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MAKASSAR SMART CITY OPERATION CENTER PRIORITY OPTIMIZATION USING FUZZY MULTI-CRITERIA DECISION-MAKING

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Abstract- The development of smart city operation room of Makassar possesses several equally important stages which are equally important. There are four stages of development that are 1) data center construction, 2) camera distribution around the city , 3) wall room monitoring construction, and 4) smart operation room architecture construction. Since the time and cost are limited, it forces the project manager to be able to manage and control the priority in conducting the project. There are several usable criteria to determine the priority in conducting the project development through criteria consideration of the entire project stages. Project priority optimization system aims at making every single project activity effective including its evaluation process. It also exposes a ranking illustration of foremost project priority by providing cost preference of the entire development stages. Fuzzy Multi-Criteria Decision-Making is used to illustrate the project priority rank and further to determine the alternative optimal option in conducting the project. This enforces particular project to allocate its cost to the project with a higher level of cost necessity. The company, therefore, enables to make effective funding for the entire project based on the level of importance and time achievement and subsequently it promotes accessible technology integration. The conducted experiment suggests that the first construction of the project is data center construction followed by wall room construction and CCTV distribution. This is relevant with optimization value result of data center 0,405 higher than A2 0,42 for wall room construction and A3 CCTV distribution 0,24.

Keywords: Project optimization; smart operation room; main priority; fuzzy MCDM.

I. INTRODUCTION

Cost plays an important factor of a company dealing with the development of information technology. Generally, within a particular project, the company conducts more than one task[1][2]. Consequently, it needs a proper and worthwhile strategy in order to conduct the task on-time[2][3]. As a parental project, the company needs to manage project cost of every task. It is imperative to manage the cost of project tasks since the cost influences the performance in finishing the task (additional time will result in an additional cost)[4][5][6]. However, in fact, the availability cost within the company and each project are not adequate at any time. Subsequently, it enforces the company to optimize the available cost for a particular project or only for several projects[7][8][9]. The above-mentioned issues force the company to manage production cost within particular project optimally[10][3]. As a result, the allocated cost is effectively distributed and it does not hamper the finalizing of the project[9].

To answer and resolve the above-mentioned issues, optimization system which is able to optimize and manage the allocated cost flow in each project and also oversee the cost condition within each project is designed[11][12]. The project development are data center construction, wall room construction, city CCTV distribution, mechanical engineering development and supporting facility construction[13][14]. Indeed, each company possesses different criteria to determine the status and condition of the particular project cost[15][10]. The aforementioned system uses a *Fuzzy Multiple Criteria Decision Making* (FMCDM) to optimize decision making within the project tasks which consider the priority of cost allocated by the company and therefore, it does not interfere with the allocated company cash flow and established a schedule[9][16][8]. The use of this fundamental yet powerful method is suitable for this pilot research. The linguistic variables [17] of the smart city project could be easily modelled by this MCDM technique.

II. THEORITICAL FRAMEWORK

A. Project Financing

Project financing within smart city construction project requires a much amount of cost. Thus, it is essential to manage and oversee the necessity cost of each project task to make the allocation effective and does not hinder the project development [11][14][18].

The head of project financing should take an active role in managing and overseeing the financial report of the project weekly and validating the entire financial plan arranged by the manager of each project[11][19]. During report overseeing, the head of project financing should be able to view and consider which project possessing secure and harmless project financing record [2] [19][20].

To determine the status of the financial report and record, the head of project financing possesses several criteria. The criteria are Authorization Expenditure, Operational

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Expenditure, Human Resources Expenditure, Procurement Expenditure, Recent Report of Project Development, Project Period and Scale[4][16][21].

B. *Fuzzy Multiple Criteria Decision Making*

Fuzzy Multiple Criteria Decision Making (FMCDM) is a decision-making method that aims to determine the finest alternative decision from several available alternatives based on several considerable criteria. Several general preferences in MCDM are:

a. The alternative is a different object and possesses an equal chance to be chosen by the decision maker.
b. Attribute or characteristic is a decision component or criteria.
c. Weight shows a relative interest from each criteria W= (W1, W2, … Wn)
d. Decision matrix is an X decision matrix sized m x n, contains an X_{ij} elements which represent A_i (i = 1,2, …,m) rating and alternative toward C_j (j= 1,2, …, n) criteria.

III. FMCDM Accomplishment Stage

Within Fuzzy Decision Making there are three important stages which need to be conducted. The stages are detailed in the following sub-sections.

A. *Problem Representation Stage*

Here are the steps in the problem formulation:

a. Identification of decision purpose is represented by natural language or numerical value based on the characteristic of problems.
b. The identification on the collection of alternative decision, A, if any n alternative, A= $\{A_i|$ i= 1,2,…,n}.
c. The identification on criteria collection. If criteria, it is written as C = $\{C_t|$ t= 1,2,…,k}.
d. Establishing Hierarchy Structure of problems.

B. *Evaluating Fuzzy Set*

The process of formulating rules using fuzzy method needs some following process:

a. Designate rating set of weights in each criterion and the degree of conformity from the alternatives upon criteria.
b. Evaluate the weights in each criterion and the degree of conformity from the alternatives upon criteria.
c. Aggregate the weights of criteria and the degree of conformity of each alternative with its criteria using the mean method. The use of mean operator is formulated on the following equation (1):

$$F_t = \left(\frac{1}{k}\right)[(S_{t1} \otimes W_1) \oplus (S_{t2} \otimes W_2) \oplus \wedge \oplus (S_{tk} \otimes W_k)] \quad (1)$$

By substituting S_{it} and W_t with triangular fuzzy numbers S_{it}= (o_{it}, p_{it}, q_{it}) and W_t = (a_t, bt, c_t) where o_{it} and a_t is a triangular curve p_{it} and b_t is a triangular median curve and q_{it} and c_t is an upper value of triangular curve. Thus, F_t could be formulated as:

$$F = (Y_i, Q_i, Z_i) \quad (2)$$

With:

$$Y_i = \left(\frac{1}{k}\right)\sum_{t=1}^{k}(o_{it}, a_i) \quad (3)$$

$$Q_i = \left(\frac{1}{k}\right)\sum_{t=1}^{k}(p_{it}, b_i) \quad (4)$$

$$Z_i = \left(\frac{1}{k}\right)\sum_{t=1}^{k}(q_{it}, c_i) \quad (5)$$

i = 1,2,3,…,n.

C. *Optimum Selection Alternative*

The alternative decision is prioritized based on aggregation result. The priority and aggregation result are used to rank the decision. Since the result of aggregation is represented through triangular fuzzy numbers, a ranking method for the triangular fuzzy number is needed. The triangular membership's function is used as a response of calculation simplicity and the limited data availability. For instance, F is triangular fuzzy numbers, F = (Y, Q, Z), the total value of integral is formulated as follows:

$$I_T^{\alpha}(F) = \left(\frac{1}{2}\right)(\alpha c + b + (1-\alpha)a) \quad (6)$$

The value of α is an optimism index which represent the degree of optimism of for making a decision ($0 \leq \alpha \leq 1$). If the value of α is getting higher, it indicates the higher degree of optimism. In other words, the MCDM works based on the highest optimism degree.

D. *Needs Analysis and Trial Result*

Within the development of smart operation room, there are several main tasks which become the alternatives that need to be conducted earlier considering financial issue assumption and limited time period. The main tasks within the development are data center construction, wall room construction, city CCTV distribution, mechanical engineering development and supporting facility construction. There are seven criteria for the decision making: Authorization Expenditure, Operational Expenditure, Human Resources Expenditure, Procurement Expenditure, Recent Report of Development, Project Period, and Project Scale.

The problem representation is:

a. The aim of this decision is to determine the secure and harmless project to re-allocate the project financing to the project which in needs of finance.
b. There are three given project alternatives, they are A = {A_1, A_2, A_3}. A_1= data center, A_2= wall room A_3= city CCTV distribution.
c. There are seven given decision: C = {C_1, C_2, C_3, C_4, C_5, C_6, C_7} consist of C_1= Authorization Expenditure Percentage, C_2= Operational Expenditure percentage, C_3= Human Resources Expenditure Percentage, C_4=

Procurement Expenditure Percentage, C_5= Development Progress, C_6= Project Period dan C_7= Project Scale.

d. Figure 1 exposes the hierarchy structure of the problem:

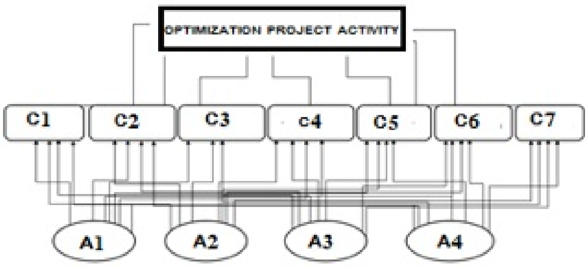

Figure 1. The Hierarchy Structure of the Problem

E. Fuzzy Set Evaluation

The following variable is a linguistic variable to represent the weight of interest. Each of criteria W= {VE, E, N, A, VA, VB, B, S, R, M, F} is represented by the following triangular fuzzy numbers:

- VE = Very Exceeding
- E = Exceeding
- N = Normal
- A = Abundance
- VA = Very Abundance
- VB = Very Big
- B = Big
- S = Small
- R = Recent
- M = Mid
- F = Former

Each of variable is represented by the following triangular fuzzy numbers:

- VE = (0.75, 1, 1)
- E = (0.5, 0.75, 1)
- N = ((0.25, 0.5, 0.75)
- A = (0, 0.25, 0.5)
- VA = (0, 0, 0.25)
- VB = (0.75, 1, 1)
- B = (0.25, 0.5, 0.5)
- S = (0, 0.25, 0.5)
- R = (0.5, 0.75, 1)
- M = (0.25, 0.25, 0.5)
- F = (0, 0.25, 0.5)

Also, linguistic variables which represent the degree of alternative conformity using criteria T (conformity) S={VE, E, S, U, VU} with the following description:

- VE = Very Excellent
- E = Excellent
- S = Sufficient
- U = Unsatisfactory
- VU = Very Unsatisfactory

It must be within the range of the following triangular fuzzy numbers

- VE = (0.75, 1, 1)
- E = (0.5, 0.75, 1)
- S = (0.25, 0.5, 0.75)
- U = (0, 0.25, 0.5)
- VU = (0, 0, 0.25)

After determining the linguistic variables, then the rating of each decision criteria is ascertained. The following description is the determination of interest rating in each criterion:

Table 1. Interest Rating on Each Criteria

Criteria	C1	C2	C3	C4	C5	C6	C7
Interest Rating	N	N	N	N	N	B	VE

The initial data processing is to generate a nominal which is inputted on budgeting system and continued on the weighing process. Then, the conformity degree rating on each alternative of each criterion is discovered. The following table describes the above-mentioned weighing process:

Table 2 .The Conformity Degree Rating on Each Alternative of Each Criteria

Alternative	Conformity Degree						
	C1	C2	C3	C4	C5	C6	C7
A_1 = Data Centre	S	VU	VE	VE	VU	VE	S
A_2 = Wall Room	S	E	E	E	VU	VE	S
A_3= CCTV distribution	VU	VU	E	E	VU	VE	VU

After aggregation process, substituting criteria weight and alternative conformity degree of criteria k using (3), (4) and (5) equation, then the value of F= (Y_i, Q_i, Z_i) for each alternative is discovered. The following table 3 describes the result of fuzzy conformity index result from project data trial.

Table 3 Fuzzy. Conformity Index for Each Alternative

Alternative	Fuzzy Conformity Index		
	F	Q	Z
A_1 = Data Centre	0.27	0.54	0.71
A_2 = Wall Room	0.27	0.57	0.82
A_3= CCTV distribution	0.16	0.32	0.57

F. Selecting Optimum Alternative

The next phase is to select the optimum alternative. It is done by substituting fuzzy conformity index F = (F, Q, Z) = (a, b, c) on the integral equation (6). And using the degree of the optimism α=0 (not optimistic), α=0.5 and α=1 (very optimistic), thus the result as follows:

Table 4. Integral Total for Each Alternative

Alternative	Integral of Each Alternative		
	α= 0	α= 0.5	α= 1
A_1 = Data Centre	0.405	0.515	0.625
A_2 = Wall Room	0.42	0.5575	0.695
A_3= CCTV distribution	0.24	0.3425	0.445

IV. CONCLUSION

Deriving out of the conducted experiment and trial on development optimization of Makassar City smart operation room, it can be concluded that F-MCDM method is able to optimize the trial on three project tasks, considering the financial allocation and the time period of smart operation room 3 months.Thus, development data center is considered as the first task that needs to be completed and it is followed by wall room development and CCTV distribution.

This initial project is far from perfect. The result possesses total highest integral value from the three projects task with 0,005 and 1 degree of the optimism. The finding of this initial research can be used as a baseline of more sophisticated decision-making methods.

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REFERENCES

[1] Y. Huang, J. Deng, and Y. Zhang, “Ti time-cost-quality tradeoff optimization in construction project based on modified ant colony algorithm,” no. July, pp. 12–15, 2008.

[2] H. Mokhtari, A. Aghaie, and J. Rahimi, “Project time – cost trade-off scheduling : a hybrid optimization approach,” pp. 811–822, 2010.

[3] L. I. Shuquan, “Research on Multi-Objective Optimization of Lean Construction Project,” pp. 480–483, 2008.

[4] R. F. Aziz, “Smart optimization for mega construction projects using artificial intelligence,” *Alexandria Eng. J.*, vol. 53, no. 3, pp. 591–606, 2014.

[5] C. Lin, “Predicting Consumer Repurchase Intentions to Shop Online,” vol. 5, no. 10, pp. 1527–1533, 2010.

[6] N. J. Brookes and G. Locatelli, “Power plants as megaprojects : Using empirics to shape policy , planning , and construction management,” *Util. Policy*, vol. 36, pp. 57–66, 2015.

[7] X. Pan, F. Liu, and L. Jiao, “A Dynamic Clonal Selection Algorithm for Project Optimization Scheduling,” no. 2001, pp. 821–822, 2006.

[8] T. D. H. Nguyen, Thi Hoai Thuong; Zongmin, Li; Phi, “A Fuzzy Multi-criteria Decision Making Method for the Financial Statement Quality Evaluation,” in *Proceedings of the Tenth International Conference on Management Science and Engineering Management. Advances in Intelligent Systems and Computing, vol 502. Springer, Singapore*, 2016, p. Volume 502 of the book series Advances in Intellig.

[9] V. S. C. Teixeira, D. N. Oliveira, H. Cunha, and R. S. T. Pontes, “Influence of the proj ect parameters on the LSRM Proj ect optimization,” pp. 554–558, 2007.

[10] W. Peng and J. Zhang, “Investment Portfolio Optimization of Power Grid Projects Based on Niche Genetic Algorithms,” pp. 1170–1175, 2015.

[11] N. Boyette, “Budget Allocation Optimization in a Complex Multi - Project Environment,” pp. 456–461, 2012.

[12] I. A. Chub, M. V Novozhylova, and M. N. Murin, “Optimization Problem of Allocating Limited Project Resources with Separable Constrains,” vol. 49, no. 4, pp. 632–642, 2013.

[13] Fachrul Kurniawan;Supeno Mardi SN and M. Hariadi, “Smart Operation Room for Smart City in Makassar : A Design Perspective,” *J. Next Gener. Inf. Technol.*, vol. 7, no. 2, pp. 76–83, 2016.

[14] A. Al-refaie, T. Chen, and M. Judeh, “Optimal operating room scheduling for normal and unexpected events in a smart hospital,” *Oper. Res.*, 2016.

[15] P. G. Ipsilandis, “Multiobjective Optimization in Linear Repetitive Project Scheduling 1,” vol. 6, no. 3, pp. 255–269, 2006.

[16] Z. Xiaolong, W. Ling, and Z. Huanyu, “A knowledge-based fruit fly optimization algorithm for multi-skill resource-constrained project scheduling problem,” pp. 2615–2620, 2015.

[17] J. Y. Pak, V. V. Thai, and G. T. Yeo, “Fuzzy MCDM Approach for Evaluating Intangible Resources Affecting Port Service Quality,” *Asian J. Shipp. Logist.*, vol. 31, no. 4, pp. 459–468, 2015.

[18] C. A. Greco I., “A Smart Planning for Smart City: The Concept of Smart City as an Opportunity to Re-think the Planning Models of the Contemporary City,” in *Computational Science and Its Applications -- ICCSA 2015*, 2015, pp. 563–576.

[19] H. M. Kindsmüller M.C., Haar M., Schulz H., “Designing User Interfaces for Smart-Applications for

Operating Rooms and Intensive Care Units," in *Human-Computer Interaction – INTERACT 2009*, 2009, p. pp 684-695.

[20] Y. Huang, J. Zhou, and J. Qi, "Optimization of Technological Innovation Projects Based," no. August, pp. 18–21, 2005.

[21] C. P. Uceda J.D., Sánchez C., Elena M., Blasco S., "Smart Sensors for Environmental BioSecurity Control at Operating Rooms. In: Dössel O., Schlegel W.C. (eds)," in *World Congress on Medical Physics and Biomedical Engineering, September 7 - 12, 2009, Munich, Germany*, 2009, pp. 340–343.