PM World Journal (ISSN: 2330-4480)
Vol. IX, Issue II – February 2020
www.pmworldjournal.com

Using Cost Indices to Develop Project Cost Estimation for Oil & Gas Industry in Indonesia
Featured Paper   by Arief Rachman

Using Cost Indices to Develop Project Cost Estimation for Oil & Gas Industry in Indonesia [1]

Arief Rachman

ABSTRACT

Managing projects that are operating in disrupted and rapidly changing landscapes requires maturity for achieving the project's objectives. In order to be mature in planning and financial forecasting, the biggest concern is accurate estimating of anticipated costs before committing to the project. Projects are moving so fast, and they have limited time to develop the scope and accurately estimate costs.

Due to the requirements of end-use, we need methods or tools that can help to develop cost estimates easily and quickly. To seek the method or tool for solving the problem, the alternatives are selected and be assessed to define the project cost estimation from the other project in another location or the previous project.

Key words: Cost Indices, Cost Index, City Cost Index, Construction Cost Indices, Construction Cost Index, Project Cost Estimation, Project Cost Index, Project Cost Calculation

INTRODUCTION

In 2019, the synergy of the International Project Management Association (IPMA), Australian Institute of Project Management (AIPM) and Klynveld Peat Marwick Goerdeler (KPMG) undertook the research survey to identify and highlight the challenges of project management. With respondents with nearly 500 companies from 57 countries around the world, the research survey result states that organizations globally continue to find it difficult to deliver projects that meet all objectives around the triangle of time, cost, and scope, along with achieving stakeholder satisfaction. From the survey results, 44% of organizations are likely to deliver projects that meet original goal and business intent, 30% of organizations are likely to deliver projects that are on time, and 36% of organizations are likely to deliver projects that are on a budget. The data indicates that over half of the projects are failed and not give the original goal of the project.

Managing projects that operate in disrupted and rapidly changing conditions requires maturity to achieve project goals. We require maturity in planning and financial forecasting, maturity in hiring, and developing the right talent, maturity in ongoing risk and project management. We also require maturity in contingency management and maturity to build a positive and

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[1] How to cite this paper: Rachman, A. (2020). Using Cost Indices to Develop Project Cost Estimation for Oil & Gas Industry in Indonesia; *PM World Journal*, Vol. IX, Issue II, February.

PM World Journal (ISSN: 2330-4480)
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productive working relationship between project owners and contractors that bring out the best in all parties. Lack of one of the maturity level will cause the project to fail to achieve the goals.

Maturity in planning and financial forecasting, the biggest concern is accurate estimating of anticipated costs before committing to the project. Projects are moving so fast, and they have limited time to develop the scope and accurately estimate costs.

Cost estimating is the forecast power to quantify the cost and price of the resources needed for the magnitude of the scope of investment options, activities, or projects. The goal of cost estimating is to minimize the uncertainty of the estimate given the level and quality of scope definition. The outcome of cost estimating includes both an expected cost and a probabilistic cost distribution.

Generally, the implementation cost estimating process during each phase of the project life cycle as the project scope is defined. At the beginning of the project where the scope definition is rough, the accuracy of the cost estimating is low. The preparation of these cost estimates is used for many strategic business planning purposes, such as market studies, initial feasibility assessments, evaluation of alternative schemes. Besides that, for project screening, project location studies, evaluation of resource needs and budgeting, long-range capital planning, etc.

When the project definition moves to a more detail phase, we need cost estimation with higher accuracy. To prepare the most detailed (Class 1) cost estimate to develop an estimation control system that is used as a final control baseline that monitors all current costs and current resources against variations in costs and parts of changes. The estimated cost can be used to evaluate bid proposals, to support vendor/contractor negotiations, or to evaluate claims and resolve disputes. Typically, it consists of engineering progress from 50% to 100% has completed, and will be complemented by all project engineering and design documentation, and virtually the completion of project implementation and commissioning plans.
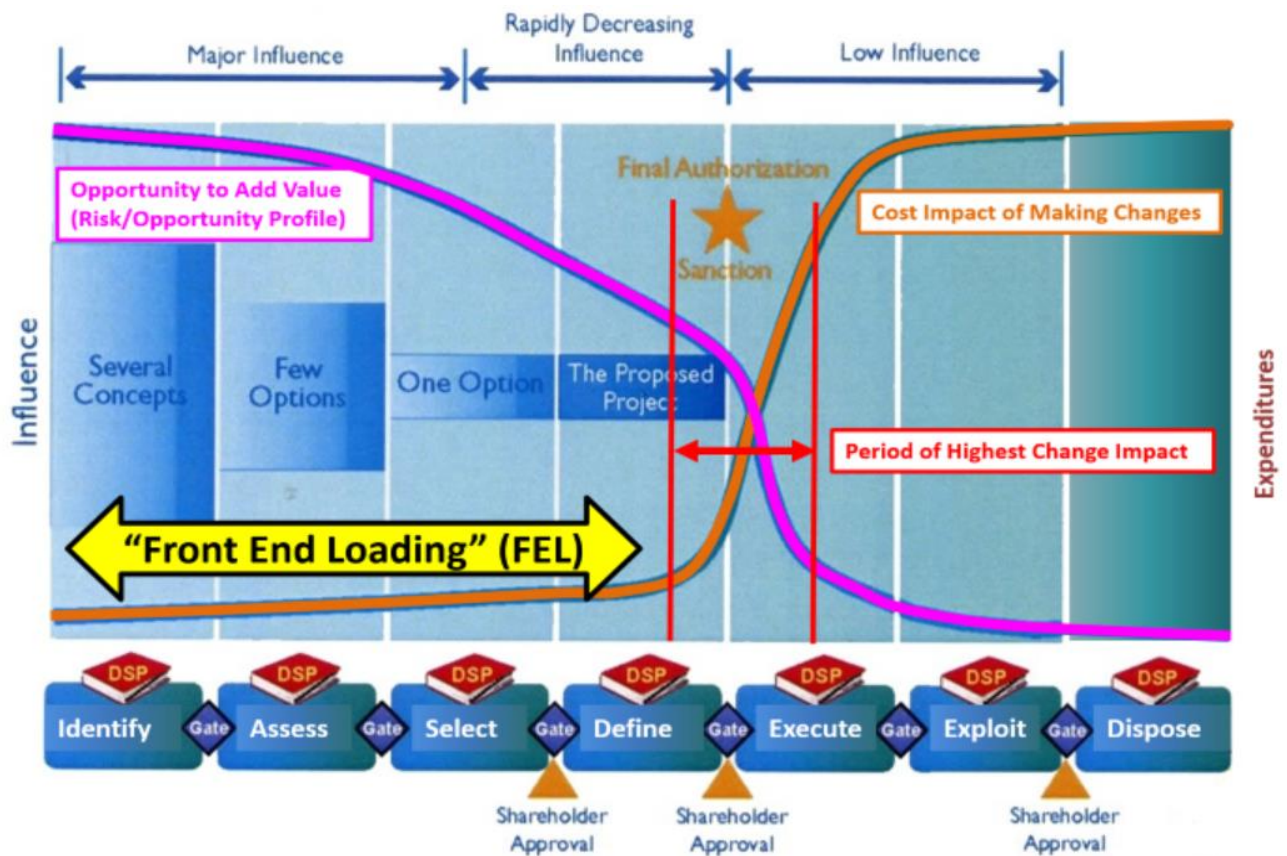
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Figure 1. Concept of "Front End Loading" (FEL) Illustrated (MacLeamy Curve)[2]

Class 5 cost estimates are used for many strategic business planning purposes, such as but not limited to initial feasibility assessments, market studies, project location studies, evaluation of alternative schemes, evaluation of resource and budget requirements, project screening, long-range of capital planning, etc. A Class 5 estimate is the lowest level of the project scope definition or project maturity, and a Class 1 estimate is the highest one. The estimating methodology tends to progress from modeling or analogy to deterministic methods with an increase in the level of project maturity, which results in an increase inaccuracy.

DOE's cost estimate classifications generally follow the Association for Advancement of Cost Engineering International (AACEI), Recommended Practice (RP) No. 17R-97, and RP No. 18R-97. However, historically the more common cost estimate classification is the order of magnitude, preliminary, and definitive, which approximately equates to the AACEI's Classes 5, 3, and 1[3].

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[2] Giammalvo, Paul D. (2015) Course Materials Contributed Under Creative Commons License BY v 4.0
[3] United States Department of Energy (2015) Cost Estimating Guide, DOE G 413.3-21

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| ESTIMATE CLASS | Primary Characteristic | Secondary Characteristic | | |
	DEGREE OF PROJECT DEFINITION Expressed as % of complete definition	END USAGE Typical purpose of estimate	METHODOLOGY Typical estimating method	EXPECTED ACCURACY RANGE Typical variation in low and high ranges [a]
Class 5	0% to 2%	Concept screening	Capacity factored, parametric models, judgment, or analogy	L: -20% to -50% H: +30% to +100%
Class 4	1% to 15%	Study or feasibility	Equipment factored or parametric models	L: -15% to -30% H: +20% to +50%
Class 3	10% to 40%	Budget authorization or control	Semi-detailed unit costs with assembly level line items	L: -10% to -20% H: +10% to +30%
Class 2	30% to 70%	Control or bid/tender	Detailed unit cost with forced detailed take-off	L: -5% to -15% H: +5% to +20%
Class 1	70% to 100%	Check estimate or bid/tender	Detailed unit cost with detailed take-off	L: -3% to -10% H: +3% to +15%

Notes: [a] The state of process technology and availability of applicable reference cost data affect the range markedly. The +/- value represents typical percentage variation of actual costs from the cost estimate after application of contingency (typically at a 50% level of confidence) for given scope.

Table 1. Cost Estimate Classification for Process Industries[4]

METHODOLOGY

Step 1-Problem Definition.

In the beginning phase of the project (Concept Screening, Study or Feasibility), cost estimates are generally prepared based on minimal information and subsequently have wide accuracy range. Due to the requirements of end-use, cost estimates usually prepared within minimal time. For that, we need methods or tools that can help to develop cost estimates easily and quickly.

The objectives of this paper are:
  To find the appropriate method or tool that can define the project cost estimation easily and quickly, both from a similar project in another location or from a similar previous project.

Step 2-Development of the Feasible Alternatives

The alternatives are selected and assessed for seeking the method or tool to solve the problem. They are BCI Tender Price Indices, Singapore Tender Price Indices, Arcadis Indonesia Construction Cost Indices, and RS Means Cost Index. Besides that, BCI Building Cost Indices, Big Mac Index, ENR Construction Cost Index, Statistic Indonesia Construction Cost Indices, and Gold Equivalency Indices.

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[4] United States Department of Energy (2015) Cost Estimating Guide, DOE G 413.3-21

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1. **BCI Tender Price Indices.**

There is a chart of historical, current, and forecasted UK tender price and building cost indices that compiled by Cost modeling Limited from information released by the RICS, the Office of National Statistics, and several big and prominent UK construction cost consultancies.

Tender Price Indices represent the contractor's price to finish the project, i.e., the cost to the client. The indices are updated annual, and the data cost is verified quarterly.
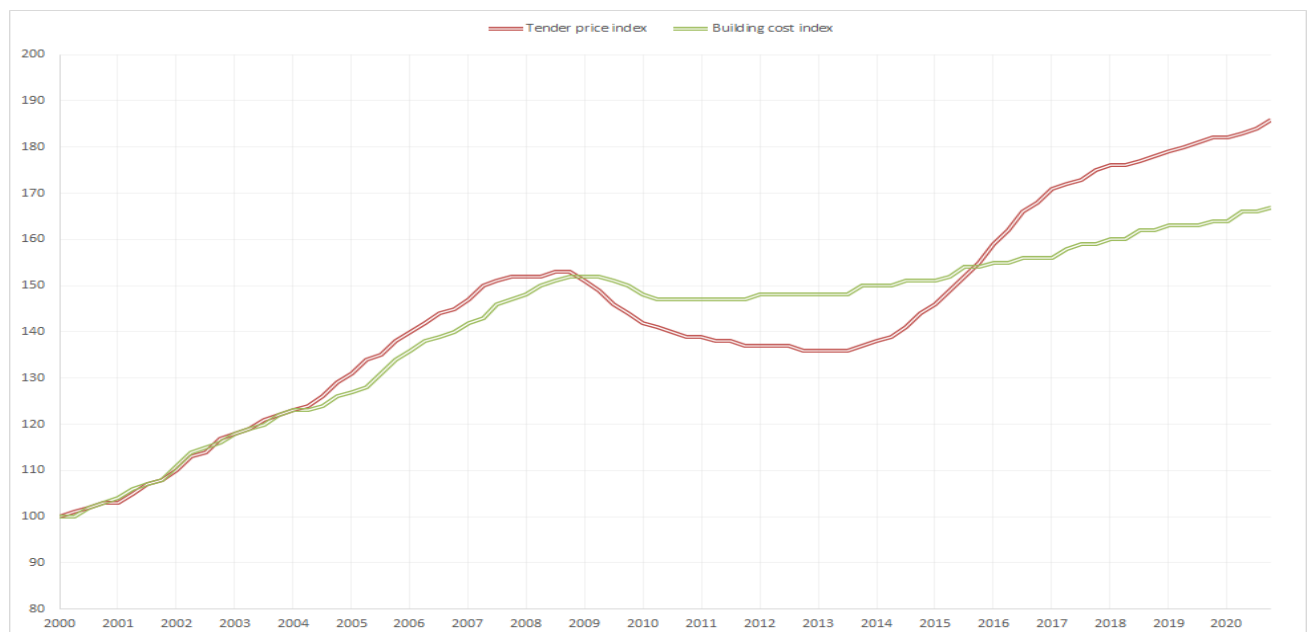

Figure 2. Historic, Current, and Forecast UK Tender Price and Building Cost Indices[5].

2. **Singapore Tender Price Indices.**

Singapore Tender Price Indices consists of 3 types of indexes are Public Residential Index, Private Residential Index, and Commercial Index. Singapore's Public Residential Property Price Index data is updated annual and verified quarterly.

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[5] Cost modeling, UK Tender Price, and Building Cost Indices (2019). Retrieve from
https://costmodelling.com/construction-indices

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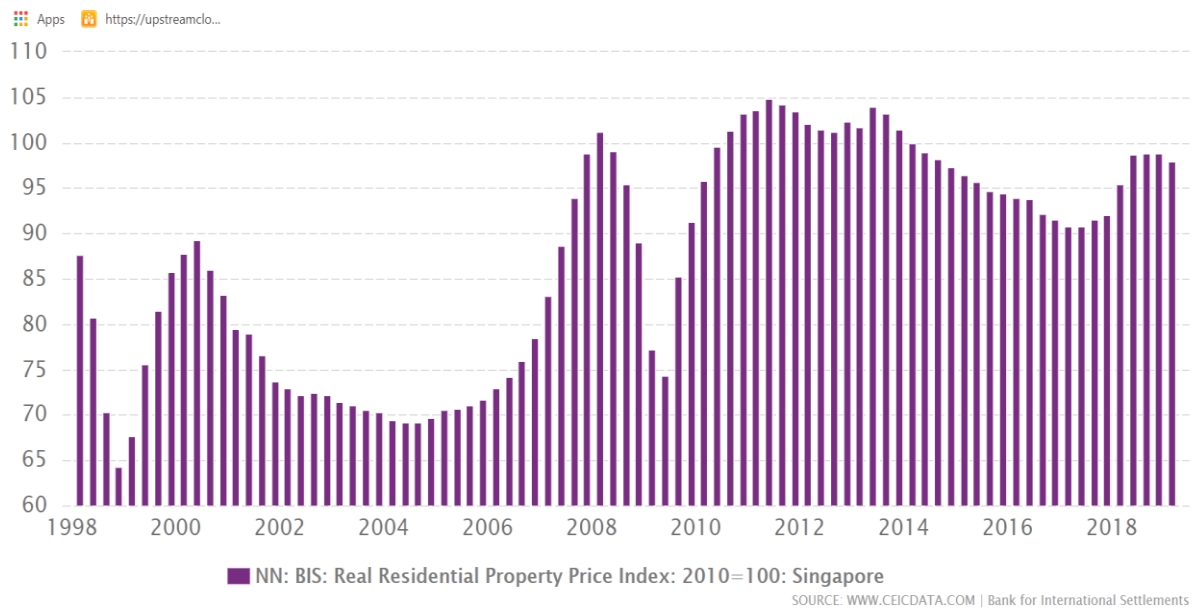
Figure 3. Singapore Tender Price Index Curve[6]

3.   Arcadis Indonesia Construction Cost Indices.

Arcadis Indonesia Construction Cost Indices is developed based on the tender price of the residential, commercial, hotel, factories, warehouses, car parks, retail malls, hospitals, etc. There are construction costs of 13 selected cities in Asian countries and 20 cities in Indonesia. These indices have historical data since this company established in Indonesia in 1999. These indices are updated annually and validated on quarterly.

Figure 4. Arcadis Indonesia Construction Cost Indices[7]

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[6] CEIC, (2019), Singapore Tender Price Index. Retrieve from https://www.ceicdata.com/en/singapore/tender-price-index
[7] Arcadis, (2019), Construction Cost Handbook Indonesia 2019. Retrieve from https://images.arcadis.com/media/9/2/2/%7B922CED49-F684-4CFF-99CE-4727B105C3DA%7DConstruction%20Cost%20Handbook%20Indonesia%202019_001.pdf

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4. RS Means Cost Index.

RS Means City Cost Indexes (CCI) are the tools that compare costs from city to city and region to region. The City Cost Index figures represent relative construction factors for Material and Installation costs. The 30 City Average Index is the average of 30 major U.S. cities and serves as a National Average.

Year	Historical Cost Index Jan. 1, 1993 = 100		Current Index Based on Jan. 1, 2020 = 100		Year	Historical Cost Index Jan. 1, 1993 = 100	Current Index Based on Jan. 1, 2020 = 100		Year	Historical Cost Index Jan. 1, 1993 = 100	Current Index Based on Jan. 1, 2020 = 100	
	Est.	Actual	Est.	Actual		Actual	Est.	Actual		Actual	Est.	Actual
Oct 2020*					July 2005	151.6	63.4		July 1987	87.7	36.7	
July 2020*					2004	143.7	60.1		1986	84.2	35.2	
Apr 2020*					2003	132.0	55.2		1985	82.6	34.6	
Jan 2020*	239.1		100.0	100.0	2002	128.7	53.8		1984	82.0	34.3	
July 2019		232.2	97.1		2001	125.1	52.3		1983	80.2	33.5	
2018		222.9	93.2		2000	120.9	50.6		1982	76.1	31.8	
2017		213.6	89.3		1999	117.6	49.2		1981	70.0	29.3	
2016		207.3	86.7		1998	115.1	48.1		1980	62.9	26.3	
2015		206.2	86.2		1997	112.8	47.2		1979	57.8	24.2	
2014		204.9	85.7		1996	110.2	46.1		1978	53.5	22.4	
2013		201.2	84.1		1995	107.6	45.0		1977	49.5	20.7	
2012		194.6	81.4		1994	104.4	43.7		1976	46.9	19.6	
2011		191.2	80.0		1993	101.7	42.5		1975	44.8	18.7	
2010		183.5	76.7		1992	99.4	41.6		1974	41.4	17.3	
2009		180.1	75.3		1991	96.8	40.5		1973	37.7	15.8	
2008		180.4	75.4		1990	94.3	39.4		1972	34.8	14.6	
2007		169.4	70.8		1989	92.1	38.5		1971	32.1	13.4	
2006		162.0	67.8		1988	89.9	37.6		1970	28.7	12.0	

Table 2. Historical and Forecast RS Means City Cost Index (1970 – 2020)[8]

5. BCI Building Cost Indices.

There is a chart of historical, current, and forecasted UK tender price and building cost indices that compiled by Cost modeling Limited from information released by the RICS, the Office of National Statistics, and several big and prominent UK construction cost consultancies.

Building Costs Indices are the costs spent by the contractor for the need of his business, the principal ones being those for labor and materials, i.e., the cost to the contractor. The indices are updated annual, and the data cost is verified quarterly.

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[8] RS Means, (2019) Historical Cost Indexes. Retrieve from
https://www.rsmeansonline.com/references/unit/refpdf/hci.pdf

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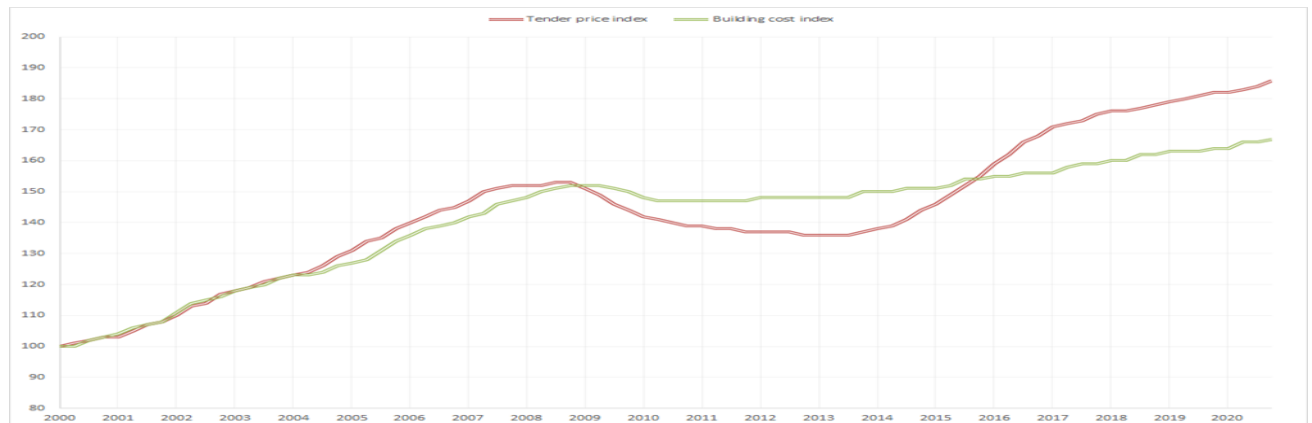Featured Paper   by Arief Rachman

Figure 5. Historic, Current, and Forecast UK Tender Price and Building Cost Indices[9].

6. Big Mac Index

The Big Mac index has been published annually by The Economist since 1986. The Big Mac Index is calculated by comparing the price of a Big Mac in one country with the price of a Big Mac in another country in their respective local currency to get the exchange rate. Then it is compared to the official exchange rate between the two currencies to assess whether the currency is undervalued or overvalued based on PPP theory.

Global prices of a Big Mac are updated monthly in U.S. dollars. There are many Big Mac stores in 45 cities in Indonesia.

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[9] Cost modeling, UK Tender Price, and Building Cost Indices (2019). Retrieve from
https://costmodelling.com/construction-indices

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Global prices for a Big Mac in July 2019, by country
(in U.S. dollars)

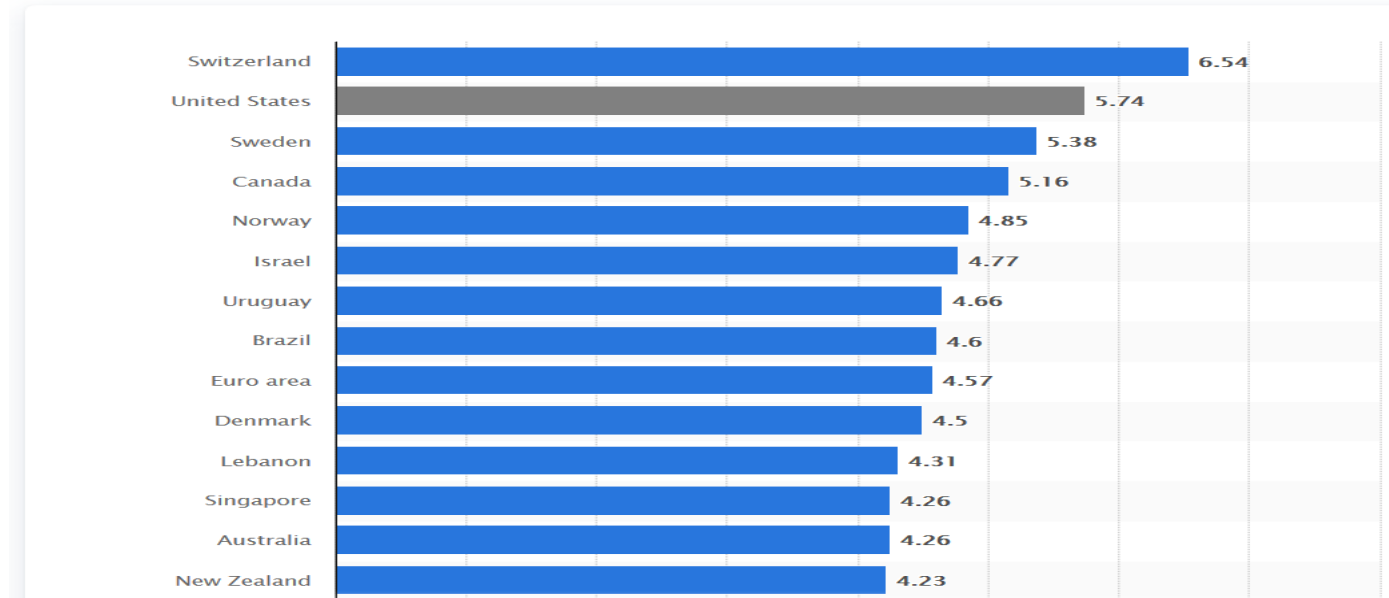| Country	Price
Switzerland	6.54
United States	5.74
Sweden	5.38
Canada	5.16
Norway	4.85
Israel	4.77
Uruguay	4.66
Brazil	4.6
Euro area	4.57
Denmark	4.5
Lebanon	4.31
Singapore	4.26
Australia	4.26
New Zealand	4.23

Figure 6. Comparison of Big Mac Price in July 2019[10]

7.   ENR Construction Cost Index.

"The Engineering News-Record (ENR) indexes have two types are the Construction Cost Index (CCI) and Building Cost Index (BCI). The CCI is suitable where labor costs are a high proportion of total costs. The BCI is more applicable for structures"[11].

ENR publishes a limited amount of international cost data. ENR projects its BCI and CCI for the next 12 months once a year. ENR also has historical cost data from 1929 until now.

[10] Global Prices for a Big Mac in July 2019, by Country (in U.S. dollars). Retrieve from
https://www.statista.com/statistics/274326/big-mac-index-global-prices-for-a-big-mac/
[11] Zevin, Alisa, (2018), Using ENR's Indexes, ENR 1Q Cost Report Indexes.

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CONSTRUCTION COST INDEX HISTORY (1929-2018)

HOW ENR BUILDS THE INDEX: Two hundred hours of common labor at the 20-city average common-labor wage rates, plus 25 cwt of standard structural-steel shapes at the mill price prior to 1996 and the fabricated 20-city price from 1996, plus 1.128 tons of portland cement at the 20-city price, plus 1,088 board-ft of 2x4 lumber at the 20-city price.

ANNUAL AVERAGE, 1993=100

Year	Year	Year		JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	ANNUAL AVERAGE
1929: 207	1953: 600	1977: 2576	2001	6281	6272	6279	6286	6288	6318	6404	6389	6391	6397	6410	6390	6334
1930: 203	1954: 628	1978: 2776	2002	6462	6462	6502	6480	6512	6532	6605	6592	6589	6579	6578	6563	6538
1931: 181	1955: 660	1979: 3003	2003	6581	6640	6627	6635	6642	6694	6696	6733	6741	6771	6794	6782	6695
1932: 157	1956: 692	1980: 3237	2004	6825	6861	6957	7017	7064	7109	7126	7188	7298	7314	7312	7308	7115
1933: 170	1957: 724	1981: 3535	2005	7297	7298	7309	7355	7398	7415	7422	7479	7540	7563	7630	7647	7446
1934: 198	1958: 759	1982: 3825	2006	7660	7689	7692	7695	7691	7700	7721	7723	7763	7883	7911	7888	7751
1935: 196	1959: 797	1983: 4066	2007	7880	7880	7856	7865	7942	7939	7959	8007	8050	8045	8092	8089	7967
1936: 206	1960: 824	1984: 4148	2008	8090	8094	8109	8112	8141	8185	8293	8362	8557	8623	8602	8551	8310
1937: 235	1961: 847	1985: 4182	2009	8549	8533	8534	8528	8574	8578	8566	8564	8586	8596	8592	8641	8570
1938: 236	1962: 872	1986: 4295	2010	8660	8672	8671	8677	8761	8805	8844	8837	8836	8921	8951	8952	8799
1939: 236	1963: 901	1987: 4406	2011	8938	8998	9011	9027	9035	9053	9080	9088	9116	9147	9173	9172	9070
1940: 242	1964: 936	1988: 4519	2012	9176	9198	9268	9273	9290	9291	9324	9351	9341	9376	9398	9412	9308
1941: 258	1965: 971	1989: 4615	2013	9437	9453	9456	9484	9516	9542	9552	9545	9552	9689	9666	9668	9547
1942: 276	1966: 1019	1990: 4732	2014	9664	9681	9702	9750	9796	9800	9835	9846	9870	9886	9912	9936	9806
1943: 290	1967: 1074	1991: 4835	2015	9972	9962	9972	9992	9975	10039	10037	10039	10065	10128	10092	10135	10034
1944: 299	1968: 1155	1992: 4985	2016	10133	10182	10242	10279	10315	10337	10379	10385	10403	10435	10443	10531	10339
1945: 308	1969: 1269	1993: 5210	2017	10542	10559	10667	10678	10692	10703	10789	10826	10823	10817	10870	10873	10737
1946: 346	1970: 1381	1994: 5408	2018	10878	10889	10959	10971	11013	11069	11116	11124	11170	11183	11184	11186	11062
1947: 413	1971: 1581	1995: 5471														
1948: 461	1972: 1753	1996: 5620														
1949: 477	1973: 1895	1997: 5826														
1950: 510	1974: 2020	1998: 5920														
1951: 543	1975: 2212	1999: 6059														
1952: 569	1976: 2401	2000: 6221														

Table 3. ENR Construction Cost Index History (1929 – 2018)[12]

8. Statistics Indonesia Construction Cost Index.

Statistics Indonesia Construction Cost Index is a cost index that illustrates the construction cost of a district/city compared to the reference city. In 2019 and 2018, the reference city used is the Semarang. The previous reference city was Surabaya in 2015-2017, and in 2012-2014 was the Samarinda.

The publication of the Construction Cost Index is conducted by BPS-Statistics Indonesia annually. This Construction Cost Index covers all locations of Indonesia (34 provinces, 514 regions, and municipalities)[13].

No/ Nu	Kode/ Code	Provinsi Province	IKK IKK	No/ Nu	Kode/ Code	Provinsi Province	IKK IKK
(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
1	1100	ACEH	98,68	18	5200	NUSA TENGGARA BARAT	98,76
2	1200	SUMATERA UTARA	102,79	19	5300	NUSA TENGGARA TIMUR	99,03
3	1300	SUMATERA BARAT	93,72	20	6100	KALIMANTAN BARAT	111,53
4	1400	R I A U	94,92	21	6200	KALIMANTAN TENGAH	101,90
5	1500	J A M B I	94,38	22	6300	KALIMANTAN SELATAN	100,90
6	1600	SUMATERA SELATAN	94,50	23	6400	KALIMANTAN TIMUR	114,37
7	1700	BENGKULU	94,74	24	6500	KALIMANTAN UTARA	112,11
8	1800	LAMPUNG	88,84	25	7100	SULAWESI UTARA	108,32
9	1900	KEPULAUAN BANGKA BELITUNG	101,27	26	7200	SULAWESI TENGAH	91,98
10	2100	KEPULAUAN RIAU	128,34	27	7300	SULAWESI SELATAN	97,34
11	3100	DKI JAKARTA	114,06	28	7400	SULAWESI TENGGARA	101,45
12	3200	JAWA BARAT	103,03	29	7500	GORONTALO	97,45
13	3300	JAWA TENGAH	99,93	30	7600	SULAWESI BARAT	92,27
14	3400	DI YOGYAKARTA	103,42	31	8100	M A L U K U	123,02
15	3500	JAWA TIMUR	103,68	32	8200	MALUKU UTARA	119,11
16	3600	B A N T E N	95,84	33	9100	PAPUA BARAT	132,67
17	5100	B A L I	119,10	34	9400	PAPUA	218,59

Table 4. Provinces Construction Cost Index 2019[14]

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[12] Zevin, Alisa, (2018), Using ENR's Indexes, ENR 1Q Cost Report Indexes.

[13] BPS-Statitstics Indonesia, (2019). Construction Cost Index Province and Regency/Municipality 2019. Retrieve from https://www.bps.go.id/publication/2019/10/22/4f15e1abdd57353a3e966e25/indeks-kemahalan-konstruksi-provinsi-dan-kabupaten-kota-2019.html

[14] BPS-Statitstics Indonesia, (2019). Construction Cost Index Province and Regency/Municipality 2019. Retrieve from https://www.bps.go.id/publication/2019/10/22/4f15e1abdd57353a3e966e25/indeks-kemahalan-konstruksi-provinsi-dan-kabupaten-kota-2019.html

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9. Gold Equivalency Index.

Gold had served as money for thousands of years until 1971 when the gold standard was abandoned and used as an investment. The gold market is quite large and estimated that the size of the investable gold market is $2.4 trillion. "The average daily trading volume in gold in the over-the-counter market alone is estimated at $67 billion, indicating that the gold market is very liquid"[15]. Additionally, "the London Bullion Market Association determines the fix twice a day. So, London fix is set daily at 10:30 GMT and 15:00 GMT, serving as a benchmark for pricing gold"[16].
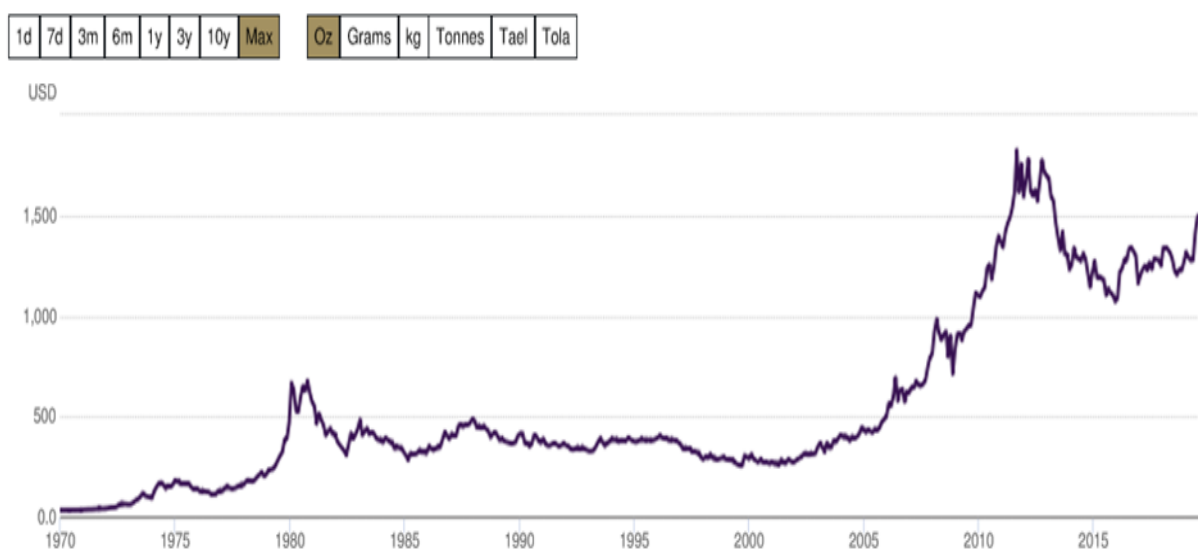
Figure 7. Historical Gold Price in US Dollar[17]

Step 3-Development of the Outcomes for Each Alternative

Generally, there are three types of cost indices for construction activities:

1. Tender Price Indices (TPI).

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[15] Sunshine Profits (2019). Gold As an Investment. Retrieve from https://www.sunshineprofits.com/gold-silver/dictionary/gold-as-an-investment/
[16] Sunshine Profits (2019). Gold As an Investment. Retrieve from https://www.sunshineprofits.com/gold-silver/dictionary/gold-as-an-investment/
[17] World Gold Council. (2019, Nov 26). Interactive gold price chart and downloads. Retrieved from https://www.gold.org/goldhub/data/gold-prices

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These indices measure the price movement agreed between the client and the contractor in their regular commitment to construct when a tender is received. Use these indices to adjust estimates and budgets to different dates.

2. Output Price Indices (OPI)

These indices measure the average price of construction projects currently on-site, i.e., the movements of costs paid by clients when work has finished. These indices usually reflect the tender price received in the previous period. To use these indices to convert construction output volume figures from current to constant prices, either for national statistics or construction programs.

3. Resource Cost Indices (RCI)

These indices measure the movement of labor, material, and plant costs to contractors.

These indices generally include factory gate prices for materials and plants as well as nationally agreed wage awards and legal labor costs. Usually used to understand inflationary pressures when preparing estimates and budgets and in the context of adjusting inflation in contracts.

1. BCI Tender Price Indices.

The BCI Indices is one of the Tender Price Indices categories because BCI Indices has arranged based on the construction price that has resulted in a tender process.

The SWOT analysis of BCI Tender Price Indices:
- Strengths

  - Have historical, recent, and forecast cost data.

  - Have historical cost data for 20 years.

  - Forecast future cost index for the next 12 months

  - Data update annually and validate quarterly.

- Weaknesses

  - The value cost index only for the UK

  - It can't be used in Indonesian cities.

- Opportunities

  - Publish other cost indices.

- Threats

  - Cost Index that covers other costs.

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2. Singapore Tender Price Indices.

The Singapore Indices is one of the Tender Price Indices categories because the Singapore Indices has arranged based on the construction price that has resulted in a tender process.

The SWOT analysis of Singapore Tender Price Indices:

- Strengths

  – Have historical cost data since 1998 and recent cost data.

  – Have 3 type tender price index

  – Data update annually and validate quarterly.

- Weaknesses

  – Cost indexes only for Singapore.

  – It can't be used in Indonesian cities.

  – Don't have historical cost data.

- Opportunities

  – Publish other cost indices.

- Threats

  – Cost Index that covers other costs.

3. Arcadis Indonesia Construction Cost Indices.

The Arcadis Indonesia Indices is one of the Tender Price Indices types because the Arcadis Indonesia Indices has arranged based on the construction price that has resulted in a tender process.

The SWOT Analysis of Arcadis Indonesia Construction Cost Indices:
- Strengths

  – Have a cost index that covers 20 cities in Indonesia

  – Have historical cost indexes for 20 years.

  – Have the price of high rise buildings of residence and office, factories, warehouses, etc.

  – Data update yearly and validate quarterly.

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- Weaknesses

  – Have limited data for cities of the East Indonesia zone.

- Opportunities

  – Develop cost index for East Indonesia zone

- Threats

  – Cost Index that covers more cities of Indonesia

4. RS Means Cost Index.

The RS Means Cost Index is one of the Output Price Indices categories because the RS Means Cost Index has arranged based on the price paid by clients when the work has finished.

The SWOT analysis of RS Means Cost Index:
- Strengths

  – Have a data cost index of 30 US cities.

  – Have historical, recent, and forecast cost data.

  – Have historical price data for 50 years (1970 – 2019)

  – Data update yearly and validate quarterly.

- Weaknesses

  – Cost Indexes only for the US cities

  – It can't be used in Indonesian cities.

- Opportunities

  – Publish international cost data

  – Develop cost indexes for cities outside the US

- Threats

  – Cost Index that covers more cities in the US, outside the US, and international cities.

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5. BCI Building Cost Indices.

The BCI Building Cost Indices is one of the Output Price Indices categories because the BCI Building Cost Indices has arranged based on the price paid by clients when the work has finished.

The SWOT analysis of BCI Building Cost Indices:
- Strengths

    - Have 20 years of historical cost data and recent cost.

    - Have future cost index for the next 12 months

    - Data update quarterly.

- Weaknesses

    - Cost indexes only for the UK

    - It can't be used in Indonesian cities.

    - Data compiled from several sources.

- Opportunities

    - Develop cost indexes for cities of the UK.

- Threats

    - Cost Index that covers cities of the UK.

6. Big Mac Indices.

The Big Mac Indices is one of the Output Price Indices categories because the Big Mac Indices has arranged based on the price paid by clients when the work has finished.

The SWOT Analysis of Big Mac Index:
- Strengths

    - Use to arrive at an exchange rate of one country to another country.

    - Have historical price data for 34 years (1986 – 2019)

    - Data update monthly

    - Have many stores in 45 cities of Indonesia

    - As an investigative tool in the country with unreliable indexes

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- Weaknesses

  – The Big Mac store location only in Indonesia's big cities.

- Opportunities

  – Develop historical big mac price data of a country

- Threats

  – Other indices as Apple iPods, Starbucks coffees, Ikea Billy bookshelves, and more

7. ENR Construction Cost Index.

The ENR Construction Cost Index is one of the Resources Cost Index categories because the ENR Construction Index has arranged based on the cost of labor, material, and rental equipment.

The SWOT Analysis of ENR Construction Cost Index:
- Strengths

  – Have material and labor prices of 20 US cities.

  – Have historical price data for 90 years (1929 – 2018).

  – Data update annually and validate quarterly.

  – Forecast future cost index for the next 12 months

- Weaknesses

  – Cost Indexes only for US cities.

  – It can't be used in Indonesian cities.

- Opportunities

  – Publish international cost data

  – Develop cost indexes for cities outside the US

- Threats

  – Cost Index that covers more cities in the US and outside the US

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8. Statistics Indonesia Construction Cost Index.

The Statistics Indonesia Construction Cost Index is one of the Resources Cost Index categories because the Statistic Indonesia Construction Cost Index has arranged based on the cost of labor, material, and rental equipment.

The SWOT Analysis of Statistics Indonesia Construction Cost Index:
- Strengths

    - Have a cost index that covers all locations of Indonesia (34 provinces, 514 regions, and cities).

    - Data update yearly and validate quarterly.

    - Have 22 components input: 17 types of material, four types of equipment rental, and labor.

- Weaknesses

    - Reference's city is change depend on similarity value with an average national cost

    - Don't have historical cost indexes (because of reference's city change)

    - Don't have forecast future cost index

- Opportunities

    - Develop historical cost indexes

- Threats

    - Cost Index that has historical cost indexes of Indonesia locations.

9. Gold Equivalency Index.

The Gold Equivalency Index is one of the Resources Cost Index categories because the Gold Equivalency Index can use for understanding inflationary when preparing estimates and budgets.

The SWOT Analysis of Gold Equivalency Index:
- Strengths

    - The gold market is quite large and very liquid.

    - The gold market is a global market, including the cities of Indonesia.

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   – Have historical gold price data for 49 years.

   – Gold price fixes twice a day.

- Weaknesses

   – Not tied to any specific country.

- Opportunities

   – Gold is the best portfolio, the best diversifier, and the best insurance against high inflation and systemic crises.

- Threats

   – The emergence of a new currency that replaces the function of gold.

Then all the alternatives are assessed by Force Field Analysis to seek the best choice of the alternatives.
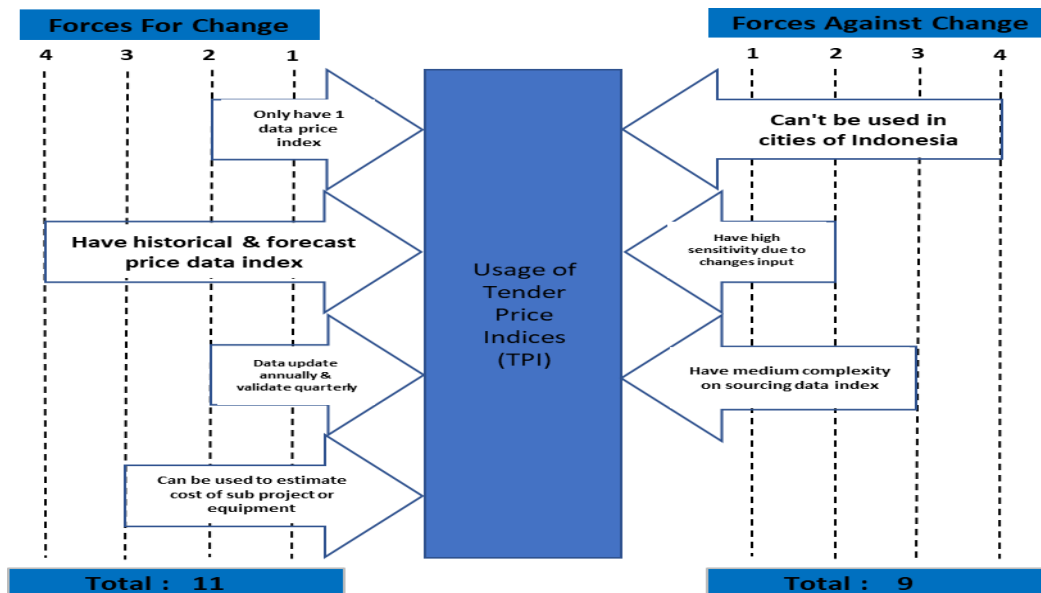
1. BCI Tender Price Indices

Figure 8. Force Field Analysis of BCI Tender Price Indices[18]

The net value of BCI Tender Price Indices is **2 points**.

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[18] By Author

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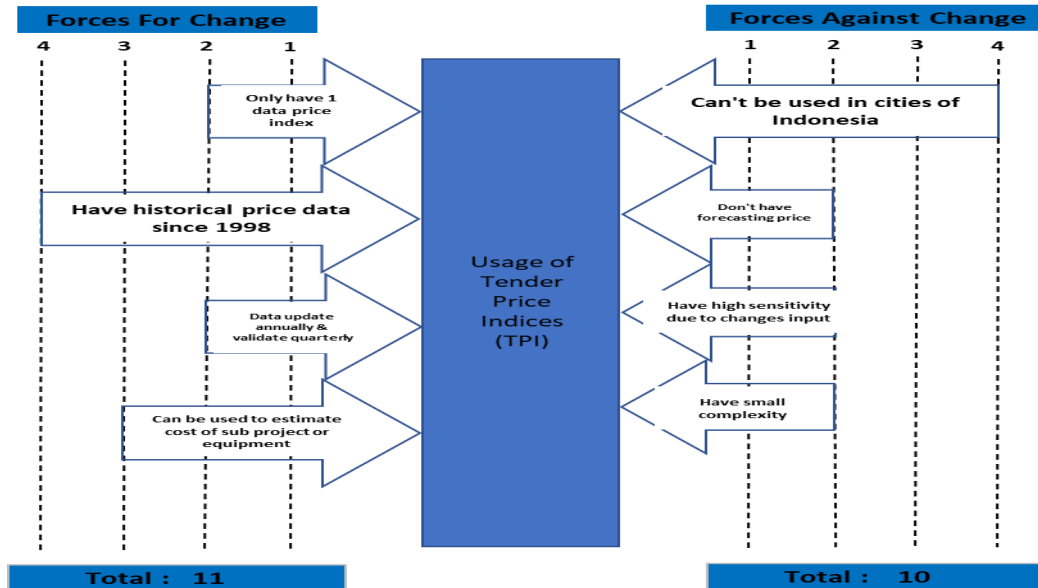## 2. Singapore Tender Price Indices

Figure 9. Force Field Analysis of Singapore Tender Price Indices[19]

The net value of Singapore Tender Price Indices is 1 **point**.

3. Arcadis Indonesia Indices
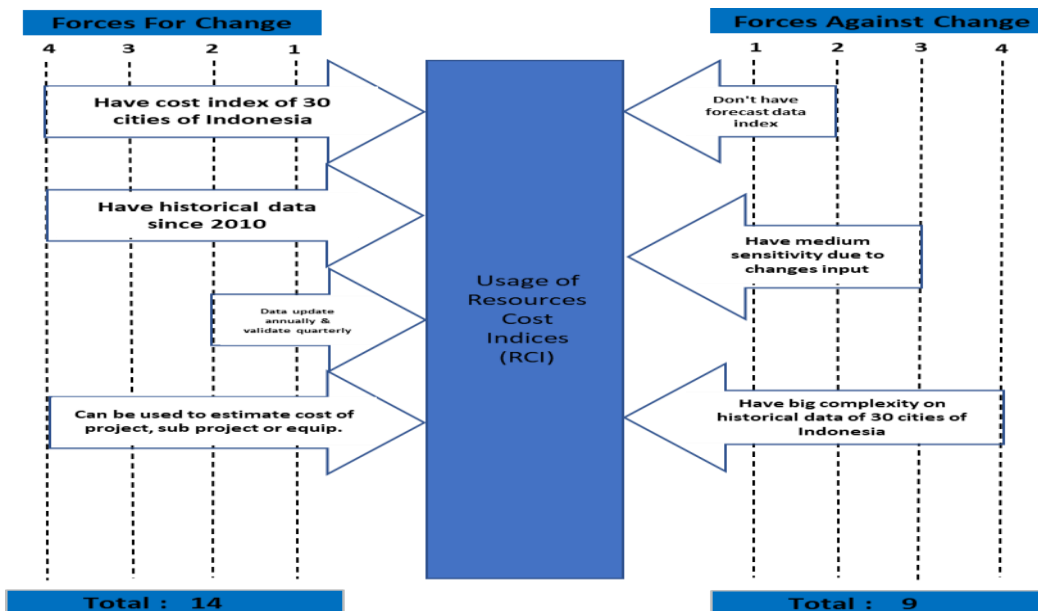
Figure 10. Force Field Analysis of Arcadis Indonesia Construction Cost Indices[20].

The net value of Arcadis Indonesia Construction Cost Indices is **5 points.**

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[19] By Author
[20] By Author

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4. RS Means Cost Index
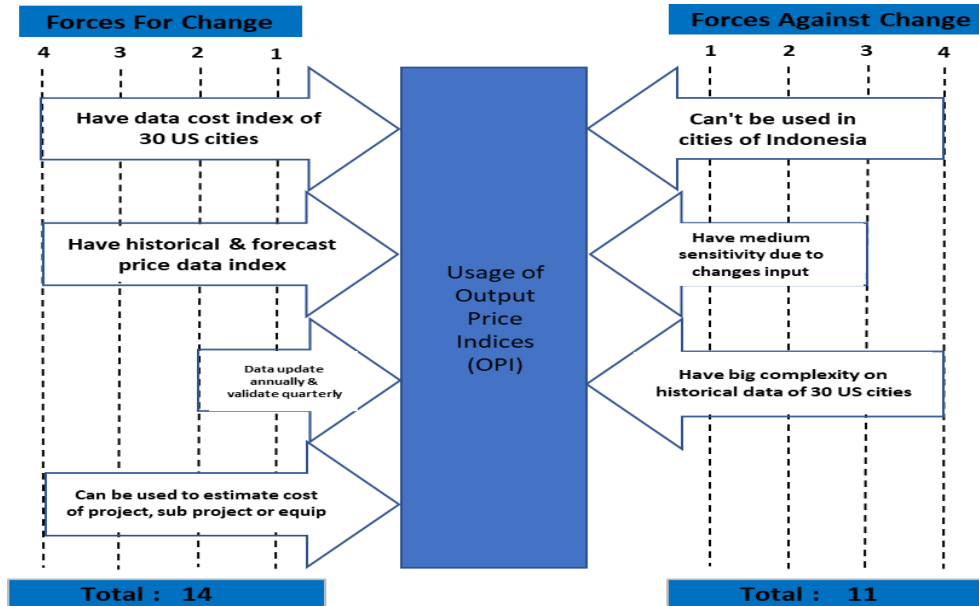
Figure 11. Force Field Analysis of RS Means Cost Index[21]

The net value of RS Means Cost Index Indices is **3 points**.

5. BCI Building Cost Indices
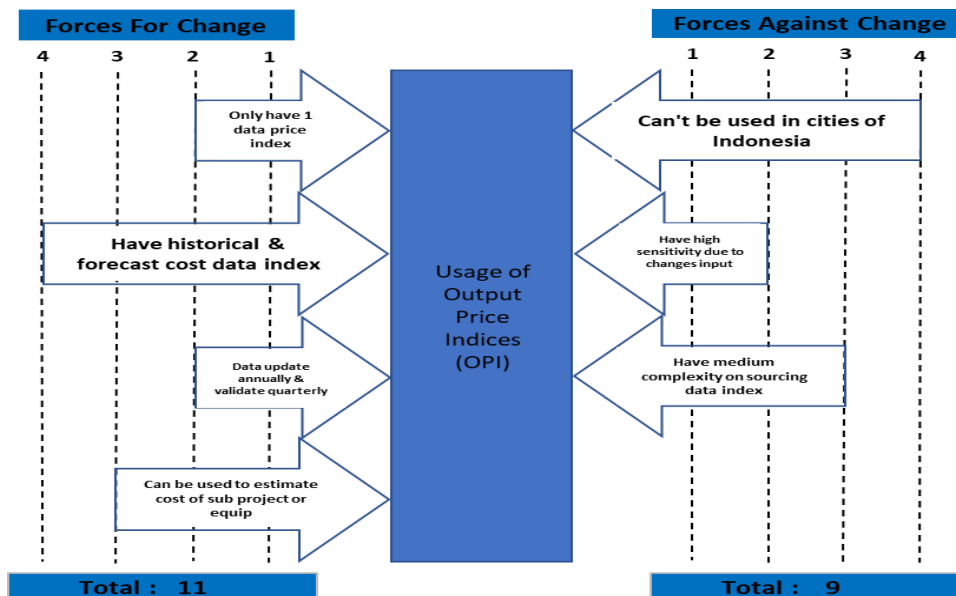
Figure 12. Force Field Analysis of BCI Building Cost Index[22]

The net value of BCI Building Cost Indices is **2 points**.

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[21] By Author
[22] By Author

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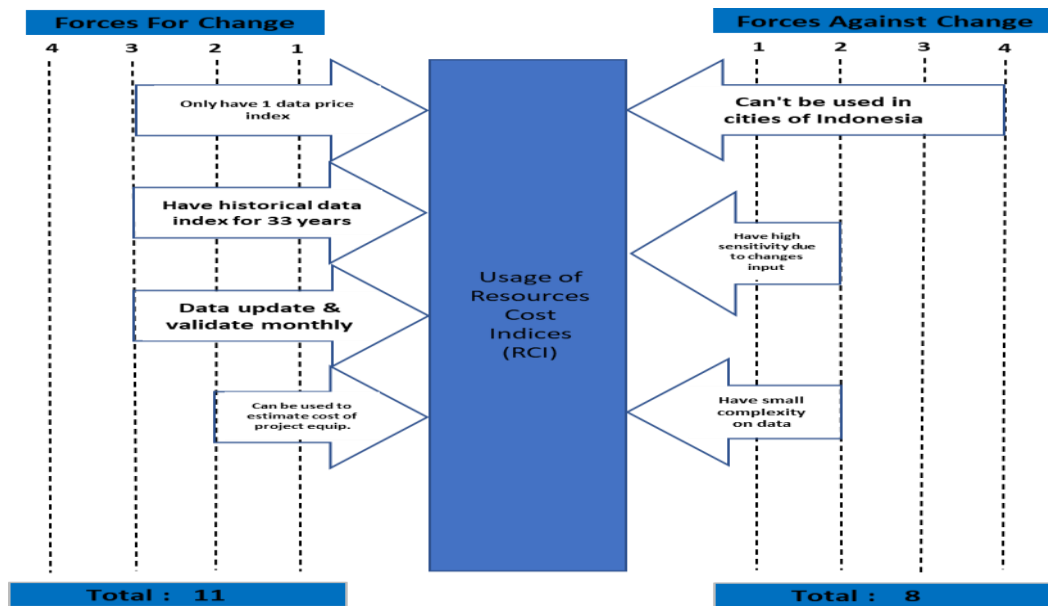
6. Big Mac Index

Figure 13. Force Field Analysis of Big Mac Index[23].

The net value of the Big Mac Index is **3 points**.

7. ENR Construction Cost Index
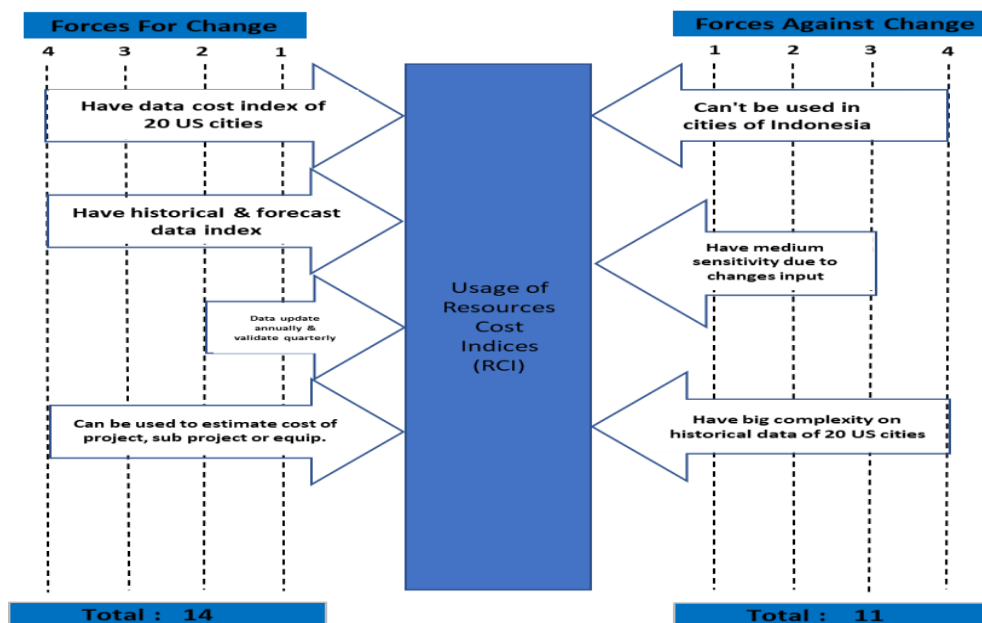
Figure 14. Force Field Analysis of ENR Construction Cost Index[24]

The net value of the ENR Construction Cost Index is **3 points**.

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[23] By Author
[24] By Author

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8. Statistic Indonesia Construction Cost Index

Figure 15. Force Field Analysis of Statistic Indonesia Construction Cost Index[25].

The net value of the Statistic Indonesia Construction Cost Index is **3 points**.

9. Gold Equivalent Index

Figure 16. Force Field Analysis of Gold Equivalent Index[26].

The net value of the Gold Equivalent Index is **4 points**.

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[25] By Author
[26] By Author

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Based on Force Field Analysis results, the series of net value are:

- Arcadis Indonesia Indices: 5 points
- Gold Equivalent Index: 4 points
- ENR Construction Cost Index: 3 points
- Statistic Indonesia Construction Cost Index: 3 points
- RS Means Cost Index: 3 points
- The Big Mac Index: 3 points
- BCI Building Cost Indices: 2 points
- BCI Tender Price Indices: 2 points
- Singapore Tender Price Indices: 1 point.

Step 4-Selection of Criteria

Base on the GAO Cost Estimating Guide, the US DOE Cost Estimating Guide, and solving the problem, all alternatives have assessed to produce high-quality cost estimation. The requirements that used to evaluate are Indonesia usage area, coverage zone, city cost index, historical cost index, update data period, validation data period, and index versatility[27]. The results of the alternatives assessment can be shown in the table below:

No	Attribute	BCI Tender Price Index	Singapore Tender Price Index	Arcadis Indonesia Cost Index	RS Means Cost Index	BCI Building Cost Index	ENR Cost Index	Statistics Indonesia Cost Index	Big Mac Index	Gold Equivalent Index
1	Indonesia Usage Area	Not Available	Not Available	20 Cities	Not Available	Not Available	Not Available	All Cities	45 Cities	All Cities
2	Coverage Zone	UK	Singapore	Regional (Asia)	US	UK	US	Indonesia	Global	Global
3	City Cost Index	10 Cities	1 City	20 Cities	30 Cities	10 Cities	20 Cities	548 Cities	45 Cities	548 Cities
4	Historical Cost Index	20 Years	22 Years	20 Years	50 Years	20 Years	90 Years	Not Available	34 Years	49 Years
5	Update Data Period	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Monthly	Daily
6	Validation Data Period	Quarter	Quarter	Quarter	Quarter	Quarter	Quarter	Quarter	Monthly	Daily
7	Index Versatility	High	Low	High	High	High	High	Middle	High	High

Table 5. Assessment Results of The Alternatives[28]

The level of the priority of the attributes shall follow:

Indonesia Usage Area > Coverage Zone > City Cost Index > Historical Cost Index > Update Data Period > Validation Data Period > Index Versatility

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[27] U.S. Department of Energy, (2018), Cost Estimating Guide, Chapter 2, Sub Chapter 2.1. High-Quality Cost Estimate p. 2-4.
[28] By Author.

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Based on the results of alternatives assessment, the dominance method is used to eliminate the inferior alternatives from the analysis. The dominance analysis results of the alternatives can be shown in the table below:

No	Attribute	BCI TPI vs Singapore TPI	BCI TPI vs Arcadis Indonesia	BCI TPI vs RS Means Cost Index	BCI TPI vs BCI Building Cost Index	BCI TPI vs ENR Cost Index	BCI TPI vs Statistic Indonesia	BCI TPI vs Big Mac Index	BCI TPI vs Gold Index
1	Indonesia Usage Area	Equal	Worse	Equal	Equal	Equal	Worse	Worse	Worse
2	Coverage Zone	Equal	Worse	Equal	Equal	Equal	Equal	Worse	Worse
3	City Cost Index	Better	Worse	Worse	Equal	Worse	Worse	Worse	Worse
4	Historical Cost Index	Equal	Equal	Worse	Equal	Worse	Better	Worse	Worse
5	Update Data Period	Equal	Equal	Equal	Equal	Equal	Equal	Worse	Worse
6	Validation Data Period	Equal	Equal	Equal	Equal	Equal	Equal	Worse	Worse
7	Index Versatility	Better	Equal	Equal	Equal	Equal	Better	Equal	Equal

No	Attribute	Singapore TPI vs Arcadis Indonesia	Singapore TPI vs RS Means Cost Index	Singapore TPI vs BCI Building Cost	Singapore TPI vs ENR Cost Index	Singapore TPI vs Statistic Indonesia	Singapore TPI vs Big Mac Index	Singapore TPI vs Gold Index
1	Indonesia Usage Area	Worse	Equal	Equal	Equal	Worse	Worse	Worse
2	Coverage Zone	Worse	Equal	Equal	Equal	Equal	Worse	Worse
3	City Cost Index	Worse	Worse	Worse	Worse	Worse	Worse	Worse
4	Historical Cost Index	Equal	Worse	Equal	Worse	Better	Worse	Worse
5	Update Data Period	Equal	Equal	Equal	Equal	Equal	Worse	Worse
6	Validation Data Period	Equal	Equal	Equal	Equal	Equal	Worse	Worse
7	Index Versatility	Worse	Worse	Worse	Worse	Worse	Worse	Worse

No	Attribute	Arcadis Indonesia vs RS Means Index	Arcadis Indonesia vs BCI Building Index	Arcadis Indonesia vs ENR Cost Index	Arcadis Indonesia vs Statistic Indonesia	Arcadis Indonesia vs Big Mac Index	Arcadis Indonesia vs Gold Index
1	Indonesia Usage Area	Better	Better	Better	Worse	Worse	Worse
2	Coverage Zone	Better	Better	Better	Better	Worse	Worse
3	City Cost Index	Better	Better	Better	Worse	Worse	Worse
4	Historical Cost Index	Worse	Equal	Worse	Better	Worse	Worse
5	Update Data Period	Equal	Equal	Equal	Equal	Worse	Worse
6	Validation Data Period	Equal	Equal	Equal	Equal	Worse	Worse
7	Index Versatility	Equal	Equal	Equal	Better	Equal	Equal

No	Attribute	RS Means Index vs BCI Building Index	RS Means Index vs ENR Cost Index	RS Means Index vs Statistic Indonesia	RS Means Index vs Big Mac Index	RS Means Index vs Gold Index	BCI Building Index vs ENR Index	BCI Building Index vs Statistic Indonesia
1	Indonesia Usage Area	Equal	Equal	Worse	Worse	Worse	Equal	Worse
2	Coverage Zone	Equal	Equal	Equal	Worse	Worse	Equal	Equal
3	City Cost Index	Better	Better	Worse	Worse	Worse	Worse	Worse
4	Historical Cost Index	Better	Worse	Better	Better	Equal	Worse	Better
5	Update Data Period	Equal	Equal	Equal	Worse	Worse	Equal	Equal
6	Validation Data Period	Equal	Equal	Equal	Worse	Worse	Equal	Equal
7	Index Versatility	Equal	Equal	Better	Equal	Equal	Equal	Better

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No	Attribute	BCI Building Index vs Big Mac Index	BCI Building Index vs Gold Index	ENR Cost Index vs Statistic Indonesia	ENR Cost Index vs Big Mac Index	ENR Cost Index vs Gold Index	Statistic Indonesia vs Big Mac Index	Statistic Indonesia vs Gold Index	Big Mac Index vs Gold Index
1	Indonesia Usage Area	Worse	Worse	Worse	Worse	Worse	Better	Equal	Worse
2	Coverage Zone	Worse	Worse	Equal	Worse	Worse	Worse	Worse	Equal
3	City Cost Index	Worse	Worse	Worse	Worse	Worse	Better	Equal	Worse
4	Historical Cost Index	Worse	Worse	Better	Better	Better	Worse	Worse	Worse
5	Update Data Period	Worse	Worse	Equal	Worse	Worse	Worse	Worse	Worse
6	Validation Data Period	Worse	Worse	Equal	Worse	Worse	Worse	Worse	Worse
7	Index Versatility	Equal	Equal	Better	Equal	Equal	Worse	Worse	Equal

Table 6. The dominance analysis results of the alternatives[29]

Based on the dominance analysis results of the alternatives that in table 6, we should eliminate the most inferior alternatives are BCI Tender Price Index, Singapore Tender Price Index, RS Means Cost Index. Besides that, BCI Building Cost Indices, ENR Construction Cost, and Statistic Indonesia Construction Cost Index.

Step 5-Comparison of The Alternatives

Indonesia Usage Area, Coverage Zone, City Cost Index, and Historical Cost Index are the essential parameter compare to other attributes because of the need for cost index for project cost estimation in Indonesia. So, the attribute parameter then is ranked based on the value and be shown in the table below:

No	Attribute	Value
1	Indonesia Usage Area	7
2	Coverage Zone	6
3	City Cost Index	5
4	Historical Cost Index	4
5	Update Data Period	3
6	Validation Data Period	2
7	Index Versatility	1

Table 7. The Attribute Ranking[30]

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[29] By Author
[30] By Author

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No	Attribute	Value	Rating Procedure	Dimensionless Value
1	Indonesia Usage Area	Not Relevant	(Relative rank[a] – 1)/4	0.00
		10 Big Cities		0.25
		20 Cities		0.50
		45 Cities		0.75
		All Cities		1.00
2	Coverage Zone	Country	(Relative rank[a] – 1)/2	0.00
		Regional		0.50
		Global		1.00
3	City Cost Index	1 City	(City index – 1)/547	0.00
		10 Cities		0.02
		20 Cities		0.03
		30 Cities		0.05
		45 Cities		0.08
		548 Cities		1.00
4	Historical Cost Index	Not Available	(Historical index – 0)/90	0.00
		20		0.22
		22		0.24
		34		0.38
		49		0.54
		50		0.56
		90		1.00
5	Update Data Period	Annually	(Relative rank[a] – 1)/3	0.00
		Quarter		0.33
		Monthly		0.67
		Daily		1.00
6	Validation Data Period	Quarter	(Relative rank[a] – 1)/2	0.00
		Monthly		0.50
		Daily		1.00
7	Index Versatility	Low	(Relative rank[a] – 1)/2	0.00
		Middle		0.50
		High		1.00

Table 8. Nondimensional Scaling[31]

Based on the results of dominance method and using data on table 7, table 8, and perform the calculation with the additive weighting technique give the results that can be shown in below:

No	Attribute	Value	Normalized Weight	Arcadis Indonesia Index		Big Mac Index		Gold Equivalent Index	
1	Indonesia Usage Area	7	7/28 = 0.25	0.50	0.11	0.75	0.17	1.00	0.22
2	Coverage Zone	6	6/28 = 0.21	0.50	0.10	1.00	0.19	1.00	0.19
3	City Cost Index	5	5/28 = 0.18	0.03	0.01	0.08	0.01	1.00	0.17
4	Historical Cost Index	4	4/28 = 0.14	0.22	0.03	0.38	0.05	0.54	0.08
5	Update Data Period	3	3/28 = 0.11	0.00	0.00	0.67	0.07	1.00	0.11
6	Validation Data Period	2	2/28 = 0.07	0.00	0.00	0.50	0.04	1.00	0.08
7	Index Versatility	1	1/28 = 0.04	1.00	0.06	1.00	0.06	1.00	0.06
		Sum = 28	1.00	Sum =	**0.30**	Sum =	**0.60**	Sum =	**0.91**

Table 9. Calculation Results Using the Additive Weighting Technique[32]

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[31] By Author
[32] By Author

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Considering from calculation results that using The Additive Weighting Technique in table 9, the highest point is the **Gold Equivalent Index.** These indices have the best value of attributes Indonesia Usage Area, Coverage Zone, City Cost Index, Update Data Period, Validation Data Period, and Index Versatility.

Step 6-Selection of The Preferred Alternative

Based on the result of the dominance method, three alternatives come from 3 types of indices. The Arcadis Indonesia Indices is representative of the tender price indices, the Big Mac Index is representative of the Output Price Indices, and the Gold Equivalency Indices is representative of the Resources Cost Indices. The alternative can be selected depending on the type of cost estimation that will be developed.

Step 7-Performance Monitoring

Every cost estimator is challenged to strive for high-quality cost estimates by using the preferred best practices and methods. The high-quality cost estimate is essential to achieving program and project success.

The successful completion of the project measures the success cost estimation. The project cost realization with a smaller deviation has the higher quality of the project cost estimation.

Construction cost indices performance is monitored based on the success of the project cost estimation, both at the project tender and project completion. The deviation of the project estimation will be recorded and validated on quarterly periods. The revision of the cost indices will be conducted if the variation that occurs is more than the ranges.

CONCLUSIONS & RECOMMENDATIONS

The objectives of this paper were to answers for the below-mentioned questions:

To find the appropriate method or tool that can define the project cost estimation easily and quickly, both from a similar project in another location or from the previous similar project.

- Based on the results of The Additive Weighting Technique of the Multi-Attributes Decision Making (MADM) shows that the Gold Equivalency Indices as the "best valued and the most relevant used" because the indices have the gold prices on all provinces and all regions of Indonesia.

- To determine the project cost estimation from a similar project in another location by comparing the gold price at the location of the project plan with the gold price at the location of the other similar project.

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- To determine the project cost estimation from the previous similar project by comparing the gold price in the year of the project plan with the gold price in the year of the previous similar project.

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PM World Journal (ISSN: 2330-4480)
Vol. IX, Issue II – February 2020
www.pmworldjournal.com

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