Moreover, direct negotiation with the suppliers are able to obtain the discounted prices.

According to the ANOVA results, all the null hypotheses for the first and second issue, \( H_1_o \) and \( H_2_o \), are rejected respectively except for the \( H_1_o \) (iii).

A semi structured interview is conducted with 3 industry practitioners to validate the PCA and ANOVA results. The practitioners have no further comments on the PCA and ANOVA results, but commented on the components of CCI. The components of Construction Cost Index (CCI) in Malaysia are published by CIDB Malaysia, comprises of building material cost, labour cost and machinery cost only [4]. The practitioners suggested that transportation should be included as one of the component in CCI. This is mainly due to transportation services in Malaysia are not in optimum status where the cost of transportation incorporated should not be standardized. Practitioners do agree that energy cost is not really affecting the overall construction cost.

6. Conclusions
CCI is introduced in Malaysia since 2003 and it had being proved its ability to provide accurate and reliable cost estimating in the industry. Local government believes that CCI is able to create cost transparency in the public project. However, CCI is not commonly applied in the industry due to the non-accuracy of CCI reflected the economic conditions and lack of encouragement from Malaysian government. Local government is advised to improve the accuracy and reliable cost index based on the fluctuation of market prices. Besides, CCI indices component should be re-examine. Nevertheless, local authorities should encourage and promote to the industry personnel on the ability of CCI in solving cost estimation.

This study reveals that the Malaysian construction practitioners are not ready to adopt CCI published by CIDB even though the benefits of implement CCI are proven. Therefore, barriers
causing the low level of CCI implementation in Malaysia and its’ resolutions are needed to be further investigated in order to promote the utilization of CCI in the country.

7. Acknowledgements
This study is financed by the Universiti Teknologi Malaysia, Research University Grant, Cost Centre No. Q.J130000.2522.15H38.

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