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J-SELARAS: DEVELOPMENT OF RATIONALISATION ANALYSIS MODEL

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ABSTRACT

Rate rationalization is a crucial aspect of adjusting tender rates to ensure fair contract amounts, especially in the context of the Malaysian construction industry. This study specifically focuses on rationalizing Bills of Quantity (BQ), a process traditionally done manually with Microsoft Excel templates, which can be time-consuming and affect contract signing timelines. To address this issue, this article introduces the J-Selaras model, a novel approach that utilizes the Z-Score Altman model to refine data and determine reasonable rates. The workflow of the J-Selaras model involves identifying minimum and maximum values, calculating adjusted means, and using a cut-off analysis to identify acceptable rates. Additionally, the model evaluates rates proposed by successful tenderers within predetermined ranges. The provided algorithm outlines the computations and conditions that guide this assessment. Through experimental validation, the effectiveness of the J-Selaras model becomes apparent. In Experiment 1, there is congruence between submitted rates and calculated cut-off values, confirming the model's reliability. Experiment 2 reveals instances where proposed rates deviate from the acceptable range, validating the model's ability to suggest rates based on the cut-off analysis.

In conclusion, the J-Selaras model represents a significant advancement in the rationalization process. It aligns submitted rates with reasonable values while adhering to government policies, ultimately expediting contract signing and enhancing efficiency and fairness in the tendering process.

Keywords: *Rationalisation, Bills of Quantity (BQ), Z-Score, Statistic, Model, Digital BQ,*

1. INTRODUCTION

The investigation into the cognitive processes underlying rational decision-making remains an intriguing avenue of exploration, as it bears direct implications for formulating strategies to enhance overall performance. Although individuals often perceive their decisions to be grounded in the available information and options to achieve optimal outcomes, it is evident that choices made under conditions of uncertainty introduce a nuanced dimension to this process [1]. A pivotal component of decision-making pertains to expected utility theory, wherein individuals' choices, whether geared towards maximising gains or minimising losses, are significantly influenced by their attitudes towards risk. Notably, the idiosyncratic dispositions each individual holds towards risk, and their distinct psychological attributes hold a seminal role in the decision-making framework [2]. An essential facet of decision-making lies in the interplay between individual risk aversion and the psychological constructs underlying the prospect theory expounded upon by Kahneman and Tversky [3] in 1979.

Simon (1955) [4] delineates the gap between the psychological comprehension of rationalised behaviour and the empirical comprehension of the decision-making process, wherein considerations encompassing environmental dynamics, organismic factors, and variables influencing choices converge to yield optimal decisions. Cognitive biases, emblematic of psychological and emotional predispositions, influence decision-making processes [1]. Subsequently, Sonnemann et al. (2013) [5] underscore the salience of comprehending the dependent variables impacting decisions within a given environment, while also discerning the ramifications of biases on broader market valuations.

In pursuit of mitigating biases and instating accountability and transparency, computational algorithms emerge as a viable strategy for cultivating optimised decision-making frameworks. However, within construction projects beset by intricate interdependencies involving diverse stakeholders bound by contractual arrangements and penalties, achieving rationalised pricing decisions proves to be an intricate endeavour. Initially negotiated during a stipulated timeframe, the ratified project rates inherently fluctuate due to market dynamics and material supply variations. Consequently, under a conventional contractual framework, work allocation derives from an amalgam of total work quantum, punctuated by risk apportionment percentages and auxiliary allowances.

The construction industry constitutes a complex nexus of distinct sectors fortified by diverse funding mechanisms. Individual construction tasks interface with the manufacturing sector, catalysing the transformation of raw materials—like timber, sand, and water—into secondary components such as bricks, timber planks, and concrete. Subsequent iterations of this process culminate in functional products destined for retail. Each conversion stage manifests unique market conditions, with a heterogeneous cohort of professionals and labourers contributing to distinct layers of production. Thus, every transformational stage, from raw materials to functional products, engenders a distinct environmental backdrop, satisfying specific criteria requisite for progression along the production continuum. Embedded within the broader operational milieu, construction professionals navigate uncertain terrains which encapsulate external influences that invariably impact project trajectories. Hence, construction practitioners continuously evaluate and recalibrate their risk thresholds to perpetuate their competitive standing.

Rate rationalisation (in the Malaysian context) is applied with the primary aim to adjust the rates of the successful tenderer's tender rates so that a fair and reasonable contract rates is obtained. This is done by adjusting the rates of the item in Bills of Quantities but still maintaining the contract sum. Rationalisation of Bills of Quantity (RoBQ) is to eliminate front loading in the contractor's prices and to have fair pricing of items in priced Bills of Quantity for variations etc [6].

In the procurement of tenders for the JKR Malaysia project, Bills of Quantity (BQ) are included in the tender document for all tenderers to price the rates for all items specified in detail. Only those tenderers who offer the lowest and most reasonable price within the range determined are accepted for the tender evaluation. The approval committee decides which tenderer to appoint after passing through the tender evaluation process. The tender is awarded to the appointed tenderer, i.e., the named contractor, through a Letter of Acceptance. Before the contract can be signed, the BQ rates need to be rationalised,

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and the rationalised BQ becomes the contract rate [6].

The rationalisation of BQ rates is to conform to the contract term in JKR 203A (Rev. 1/2010) and the Malaysian government policy in Treasury Circular PK4.1 [7], updated on November 29, 2022, by the Ministry of Finance Malaysia. The prices and rates in the BQ submitted by the contractor are adjusted to ensure their reasonableness, and any arithmetical error or omission in the prices or rates and/or calculations of the contractor in the BQ must be rectified and adjusted before the signing of the contract without affecting the tender price.

In Malaysia, the contract must be signed within 4 months after the contractor signs the Letter of Acceptance. [8] (Treasury Circular PK 4.2, 2023). However, due to the many projects launched by the government simultaneously in a rolling plan, the contract signing process has taken more than 4 months [9] (Auditor' General's Report, 2012). This policy has affected payments to contractors and the delivery of government projects causing the Director General Public Works Malaysia (KPKR) has set a key performance indicator with the target of signing the letter of acceptance and contract documents simultaneously [10] (Director General Public Works Malaysia Instruction Letter, 2020). Since the rationalisation process is complex and time-consuming, the Formulation Development Model for BQ Rationalization is part of the process in Model Development for System Rate Rationalization Online (J-Selaras) [11] .

2. REVIEWED OF RELATED WORKS

In JKR practice, the purpose of rationalising BQ is to examine the price rate offered by the contractor to ensure its reasonableness and to standardise the same items before the contract is signed. The rate rationalisation process will not change the contract amount as stated in the Tender Form. Any errors in pricing in the BQ need to be amended. Rates should also be checked for uniformity of rates for the same item description in the BQ.

At the moment, the BQ Rationalization (RoBQ) process are still manually process using Microsoft Excel templates. Rates are reviewed by comparing them with past contract rates from similar contracts or by constructing rates from current market prices. The process is cumbersome, time-consuming and affects the of signing contracts. Therefore, the novelty of this research is to propose an adaptation towards the existing cut-off formula used in JKR tender evaluation as part of this research's tenderer analysis for RoBQ. The cut-off formula in tender evaluation identifies the number of tender prices to be evaluated by using the standard deviation and the Z Score formula to filter the tender prices below the plus or minus 15% adjusted mean.

The cut-off formula in tender evaluation analysis is depicted below:

'Adjusted Mean - 15% Adjusted 'Mean'

or

'Adjusted Mean - 'Stdev'

whichever is higher from the calculation based on the above formula, and in whatever condition of cut-off price, it should not exceed more than the value of the Department's Estimate (DE).

Where:

a) The department's Estimate (DE) is the last department's estimate put in the tender box before the tender closes.
b) 'Adjusted 'Mean' is; -

i) 'Mean' if DE less than 'Mean' value
ii) Average between 'Mean' and DE if DE is higher than the 'Mean'

c) "'Mean' is the average for all tenderer's prices accepted and can be considered including DE as one of the tender prices, i.e.,

$$\sum X/N$$

d) ""'Stdev' is 'Standard 'Deviation' for all tenderers prices accepted and can be considered including DE, i.e.,
e)

$$\frac{\sqrt{N\sum X^2 - (\sum X)^2}}{N^2}$$

Where:-
X = All Tender Prices and DE
N = Number of Tenders + 1 (DE)

In brief, the standard deviation measures the amount of variation or dispersion in a set of values. [12-13] A low standard deviation indicates that the values tend to be close to the Mset's Mean (also called the expected value), while a high standard deviation

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indicates that the values are spread out over a wider range.

Z-score [12-13] is based on calculating an attribute's mean Mean and standard deviation. It is a measurement of the difference between individual value and the mean population, then divided by population standard deviation. The computed, Z-score (Z) provides each feature with a zero mean and a unit variance. The foundation of the Z-score is where the mathematical Gaussian curve or ""Bell Shaped"" curve is applied to the data under study [14]. The Z-score, Z as in [12-13] is expressed as follow:

$$Z\text{- } Score = \frac{x_i - \underline{x}}{s}$$

Where x_i is an individual value, $\underline{x}$ is the Mean of samples, and s is the standard deviation of samples.

The Z-score technique is proposed in the study to analyse the comparison of each rate in the BQ between all the short-listed tenderers, the successful tenderer and the department's cost estimation. Meanwhile, the proposed rates in the BQ to be agreed by the successful tenderer will be automatically generated by the system based on the cut-off formula i.e., the rate of an item description is derived from the average rates of the total number of all the short-listed tenderer including the rate of the successful tenderer and the rate of the department's estimates. The cut-off formula and the Z-score technique are like the tender evaluation system format. The cut-off principle means the lowest acceptable rate to be certified. The tenderer will not be able to complete the project if the rate is too low i.e., the rate is lower than and below the cut-off.[15]

3. J-SELARAS MODEL

The J-Selaras methodology employs the Z-Score Altman model to refine the data by removing unusual values (outliers), resulting in a more polished dataset. Subsequently, after the removal of these outliers, the model identifies the minimum (rMin) and maximum (rMax) values. These crucial steps pave the way for the execution of the Cut-Off Analysis, which aids in determining a reasonable value based on the enhanced dataset.

Furthermore, the model assesses the rates submitted by the successful tenderer to ensure they fall within a predefined range, typically between -15% and 10% of the Cut-Off Value. If the submitted rate falls within this range, the model recommends using the rate proposed by the successful tenderer. However, if the rate lies outside the specified range, the model suggests reverting to the previously determined Cut-Off Value as the proposed rate.

Here is an overview of the formulas utilized in the J-Selaras Model, comprising eleven formulas as presented in Table I.

Table 1: Formulas Used In The J-Selaras Model

Item	Step	Formula
1.	Number of tenderers	n
2.	Department's Estimate	DE
3.	Tenderer's Rate	x
4.	Total number of tenderers (N)	$\sum(n)$
5.	Mean (µ)	$\sum [x_1 + x_2 + x_n] / N$
6.	Standard Deviation (SD)	$\sqrt{(\Sigma (xi - \mu)^2 / N)}$
7.	Z-Score	$\sqrt{(x_n - \mu)^2} / SD$
8.	Adjusted Mean (Aµ)	If (DE < µ) { Aµ = µ } else { Aµ = (DE + µ) / 2 }
9.	Cut-Off Formula 1 (coF1)	Aµ - 0.15* Aµ
10.	Cut-Off Formula 2 (coF2)	Aµ - SD
11.	Cut-Off Value (co)	If (coF1 > coF2) { co = coF1 } else {co = coF1}

The J-Selaras workflow process is developed as depicted in Figure 1.

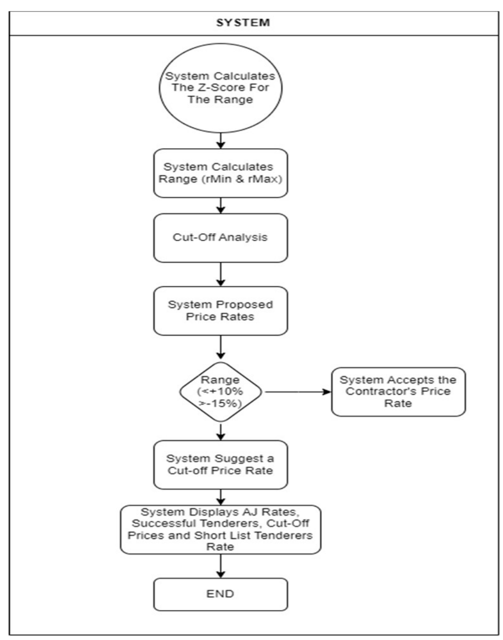

Figure 1: J-Selaras Workflow Process

The model generally shows all the calculations done during the analysis, including the data derived from the rates submitted by other tenderers. This thorough approach ensures a fair and technical assessment of the proposed rates, making the study's findings more accurate and reliable. The following algorithm outlines a step-by-step process to compute a value (z) based on the given input data using specific calculations and conditions.

Input:

x = Successful Tenderer's Rate
a = rMin
b = rMax
c = Adjusted Mean
co = Cut-off Value
coR1 = -15%
coR2 = 10%
z = output
SD = Standard Deviation

Process:

```
Step 1:   Compute of a and b
   d = {v1, v2, v3, vn}
   a = get min value of d
   b = get max value of d
Step 2:   Compute of CO
   Mean = (v1 + v2 +vn) / n
if (DE < Mean) {
   c = mean
}
else {
  c = (DE + mean) / 2
         }
Step 3: Compute coFI and coF2
         coF1 = c – 0.15*c
         coF2 = c - SD
         If (coF1 > coF2) {
           co = coF1
}
else {
   co = coF2
         }
Step 4: Compute coR1 and coR2
   coR1 = -0.15*co
   coR2 = 0.1*co
Conditions:
 i.  If (x >= coR1 && x <= coR2) {
    z = x;
}
else {
    z = co;
}
```

Output:

Display z

4. EXPERIMENT AND RESULTS

Here is an experiment and results as shown below in Experiment 1 and Experiment 2 used in the J-Selaras Model.

4.1 Experiment 1

Sample Data 1

Work Description:

STAIRCASE
64mm diameter x 2mm thick Mild Steel Hollow Section (MSHS) handrail welded to 15mm diameter mild steel bar welded to 38mm x 38mm x 1.6mm thick mild steel baluster with G.I fish tail embeded into concrete and 25mm diameter x 1.2mm thick mild steel railing and painting works

Item : 900mm High railing

Unit : m

Successful Tenderer's Rate : RM150.00

Table 2 below shows the primer data to be used in our Experiment 1. The table consists of ten (10) tenderers and Departmental Estimate Rate. Subsequently, primer data will be eliminated to produce cleaned data by using Z-Score formulation.

Assume, an initial $mean_{z1}$ value equal to 167.41 and initial SD_{z1} equal to 80.44

Z-score $= (X_n – mean) / SD$

The value of Z-Score is acceptable if less than 1.5 and more than -1.5.

Table 2: Primer Data

Tenderer's	Amount	1st			2nd			3rd			8th		
		Mean	SD	Result	Mean	SD	Result	Mean	SD	Result	Mean	SD	Result
		167.41	80.44		150.68	38.06		161.59	26.51		161.59	26.51	
X1.	27.00	-1.75		X			X			X			X
X2.	150.00	-0.22		/	-0.02		/	-0.44		/	-0.44		/
X3.	132.00	-0.44		/	-0.49		/	-1.12		/	-1.12		/
X4.	74.30	1.16		/	-2.01		X			X			X
X5.	309.00	1.76		X			X			X			X
X6.	181.00	0.17		/	0.80		/	0.73		/	0.73		/
X7.	128.16	-0.49		/	-0.59		/	-1.26		/	-1.26		/
X8.	190.00	0.28		/	1.03		/	1.07		/	1.07		/
X9.	150.00	-0.22		/	-0.02		/	-0.44		/	-0.44		/
X10.	300.00	1.65		X			X			X			X
XDE	200.00	0.41		/	1.30		/	1.45		/	1.45		/

Table 3 shows the cleaned data after performing outlier's data process. According to Table 1, four (4) tenderers has been removed because of the value of Z-Score produced is less than -1.5 or more than 1.5.

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To perform Standard Deviation calculation, variance for each tenderer's rate will be computed using the following formula and the results presented in Table 2 below.

Variance (v) = $(x_{n-}\text{Mean})^2$

Table 3: Cleaned Data After Removing Outliers

Tenderers	Amount	Variance (v)
X2.	150.00	32.812241
X3.	132.00	56.440241
X6.	181.00	6.895241
X7.	128.16	62.692201
X8.	190.00	29.989241
X9.	150.00	32.812241
XDE	200.00	0.053241

Based on the Table 3 above, the following formula will be used to compute Standard Deviation:

Standard Deviation (SD) = √ (X2 + X3 + X6 + X7 + X8 + X9 + XDE) / N

SD = 26.51

Table 4: Adjusted Mean Conditions

Conditions	Formula	Process	Result
Condition 1	DE < Mean	200 < 161.59	False
Condition 2	(DE + Mean) / 2	(200+161.59) / 2 = 180.80	True

Based on Table 4, Adjusted Mean value is 180.80 due to condition 1 not fulfil.

Table 5: Determination Of Cut-Off Value

Parameter	Formula	Process	Result
F1	Adjusted Mean – 0.15*Adjusted Mean	180.80 – 27.12	153.68
F2	Adjusted Mean - SD	180.80 – 26.51	154.29

Whichever the higher between F1 & F2, the value represent Cut-off Value. Based on the above calculation in Table 5, F1 is higher than F2. Therefore the Cut-Off Value is 154.29 rundown to four (4) decimal places = 150.00 as presented in Table 6.

Table 6: Determination Of Final Value

	Num. of Tenderers including DE	Reliable Range (rMin – rMax) (128.16 - 200)	Score Value
Model A (Cut-Off)	11	Yes	150

4.2 Experiment 2

Sample Data 2

Work Description:

<u>EXTERNAL FLOOR FINISHES</u>

<u>Approved Full Body Porcelain Half Glazed floor tiles; 600mm x 600mm x 8.5mm as specified; bedded and jointed in cement and sand (1:3) mortar; pointing with grout in white cement (JH 6)</u>

Item : To level, falls and crossfalls and to slope not exceeding 15 degrees from horizontal

Unit : m2

Successful Tenderer's Rate : RM85.00

Table VII below shows the primer data to be used in our experiment. The table consists of ten (10) tenderers and Departmental Estimate Rate. Subsequently, primer data will be eliminated to produce cleaned data by using Z-Score formulation.

Assume, an initial mean_{z1} value equal to 32.05 and initial SD_{z1} equal to 32.33

Z-score = $(X_n – \text{mean}) / SD$

The value of Z-Score is acceptable if less than 1.5 and more than -1.5.

Table 8: Primer Data

Tenderer's	Amount	1st			2nd			3rd			8th		
		Mean	SD	Result	Mean	SD	Result	Mean	SD	Result	Mean	SD	Result
		32.05	32.33		16.98	2.51		17.48	2.21		161.59	26.51	
X1.	13.00	-0.59		/	-1.59		X			X			X
X2.	20.00	-0.37		/	1.20		/	1.14		/	1.14		/
X3.	19.40	-0.39		/	0.96		/	0.87		/	0.87		/
X4.	20.10	-0.37		/	1.24		/	1.19		/	1.19		/
X5.	89.70	1.78		X			X			X			X
X6.	15.00	-0.53		/	-0.79		/	-1.12		/	-1.12		/
X7.	16.35	-0.49		/	-0.25		/	-0.51		/	-0.51		/
X8.	15.00	-0.53		/	-0.79		/	-1.12		/	-1.12		/
X9.	19.00	-0.40		/	0.80		/	0.69		/	0.69		/
X10.	110.00	2.41		X			X			X			X
XDE	15.00	-0.53		/	-0.79		/	-1.12		/	-1.12		/

Table 8 shows the cleaned data after performing outliers data process. According to Table 8, three (3) tenderers has been removed because of the value of Z-Score produced is less than -1.5 or more than 1.5.

To perform Standard Deviation calculation, variance for each tenderer's rate will be computed

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using the following formula and the results presented in Table 2 below.

Variance (v) = (xn – Mean)2

Table 8: Cleaned Data After Removing Outliers

Tenderers	Amount	Variance (v)
X2.	20.00	4.30
X3.	19.40	2.18
X4.	20.10	4.72
X6.	15.00	8.42
X7.	16.35	2.47
X8.	15.00	8.42
X9.	19.00	1.16
XDE	15.00	8.42

Based on the Table 8 above, the following formula will be used to compute standard deviation:

Standard Deviation (SD) = √ (X2 + X3 + X6 + X7 + X8 + X9 + XDE) / N

SD = 2.21

Table 9: Adjusted Mean Conditions

Conditions	Formula	Process	Result
Condition 1	DE < Mean	15.00 < 17.48	True
Condition 2	(DE + Mean) / 2	(15.00+17.48) / 2 = 16.24	False

Based on Table 9, Adjusted Mean value is 17.48 due to condition 2 not fulfil.

Table 10: Determination Of Cut-Off Value

Parameter	Formula	Process	Result
F1	Adjusted Mean – 0.15*Adjusted Mean	17.48 – 2.62	14.68
F2	Adjusted Mean - SD	17.48 – 2.21	15.27

Whichever the higher between F1 & F2, the value represents Cut-off Value. Based on the above calculation in Table 10, F2 is higher than F1. Therefore, the Cut-Off Value is 15.27 rundown to four (4) decimal places = 15.00 as presented in Table 11.

Table 11: Determination Of Final Value

	Num. of Tenderers	Reliable Range (15.00 – 20.10)	Score
Model A (Cut-Off)	11	No	15

5. CONCLUSION

Based on the findings from the experiments conducted, Experiment 1 demonstrates that the rates provided by Successful Tenderers are indeed within the acceptable range, specifically at RM150.00. The calculated Cut-Off value corroborates this figure. However, since the contractor's submitted rate falls within the range, the Cut-Off value will not be used as the Proposed Rate. In Experiment 2, the results indicate that the rate submitted by Successful Tenderers, which is RM85.00, falls outside the acceptable range. Consequently, the value obtained from the Cut-Off Analysis, which is RM15.00, will be applied as the proposed rate. In summary, these two experiments collectively illustrate the effectiveness of the J-Selaras model in determining a reasonable rate for rationalization based on the submissions of the tenderers.

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