

Cohen's Kappa Agreement among Multiple Raters in Determining Factors that Influence MTUN Academics on Data Sharing

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Abstract: Data sharing has become prominent nowadays. On the other hand, the universities produce a vast amount of data but most of these data are kept in a silo, not available, and confidential. This study will investigate the factor that influences Malaysian Technical University Network (MTUN) academics on data sharing. The questionnaire was constructed by adapting the questionnaire from the previous study. There are four (4) constructs that determine data sharing; technological, organizational, environmental, and individual. There are five (5) experts have been appointed to validate the questionnaire. The validation is needed as the questionnaire adapted needs to undergo some amendment to suit the research domain. Once the experts have given their opinion regarding the item's relevance to measuring the constructs, then the calculation of Cohen's Kappa interrater index is conducted. Cohen's Kappa interrater index is used to measure the consensus of all experts on the respective items. This paper will explain in detail how the Cohen's Kappa interrater index is conducted and how the relevancy of the items can be measured and achieved. Only when the interrater index is achieved, then it can be assumed that the questionnaire has been validated by the experts and ready to be distributed to MTUN academics for pilot study purposes.

Keywords: Cohen's Kappa, Statistic, MTUN, Data sharing, Academics

1. Introduction

(UTHM, n.d.) stated that Technical University College Network (TUCN) had been established in the year 2006 to offer technical, vocational, education, and training (TVET) program and practically oriented courses. Later, TUCN has been rebranded to MTUN in the year 2007 as the technical university colleges have been upgraded to be technical universities. According to (Jie et al, 2020), there are four (4) public universities that fall under these categories; UniversitiTun Hussein Onn (UTHM), UniversitiTeknikal Malaysia Melaka (UTeM), Universiti Malaysia Pahang (UMP), and Universiti Malaysia Perlis (UNIMAP). Data sharing is essential in the world nowadays. By sharing the data, the value of the data will increase both to the funders and respective parties (Howe et al, 2018). Nevertheless, there is still debated about data sharing regarding its potential and capabilities. Universities are organizations that produce a large amount of data. However, (Figueiredo, 2017) has stated that the data producer is reluctant to share data might because it possesses challenges at many levels such as cultural, ethical, financial, and technical. On the other hand, (Shamash et al, 2015) have highlighted that the reluctance of data sharing perhaps due to disinterest from the universities. Thus, to get to know the truth about the reluctance of data sharing among MTUN academics, the questionnaire was adapted based on the previous study and amended to suit the domains. As the adapted questionnaire has been amended, thus, there is a need to validate the questionnaire once again. There are five (5) experts were appointed to validate the questionnaire. These experts were chosen based on their experience in quantitative methods, positions as academics, and open data. Once the experts have evaluated the items that measured the constructs, the interrater index was taken place. In this paper, we will consider only two of the most common measures, percent agreement and Cohen's kappa (Cohen, 1960). Cohen's kappa, symbolized by the lower case Greek letter, κ (7) is a robust statistic useful for either interrater or intraclass reliability testing. In other words, the Cohen Kappa index is used to measure the interrater reliability of the instrument developed. It is frequent used in the research to evaluate the interrater reliability between two (2) or more experts.

1. Introduction

The research is about the development of an open data framework for MTUN academics. As for this intention, a quantitative technique was carried out. An established questionnaire was adapted and content validity was made with five (5) experts to determine whether the questionnaire is suitable to have remained and will eventually achieve the objectives.

These five (5) experts were given a set of questionnaires to validate. Note too, there would be some agreement and disagreement during this phase. Thus, there is a need to do Cohen’s Kappa interrater index, to ensure that only agreeable items will have remained and suit the MTUN academics’ domain.

This research has four (4) constructs that determine data sharing; technological, organizational, environmental, and individual. Hence, the research will show the calculation of each construct based on the expert review. Only the items that fall within the acceptable index will have remained in the questionnaire.

There are five (5) steps of calculation for each construct involve; Step 1: observe proportional agreement (P₀), Step 2: the probability of raters agreed, Step 3: the probability of raters disagreed, Step 4: calculate P_e, and Step 5: calculation into a formula before the level of agreements can be determined.

Table 1.Calculation of Cohen’s Kappa interrater index for the technological factor

Steps										
1	2				3				4	5
P ₀	The probability that the raters would randomly agree				The probability that the raters would randomly disagree				P _e	k= (P ₀ - P _e) / (1 - P _e)
79 / 85 = 0.95	Expert	Agreed	Item (n)	Agreement (%)	Expert	Disagreed	Item (n)	Agreement (%)	0.68 + 0.00 = 0.68	(0.93 - 0.68) / (1 - 0.68) = 0.78
	1	15	17	0.88	1	2	17	0.12		
	2	15	17	0.88	2	2	17	0.12		
	3	17	17	1.0	3	0	17	0.00		
	4	16	17	0.94	4	1	17	0.06		
	5	17	17	0.94	5	1	17	0.06		
	Total	79			Total	6				
0.88*0.88*100.0*0.94*0.94 = 0.68				0.12*0.12*0.00*0.06*0.06 = 0.00						

Table 1, shows the calculation from step 1, the researcher observed the proportional agreement by applying the formula number of agreements divided by the total of the questions. The total of questions for technological construct is seventeen (17). Then, these seventeen (17) items were multiplied by the number of experts and that made it a total of eighty-five (85) items. Thus, the total number of agreements is 0.95.

As for step 2, it shows the breakdown of the total probability of the raters agreed randomly is calculated by multiplying the agreement percentage and it resulted in 0.68. On the other hand, step 3 shows the details of the total probability of the raters disagreed randomly which is also calculated by multiplying the agreement percentage and it resulted in 0.00.

Thus, in step 4, the researcher adds answers from steps 2 and step 3 to get the overall probability that the raters would randomly agree to make it 0.68. Finally, in step 5, the researcher inserts calculations into the formula and solves. Based on the formula, it shows that the technological factor Cohen’s Kappa interrater index is 0.78 which indicates substantial agreement.

After getting the result for the technological factor, the researcher proceeds to calculate Cohen’s Kappa index for the organizational factor.

Steps						
1	2		3		4	5
P ₀	The probability that the raters would randomly agree		The probability that the raters would randomly disagree		P _e	k= (P ₀ - P _e) / (1 - P _e)

100 / 105 = 0.95	Expert	Agreed	Item (n)	Agreement (%)	Expert	Disagreed	Item (n)	Agreement (%)	0.77 + 0.00 = 0.77	(0.95 - 0.77) / (1 - 0.77) = 0.78
	1	21	21	1.0	1	0	21	0.00		
	2	21	21	1.0	2	0	21	0.00		
	3	21	21	1.0	3	0	21	0.00		
	4	19	21	0.90	4	2	21	0.10		
	5	18	21	0.86	5	3	21	0.14		
	Total	100			Total	5				
1.0*1.0*1.0*0.90*0.86 = 0.77				0.00*0.00*0.00*0.10*0.14 = 0.00						

Table 2.Calculation of Cohen’s Kappa interrater index for the organisational factor

Table 2, shows the calculation from step 1, the researcher observed the proportional agreement by applying the formula number of agreements divided by the total of the questions. The total of questions for organizational construct is twenty-one (21). Then, these twenty-one (21) items are multiplied by the number of experts and that made it a total of one-hundred-five (105) items. Thus, the total number of agreements is 0.95.

As for step 2, it shows the breakdown of the total probability of the raters agreed randomly is calculated by multiplying the agreement percentage and it resulted in 0.77. On the other hand, step 3 shows the details of the total probability of the raters disagreed randomly which is also calculated by multiplying the agreement percentage and it resulted in 0.00.

Thus, in step 4, the researcher adds answers from steps 2 and step 3 to get the overall probability that the raters would randomly agree to make it 0.77. Finally, in step 5, the researcher inserts calculations into the formula and solves. Based on the formula, it shows that the organizational factor Cohen’s Kappa interrater index is 0.78 which indicates substantial agreement.

After getting the result for the organizational factor, the researcher proceeds to calculate Cohen’s Kappa index for the organizational factor.

Table 3.Calculation of Cohen’s Kappa interrater index for the environmental factor

Steps										
1	2				3				4	5
P ₀	The probability that the raters would randomly agree				The probability that the raters would randomly disagree				P _e	k= (P ₀ - P _e) / (1 - P _e)
30 / 30 = 1.00	Expert	Agreed	Item (n)	Agreement (%)	Expert	Disagreed	Item (n)	Agreement (%)	1.0 + 0.00 = 1.00	(1.0 - 1.0) / (1 - 1.0) = 1.00
	1	6	6	1.0	1	0	6	0.00		
	2	6	6	1.0	2	0	6	0.00		
	3	6	6	1.0	3	0	6	0.00		
	4	6	6	1.0	4	0	6	0.00		
	5	6	6	1.0	5	0	6	0.00		
	Total	30			Total	0				
1.0*1.0*1.0*1.0*1.0 = 1.00				0.00*0.00*0.00*0.00*0.00= 0.00						

Table 3 shows the calculation from step 1, the researcher observed the proportional agreement by applying the formula number of agreements divided by the total of the questions. The total of questions for environmental construct is six (6). Then, these six (6) items were multiplied by the number of experts and that made it a total of thirty (30) items. Thus, the total number of agreements is 1.00.

As for step 2, it shows the breakdown of the total probability of the raters agreed randomly is calculated by multiplying the agreement percentage and it resulted in 1.00. On the other hand, step 3 shows the details of the total probability of the raters disagreed randomly which is also calculated by multiplying the agreement percentage and it resulted in 0.00.

Thus, in step 4, the researcher adds answers from steps 2 and step 3 to get the overall probability that the raters would randomly agree to make it 1.00. Finally, in step 5, the researcher inserts calculations into the formula and solves. Based on the formula, it shows that the environmental factor Cohen’s Kappa interrater index is 1.00 which indicates perfect agreement. It means that all of the experts were agreed unanimously on these items.

After getting the result for the environmental factor, the researcher proceeds to calculate Cohen’s Kappa index for the individual factor. Table 4 shows the calculation of Cohen’s Kappa interrater index for individual factors.

Steps										
1	2				3				4	5
P_0	The probability that the raters would randomly agree				The probability that the raters would randomly disagree				P_e	$k = \frac{(P_0 - P_e)}{(1 - P_e)}$
63/ 65 = 0.97	Expert	Agreed	Item (n)	Agreement (%)	Expert	Disagreed	Item (n)	Agreement (%)	0.85 + 0.00 = 0.85	$\frac{(0.97 - 0.85)}{(1 - 0.85)} = \mathbf{0.80}$
	1	13	13	1.0	1	0	13	0.00		
	2	13	13	1.0	2	0	13	0.00		
	3	13	13	1.0	3	0	13	0.00		
	4	11	13	0.85	4	2	13	0.15		
	5	13	13	1.0	5	0	13	0.00		
	Total	63			Total	0				
$1.0 * 1.0 * 1.0 * 0.85 * 1.0 = \mathbf{0.85}$				$0.00 * 0.00 * 0.00 * 0.15 * 0.00 = \mathbf{0.00}$						

Table 4. Calculation of Cohen’s Kappa interrater index for the individual factor

Table 4 shows the calculation from step 1, the researcher observed the proportional agreement by applying the formula number of agreements divided by the total of the questions. The total of questions for the individual construct is thirteen (13). Then, these thirteen (13) items were multiplied by the number of experts and that made it a total of sixty-five (65) items. Thus, the total number of agreements is 0.97.

As for step 2, it shows the breakdown of the total probability of the raters agreed randomly is calculated by multiplying the agreement percentage and it resulted in 0.85. On the other hand, step 3 shows the details of the total probability of the raters disagreed randomly which is also calculated by multiplying the agreement percentage and it resulted in 0.00.

Thus, in step 4, the researcher adds answers from steps 2 and step 3 to get the overall probability that the raters would randomly agree to make it 0.85. Finally, in step 5, the researcher inserts calculations into the formula and solves. Based on the formula, it shows that the individual factor Cohen’s Kappa interrater index is 0.8 which indicates substantial agreement. Table 5 shows the summary of the expert’s agreement for each construct.

Dimension/Attribute	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Cohen Kappa (κ)	Agreement
Technological	0.88	0.88	1.00	0.94	0.94	0.78	95%
Organisational	1.00	1.00	1.00	0.90	0.86	0.78	95%
Environmental	1.00	1.00	1.00	1.00	1.00	1.00	100%
Individual	1.00	1.00	1.00	0.83	1.00	0.80	97%

Table 5. Summary of Expert’s agreement for each construct

Based on Table 5, the Cohen Kappa inter-rater reliability index (κ) coefficient was calculated and it shows that the Kappa value is within 0.78 to 1.00. The value of Cohen Kappa shows that the items evaluated by the experts are suitable to be used in this research. Once the instrument is validated, a set of the questionnaire was given to the potential MTUN academics for pilot study purposes.

3. Results and Discussions

Cohen's Kappa interrater index is crucial to be undertaken after the experts had given their opinion on the item's relevancy in research. The main reason the interrater index needs to be measured is to get a consensus among all the experts on the item's relevance in the research.

The Cohen's Kappa interrater index is like correlation coefficients, it can range from -1 to $+1$, where 0 represents the amount of agreement that can be expected from random chance, and 1 represents perfect agreement between the raters. As with all correlation statistics, the kappa is a standardized value and thus is interpreted the same across multiple studies.

Cohen suggested the Kappa result be interpreted as follows: values ≤ 0 as indicating no agreement and $0.01-0.20$ as none to slight, $0.21-0.40$ as fair, $0.41-0.60$ as moderate, $0.61-0.80$ as substantial, and $0.81-1.00$ as almost perfect agreement. In short, for this research, the value of the Kappa index should be at least 0.60 .

As this research investigates the factors that influence MTUN academic data sharing, thus four (4) constructs that have been identified were measured; technological, organizational, environmental, and individual. Each construct has its items to be measured.

As shown in 2, the technological constructs resulted to get a substantial agreement of 0.78 in which the rate falls between $0.61-0.80$. The organizational constructs resulted to get a substantial agreement of 0.78 in which the rate falls between $0.61-0.80$. The environmental constructs resulted to get a perfect agreement of 1.00 in which the rate falls between $0.81-1.00$. The individual constructs resulted to get a substantial agreement of 0.80 in which the rate falls between $0.61-0.80$. It can be assumed that all of the constructs and its items measured were significant and agreed upon by the experts.

Table 5 shows a summary of the expert's agreement for each construct. From this table, it can be seen that all of the experts were agreed with 95% to 100% with the items in the questionnaire and their significance to measure the dedicated constructs. The percentage is high and it makes the questionnaire fit to measure its purposes and it is validated. In this case, there will be no item removal at this phase and all of the items will be remained. The questionnaires now are ready to be distributed to MTUN academics for pilot study purposes.

4. Conclusions

Data sharing has always been a debate in an organization for its capabilities to benefit others. However, there is an increasing demand from universities to share their data. Undeniable, the data shared will create new knowledge for the respective parties.

In determining the factor that influences MTUN academics on data sharing, the questionnaire is constructed and needs to go through the content validity phase to make the questionnaire reliable and validated. There are five (5) experts have been appointed to validate the questionnaire. Thus, comes the appointment of these experts to validate the questionnaire.

There are four (4) constructs identified that might influence MTUN academics on data sharing; technological, organizational, environmental, and individual. All of these constructs were measured by the items and these items had been evaluated its significance by the experts.

Once the experts had given their opinions regarding the items measured, then the Cohen's Kappa interrater index was calculated. This interrater index is used to get the consensus among all the experts regarding the respective items. The goal of this index to ensure that only agreeable items by the experts will have remained in the questionnaire as it shows the relevancy of the items to measure the constructs.

Based on table 5, it can be concluded that all of these four (4) construct's items were agreed by the experts with the percentage falls within 95% to 100% . Thus, there will be no item removal in this phase and the constructed questionnaire is valid to be distributed among MTUN academics for field study purposes.

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References

1. Cohen. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement*, 20(1), 37-46 ST-A coefficient of agreement for nominal. Retrieved from <http://epm.sagepub.com>
2. Figueiredo, A. S. (2017). Data Sharing: Convert Challenges into Opportunities. *Frontiers in Public Health*, 5(December), 1–6. <https://doi.org/10.3389/fpubh.2017.00327>
3. Howe, N., Giles, E., Newbury-Birch, D., & McColl, E. (2018). Systematic review of participants' attitudes towards data sharing: A thematic synthesis. *Journal of Health Services Research and Policy*, 23(2), 123–133. <https://doi.org/10.1177/1355819617751555>
4. Jie, L. P., Ramlan, R., Hassan, R., Omar, R., & Wei, C. S. (2020). Website quality of Malaysian Technical University (MTUN). *Indonesian Journal of Electrical Engineering and Computer Science*, 18(3), 1624–1628. <https://doi.org/10.11591/ijeecs.v18.i3.pp1624-1628>
5. Shamash, K., Alperin, J. P., & Bordini, A. (2015). Teaching Data Analysis in the Social Sciences: A case study with article level metrics. *Open Data as Open Educational Resources: Case Studies of Emerging Practice*, 50–56. <https://doi.org/http://dx.doi.org/10.6084/m9.figshare.1590031>
6. UTHM. (n.d.). Malaysian Technical University Network. Retrieved from 2015 website: <https://mtun.uthm.edu.my/ms/>