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Modified fuzzy Delphi to determine the consensus of government facility governance

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Abstract. The article discusses the development of governance indicators for work facility policies of local government. These indicators will be used as a policy to ensure that work facilities are durable, cost-effective in procurement and maintenance, are effective in use, and added value for end of use/life. Many researchers previously developed governance indicators with the Fuzzy Delphi method, but there were still gaps, namely the differences in the weight of expertise had not been accommodated in determining the final consensus of the importance of each indicator. In this article, the indicators are developed by expert, by considering the weight of their expertise, using a modified Fuzzy Delphi method. The final results of the study are four dimensions of government work facilities governance with twenty indicators that are important in improving the operational performance of local governments.

1. Introduction

Determination of expert consensus with traditional Delphi method requires several stages to get a convergent opinion, which is time-consuming and expensive [1]. Furthermore, the opinions of each expert on an indicator in the traditional Delphi method are generally expressed in one choice interest score on a Likert scale for the research using questionnaire [2]. The choice of interests represented in a score point is not representative, because humans in judging something is not 'black' and 'white', if in one point assessed 'black' and then shifted slightly 'white' directly, there is a slow degradation from black to white [3]. Based on the two reasons mentioned above, namely to reduce the steps and overcome the lack of a single point assessment, the Delphi method modification is needed. To overcome those problems, some researchers have used the concept of fuzzy sets, such as [4, 5, 6, 7, and 8].

Delphi decision model with existing fuzzy approaches has weaknesses, decision aggregation is determined based on the average value of the opinions of all experts. According to Kamonpatana *et al.* [7] and Quyen [8] each expert is considered to have the same level of importance. Meanwhile, according to Liu *et al.* [9] expert opinions must be distinguished based on differences in the level of importance of each expert, due to differences in educational qualifications, work experience, and level of authority. Need different weights for each expert opinion in determining the aggregate final assessment of an indicator. The experts who have higher weight have a bigger voice, more to hear. For this reason, in this article, a modified Fuzzy Delphi method concerning different expert weights was developed.

2. Formulation of modified fuzzy Delphi

The selection of work facility governance policies, ranging from procurement policies to end-of-life/use, requires a collective consensus of various stakeholders. In this study, collective decision choices were formulated using the modified Fuzzy Delphi method through focus group discussion (FGD). The purpose of using fuzzy concepts is to accommodate the uncertainty of human choice boundaries regarding the choice of policy importance [3-7]. This can reduce the decision-making process in the traditional Delphi method which takes a lot of time and money. Consensus in the traditional Delphi method generally cannot be reached in one stage, since the choice of stakeholders is expressed in a narrow or crisp choice [1, 2, and 8].

Collective decision by several interested parties to get a consensus on work facility governance policies in the local government with modified Fuzzy Delphi, starting from the identification of various dimensions of governance policies to policy indicators through literature review, field studies and input from stakeholders when FGD is performed.

Furthermore, for the model formulation, the policy dimension is denoted by *PI*, the i^{th} policy indicator of j^{th} dimension is denoted by PI_{ij}, and the k^{th} expert or interested party is denoted by E_k. The importance level of each indicator is expressed in five Likert scale [5, 7], namely *EI* (extremely important), *VI* (very important), *RI* (relatively important), *SI* (somewhat important), and *NI* (not important) with the domain of all levels in *[0, 1]* and the degree of membership μ of each point is expressed in *[0, 1]*, where the degree of membership $\mu = 0$ means not being at a level of importance, $\mu = 1$ means definitely in a level of importance, and a score between *0* and *1* means being at an importance level with membership degrees *(0, 1)*. Then the membership function of each level of importance of policy indicators can be formulated as a triangular fuzzy membership function with a domain *[0, 1]*, where the midpoint of a triangle function has a membership value of one, then the membership value is degraded to zero to the left and right as far as 0.25 [3-7].

Membership function of fuzzy set μ_{PI} of the i^{th} indicator importance level of j^{th} dimension who is evaluated by k^{th} expert with membership value is one at middle point *M*, i.e. $\mu_{PI_{ijk}}(M)=1$ can be formulated as triangular function *TRF*, with lower limit *L*, upper limit *U*, and middle point *M*:

$$\mu_{MF_{ijk}}(x) = TRF(L_{ijk}, M_{ijk}, U_{ijk}) \quad (1)$$

$$= TRF(M - 0.25, M, M + 0.25) \quad (2)$$

$$= \begin{cases} 4(x-M)+1, & M - 0.25 \le x \le M \\ -4(x-M)+1, & M < x \le M + 0.25 \end{cases} \quad (3)$$

The triangular membership function of all values of the importance levels of *NI, SI, RI, VI,* and *EI* can be described as follows (Fig. 1):

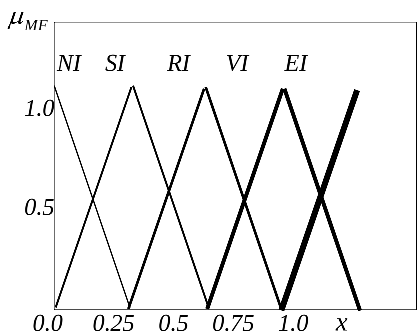

Figure 1. Triangular membership function of indicators importance level

Furthermore, if the weight of the k^{th} expert is denoted by WE_k where $\sum_k WE_k = 1$, the weight of the k^{th} expert is determined based on the level of knowledge, skills, and experience, then the fuzzy set of the consensus of all experts in determining the importance level of a policy indicator PI_{ij} can be formulated as union U of all fuzzy set of the expert, i.e.:

$$\mu_{PI_{ij}}(x) = \bigcup_k \mu_{PI_{ijk}}(x) = TRF(L_{ij}, M_{ij}, U_{ij}) \quad \forall i, j \tag{4}$$

Where

$$L_{ij} = \min_k \{L_{ijk}\} \quad \forall i, j \tag{5}$$

$$U_{ij} = \max_k \{U_{ijk}\} \quad \forall i, j \tag{6}$$

$$M_{ij} = \sum_k WE_k M_{ijk} \quad \forall i, j \tag{7}$$

Equations (5) and (6) illustrate the left L_{ij} and right U_{ij} boundaries of the importance level of all experts related to the evaluation of the i^{th} policy indicator on the j^{th} dimension. The left and right boundaries are the value with the greatest scope, meaning that the left boundary of the assessment of all experts is taken the smallest (*min*) and the right boundary taken from the largest expert assessment (*max*). These left and right boundaries correspond to Liu [5], Kamonpatana *et al.* [7], and Quyen [8]. These limits (5) and (6) aim to reduce the decision-making process that is repeated in the Delphi method. Meanwhile, equation (7) is the midpoint M_{ij} of the importance level of all experts, namely the highest importance membership value of *1*, its value is determined as the weighted average of all the highest importance assessments of all experts. Where the weight of each expert WE_K is taken into account Liu *et al.* [9], it means that experts with greater weight have greater votes and vice versa, this is by the rules of decision making in local government in general. Equation (5, 6, and 7) is a modification of the existing equation by researchers [4-7]. Specifically, in equation (7) the authors setting the arithmetic mean with different weights for experts, whereas researchers [4, 6, and 8] used arithmetic mean, and researchers [5, 7] with geometric mean, all of which assume each expert has the same weight.

Finally, the conclusion of the importance level of the i^{th} policy indicator in the j^{th} policy dimension by all *PI* experts can be formulated as a center of gravity CoG as determined by Kamonpatana *et al.* [7], which is the defuzzification of equation (4-7), i.e.:

$$PI_{ij} = \frac{\int_0^1 x\mu_{MF_{ij}}(x)dx}{\int_0^1 \mu_{MF_{ij}}(x)dx} \tag{8}$$

PI policy indicators in the j^{th} policy dimension can be used as a consensus by all experts, considered as important policy indicators in the governance of work facilities if they meet the following threshold values (*TV*):

$$PI_{ij}^* > TV_j \quad \forall j \tag{9}$$

Where the threshold value is the first quartile Q_1 of all the indicators of importance in each dimension j^{th} as mentioned by Quyen [8], i.e.:

$$TV_j = Q_1^j = \min_j \{PI_{ij}\} + 0.25 range_j \{PI_{ij}\} \tag{10}$$

The level of importance of policy indicators *PI* that meet the threshold value (9) can be classified into high importance (PI>0.75), medium importance ($0.51 \le PI \le 0.75$), and low importance (PI<0.51). Furthermore, the level of consensus of all experts for each indicator can be formulated as a coefficient of quartile value (CQV):

$$CQV_i = \frac{Q_3 - Q_1}{Q_3 + Q_1} = \frac{0.5 range_k \{M_{ijk}\}}{2\min_k \{M_{ijk}\} + range_k \{M_{ijk}\}} \quad \forall i, j \tag{11}$$

According to Quyen [8] consensus can be divided into high consensus if $CQV \le 0.15$, medium consensus, if $0.15 < CQV \le 0.20$, and low consensus, if $CQV > 0.20$.

3. Formulation of modified fuzzy Delphi

As a case study, the following is the application of modified fuzzy Delphi in determining the level of importance and consensus level of work facility governance policy decision in a local government in Indonesia. Dimension of policy decisions include decisions on procurement, usage, and maintenance of work facilities, as well as recapturing the value of end of use/life of them [10, 11]. Based on the dimensions of the governance policy, the following are each policy indicators derived from a review of some previous literature.

3.1. Procurement policy of work facility

The procurement policy of an organization has a strategic position to maintain the stability of the operational process. Government procurement division aims to supply facilities which are ready and reliable to use by the user with low on price and maintenance cost. There are many ways to procure material or facilities [12, 13, and 14]. Purchase (abbreviated as policy indicator *Proc1*). Meeting the needs of work facilities using the institution handing the amount of money to the seller to obtain work facilities by the agreement of both parties. Receipt of a grant (*Proc2*). Meeting the needs of work facilities by accepting voluntary gifts from other parties. Grants can be received from the government (national or regional) and the private sector. Rentals (*Proc3*). Meeting the needs of work facilities by temporarily utilizing the property of other parties for the benefit of the institution and then paying it based on the lease agreement. Borrowing (*Proc4*). Fulfillment of work facilities by utilizing other parties' goods for the interests of institutions voluntarily by the loan agreement. Exchange (*Proc5*). Fulfillment of work facilities by exchanging goods owned by institutions with goods owned by other parties, meanwhile exchanged work facilities must be work facilities that are no longer useful for the institution. Reconditioning/repairing (*Proc6*). Reconditioning or repairing is a means of meeting the needs of work facilities that have been damaged. Repairs can be done by replacing damaged parts so that damaged work facilities can be reused as they should.

3.2. Usage policy of work facility

All facilities must be used properly and properly so that conditions remain excellent and can be used in the long run. Some of the results of previous studies [11, 15, and 16] suggest various ways of using work facilities. Installation of facilities according to the manual book and operation of facilities by work instructions (*Usage1*). All facilities are placed in the area needed in sufficient quantities, well-organized, always clean, and ready to use (*Usage2*). Raw materials or spare parts needed to work or to operate facilities are available and adequate (*Usage3*). And, there is visual control or warning system of irregularities or abnormalities (damage, run out of material, errors) (*Usage4*).

3.3. Maintenance policy of work facility

Maintenance of work facilities is very important to keep the facilities in top condition, ready to use and can be used for a long time. There are various ways to maintain the work facilities [17, 18, and 19]. Care facilities are carried out regularly following a predetermined maintenance schedule regardless of the condition of the facility (*Maint1*). Facility maintenance is carried out by looking at the current condition (decline in performance), without waiting for the maintenance schedule or waiting until the facility is damaged (*Maint2*). Facility maintenance is carried out with repairs due to damaged or non-functioning facilities (*Maint3*). Facility maintenance is carried out by estimating the conditions or workload in the future (*Maint4*).

3.4. Recapture value of end of use/life

Handling of work facilities that are end of use/end of life or damaged ones requires a big cost. To reduce handling costs and/or recapture the remaining value, the institution must be clever. If not, then the handling costs will increase. Several ways can be done to reduce costs or to recapture value [20, 21]. Outdated facilities sold or auctioned openly (*EndUL1*). Facilities that have expired are exchanged for facilities needed by the institution (*EndUL2*). Facilities that have expired are moved to places (within the same institution) that need them more (*EndUL3*). Facilities that have expired service are given to other institutions that need them (*EndUL4*). Facilities that have expired have been reused or recycled (*EndUL5*). Facilities that have been used up have been destroyed/burned (*EndUL6*).

3.5. Model implementation on a case study

This case study was carried out at a local government that has a variety of work facilities, such as personal computers, laptops, printers, photocopiers, LCDs, etc. Seven respondents are willing to participate in this study. The seven respondents were called experts because they had very adequate knowledge and work experience in the procurement, use, maintenance, or management of finished goods. Data in Table 1 shows the level of knowledge ($Know_k$) and work experience ($Expr_k$) of each expert (E_k, $k=1, 2,\ldots,7$), with a total weight (WE_k) calculated from 40% knowledge and 60% experience.

In Table 2, by using equations (5)-(7) the fuzzy set of the importance level of each policy indicator is calculated, the lower limit of *L*, the middle value of *M*, and the upper limit of *U*, namely the boundaries of the combined fuzzy triangular membership function of the judgment of the seven experts. Furthermore, using equation (8) the centre of gravity of each fuzzy set of importance is calculated for each policy indicator *PI*. Equation (9) to calculate threshold value *TV* for each dimension policy, as a criterion for determining a *PI* in a dimension whether it is important or not important. Equation (10) was used to calculate the consensus level CQV for each policy indicator *PI* from all experts.

Table 1. Expert weight based on knowledge and experience

Expert	E1	E2	E3	E4	E5	E6	E7
$Know_k$	3	1	3	2	3	3	2
$Expr_k$	15	10	20	10	5	18	9
WE_k	0.17	0.11	0.22	0.12	0.07	0.20	0.11

Table 2. Fuzzy membership function l-m-u, level of importance pi, and level of consensus cqv

Policy		*L*	*M*	*U*	*PI*	*CQV*
Procurement	Proc1	0.25	0.59	1.00	0.61	0.20
	Proc2	0.50	0.89	1.00	0.80	0.14
	Proc3	0.50	0.92	1.00	0.81	0.14
	Proc4	0.00	0.47	1.00	0.49	0.14
	Proc5	0.00	0.35	0.75	0.37	0.33
	Proc6	0.50	0.88	1.00	0.79	0.14
Usage	Usage1	0.25	0.76	1.00	0.67	0.08
	Usage2	0.50	0.89	1.00	0.80	0.14
	Usage3	0.00	0.58	1.00	0.53	0.11
	Usage4	0.50	0.88	1.00	0.79	0.14
Mainte-nance	Maint1	0.25	0.69	1.00	0.65	0.09
	Maint2	0.50	0.89	1.00	0.80	0.14
	Maint3	0.00	0.37	0.75	0.37	0.33
	Maint4	0.50	0.85	1.00	0.78	0.14
End of use/life	EndUL1	0.25	0.78	1.00	0.68	0.08
	EndUL2	0.25	0.55	1.00	0.60	0.11
	EndUL3	0.00	0.41	1.00	0.47	0.14
	EndUL4	0.00	0.52	1.00	0.51	0.20
	EndUL5	0.25	0.83	1.00	0.69	0.14
	EndUL6	0.00	0.36	0.75	0.37	0.20

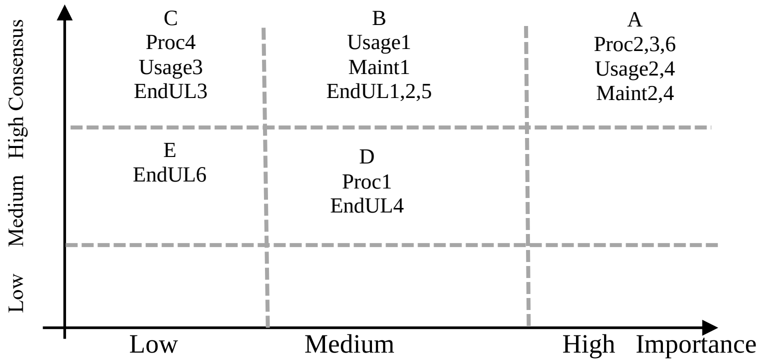

Figure 2. Importance and consensus level of each policy indicator

Threshold values *TV* for procurement, usage, maintenance, and end of use/life dimension are 0.52, 0.63, 0.58, and 0.48. Based on Table 2 and Figure 2 for procurement dimension, it can be explained that from six indicators (with TV_1=0.52), four indicators agreed to be very important by all experts, namely purchase, receive a grant, rental, and recondition/repair. While the remaining indicators are less important, i.e. loans and exchange work facilities. Meanwhile, 4 policy indicators have a high level of consensus, namely receipt of grants, leases, loans, and reconditioning/repairs. These indicators are supported by all experts. While the other two indicators received varied support, namely the purchasing indicator was in moderate consensus, and the exchange indicator received very low consensus. The same explanation for indicators in other dimensions.

In general, calculation result of modified fuzzy Delphi are all experts have high consensus for 15/20 indicators or 75% (A, B, and D groups), 15% medium consensus, and only 2/20 or 10% are low consensus, in deciding the importance level of work facility governance policy indicators government.

4. Conclusion

Modified fuzzy Delphi was quite successful in capturing the uncertainty of the approval limits of experts regarding the importance of a policy indicator. This model also succeeded in reducing the decision-making process to reach a consensus that was repeated several times. In this case, the study can produce a high consensus level of 90%, only 10% is low, indicating a decision-making process that does not need to be repeated much. This model still has weaknesses related to the fuzzy membership function which is limited as triangular, changes in the degradation of the level of importance are considered symmetrical and linear, which in reality is not the case. Future studies are expected to capture the degradation of non-linear membership functions by developing non-linear fuzzy membership functions.

References

[1] Le Pira M, Inturri G, Ignaccolo M and Pluchino A 2017 *Trans. Res. Proc.* **25** pp 3725–35
[2] Musa H D, Yacob M R, Abdullah A M and Ishak M D 2015 *Proc. Environ. Sc.* **30** pp 244–9
[3] Hsueh S-L 2015 *Renew. & Sustain. Energy Rev.* **49** pp 1286–95
[4] Habibia A, Jahantigh F F and Sarafrazic A 2015 *As. J. of Res. in Bus. Ec. & Man.* 5 **2** pp 130-143
[5] Liu W-K 2013 *Int. J. of e-Ed. e-Bus., e-Man. & e-Learn.* 3 **4**
[6] Pham T Y, Ma H M and Yeo G T 2017 *As. J. of Ship. & Log.* 33 **4** pp 211-9
[7] Kamonpatana K, Anuntavoranich P, Varodompun J, Sunakorn P, Thaitakoo D and Wattanapreechanon K 2015 *Kasetsart J.* (Soc. Sci) **36** pp 554–567
[8] Quyen D T N 2014 *Proc. Soc. & Behav. Sc.* **141** pp 828–833
[9] Liu X, Xu Y, Montes R and Herrera F 2019 *Inf. Sc.* **505** pp 215–232

[10] Hanis M H, Trigunarsyah B and Susilawati C 2010 *Proc. of 1st Makassar Int. Conf. on Civil Eng.* Indonesia
[11] Lima E S and Costa A P C S 2019 *Rel. Eng. & Sys. Safe.*, **190** 106523 pp. 1-11
[12] Filho W L, Skouloudis A, Brandli L L, Salvia A L and Rayman-Bacchus L 2019 *J. of Cleaner Prod.* **231** pp 1267-1280
[13] Bakir S, Khan S, Ahsan K and Rahman S 2018 *J. of Environ. Man.* **225** pp 325-335
[14] Patrucco A S, Luzzini D, Ronchi S and Essig M 2017 *Pub. Money & Man.* 37 **4** pp 269-276
[15] Leming-Lee T, Polancich S and Pilon B 2019 *Nursing Clinics of North Am.* 54 **1** pp 53-79
[16] Antony J, Rodgers B A and Cudney E A *Int. J. of Qual. & Rel. Man.* 34 **9** pp 1402-11
[17] Sani S I A, Mohammed A H, Misnan M S and Awang M 2012 *Proc.-Soc. & Behav. Sc.* **65** pp 827–832
[18] Ighravwe D E and Oke S A 2019 *J. of Build. Eng.* **24** 100753 pp 1-18
[19] Dickerson D E and Ackerman P J 2016 *Proc. Eng.* **145** pp 685–692
[20] Farahani S, Otieno W and Barah M 2019 *J. of Cleaner Prod.* **224** pp 25-39
[21] Agrawal S, Singh R K and Murtaza Q 2015 *Res. Conservation & Recycling* **97** pp 76–92