Decision Support Model for Mosque Renovation and Rehabilitation (Case Study: Ten Mosques in Jakarta Barat, Indonesia)

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Decision Support Model for Mosque Renovation and Rehabilitation (Case Study: Ten Mosques in Jakarta Barat, Indonesia)

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Abstract. Mosque, for Muslim, is not only a place for daily worshipping, however as a center of culture as well. It is an important and valuable building to be well managed. For a responsible department or institution (such as Religion or Plan Department in Indonesia), to practically manage a lot of mosques is not simple task to handle. The challenge is in relation to data number and characteristic problems tackled. Specifically for renovating and rehabilitating the damaged mosques, a decision to determine the first damaged mosque priority to be renovated and rehabilitated is problematic. Through two types of optimization method, simulated-annealing and hill-climbing, a decision support model for mosque renovation and rehabilitation was systematically constructed. The method fuzzy-logic was also operated to establish the priority of eleven selected parameters. The constructed model is able to simulate an efficiency comparison between two optimization methods used and suggest the most objective decision coming from 196 generated alternatives.

1. Introduction

Mosque is an important building for worshipping and multi-functional community place [1]. Millions people use the mosque daily. Particularly in Indonesia, there are more than 200 million Muslims with 200 thousand big mosques (masjid in Bahasa) and 190 thousand little mosques (mushala in Bahasa) [2]. To manage those mosques are realistically challenging effort to do.

Two activities of mosque management are renovation and rehabilitation. They are activities that an appropriate approach, such as decision support model (DSM), is reasonably required. DSM is an approach alternative that is possibly able to support the management activity. Via a combination between complete data and precise model, DSM can be used to manage the mosques, especially in accurate decision making related to renovation and rehabilitation; as an accurate decision is something difficult to reach [3].

Regarding DSM, several researchers have conducted a number of researches, where DSM as a main topic. [4] combined three types of method interpretive structural modeling, analytical network processing, and fuzzy logic in constructing a DSM for evaluating a performance of partnerships. The ranking of partnership performance index was produce by model as a basic reason to select the decision. [5] constructed a DSM for providing a robust decision making for automated railway level crossing. By using fuzzy logic control, the model was used to save the operation time, to avoid any accidental

facilities, and to eliminate human errors. [6] studied a DSM ordinarily used in the solid management area. Where, several aspects are usually considered; environmental, economic, and also social.

Moreover, [7] developed a DSM to select the best facility. The best here is related to energy saving and facility improvement program. The research was conducted in elementary school in South Korea. [8] have developed a DSM to get a higher productivity on maritime automobile terminals. The productivity measured here was correlating to internal transport, exit truck gate operation, and wagon manipulation. [9] developed a DSM for renovation. It is able to suggest a reasonable and economic policy for renovating and rebuilding organizations' facilities.

Thus, the paper presents a constructed DSM that implemented in managing the mosques, mainly for their renovation and rehabilitation intention. Where, ten mosques in Jakarta Barat (Indonesia) were taken as an object of the research, as a basis of data behavior to be generated for simulation purpose. The section of introduction of the paper is followed by sections related works, research methodology, results and discussion, and conclusion and further works.

2. Related works

The studies relating the topic "mosque" that has been academically selected as a main research object were conducted by many researchers. The mosque is a unique phenomenon, where the researchers need to learn more. [10], in engineering field, investigated implications of stereotype mosque architecture on three dimensions of sustainability. The dimensions considered are social, economic, and social problem. [11] evaluated the effect of climatic factors on construction and local architecture in hot and arid regions with special focus on Varzaneh city. The study concluded that Varzaneh Jame mosque (as an object of the research) was climatically designed, it was harmonized with the economic and social context of religion. Moreover, to answer the problem of the uncontrolled and unnecessary mosque ornamenting, [12] studied the importance of Islamic art in mosque interior. They concluded that the mosque ornamentation should be considered as a part of mosque components. As it will methodically fulfil the human beings' psychological needs.

In social and behavioral sciences, [13] examined the role of Sheikh Zayed Grand Mosque (in Abu Dhabi) to identify the aspects that the mosque intensely requires to do to be more activated. The study was conducted by using theoretical framework as a criterion. [14] studied regarding design functionality of the communal mosques to satisfy the Muslim community's needs and to create a sustainable environment. The research itself was practically conducted through comparative study based on qualitative research, text interpretation, and observation. It suggested novel insights by formulating new design approach and guideline in designing future communal mosques.

3. Research methodology

In this research, ten mosques in area Jakarta Barat (Indonesia) were taken as an object of the research. These ten mosque empirical data were also used as a basic data to technically generate 196 experimental data for simulation.

Primarily, four stages were followed to conduct the research (Figure 1), where each stage is related to specific methods. In preliminary analyzing, method literature study was done. Several journal papers and other resources were systematically reviewed. And then, the detailed analyzing was conducted. Here, several methods were operated; i.e. literature study, interview of expert in justifying eleven selected parameters, and observation.

Furthermore, method of fuzzy-logic [15] concept was operated. It was benefitted to parameterize in obtaining a parameter priority value of each parameter that has been rationalized by expert. Finally, the DSM was constructed. The model was created based on principle of object-oriented method [16], specifically in analysis and design of model. To optimize the result of decision, two types of method were utilized and compared. The model is not only able to propose the most objective decision, but present the efficiency comparison between two methods simulated-annealing [17][18][19][20] and hill-climbing [19][21] also.

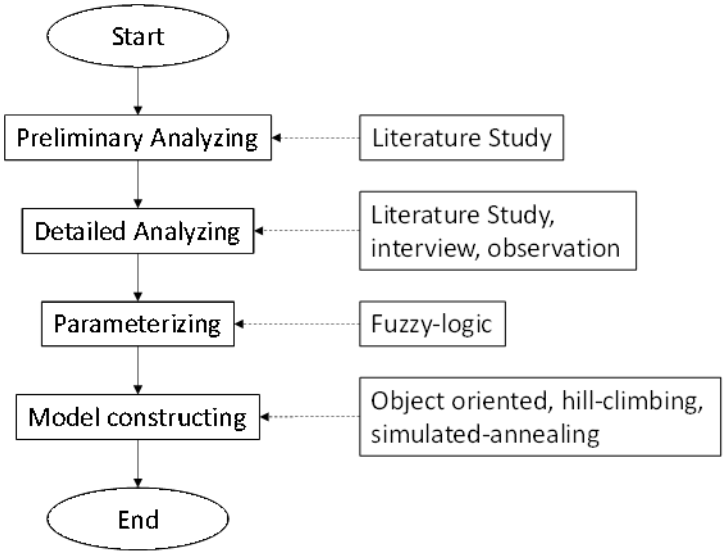

Figure 1. Stages of the research.

4. Results and discussion

4.1. The constructed model

Eleven parameters are taken into account in developing the model. Those parameters are categorized into two groups, parameters mosque (with seven parameters) and damage (with four parameters). To justify those parameters' urgency, one expert involved. The justification result that is in language value and then converted (based on fuzzy-logic concept) to crisp output value (COV) to become priority value (PV) is presented in Table 1. The type of fuzzy membership function itself that was used is triangular type with five types of language variable: very unimportant (0, 0, 25), unimportant (10, 30, 50), rather important (35, 55, 75), important (65, 80, 95), and very important (85, 100, 100).

Table 1. Parameters' value.

No.	Parameter	Language Value	COV	PV
Mosque Parameter				
1.	Mosque age	Very unimportant	11.54	0.02
2.	Mosque type	Unimportant	38.33	0.06
3.	Mosque capacity	Important	82.09	0.14
4.	Mosque activity type	Unimportant	35.00	0.06
5.	Land ownership status	Unimportant	31.67	0.05
6.	Distance to other nearest mosque	Rather important	55.00	0.09
7.	Mosque width	Unimportant	30.00	0.05
Damage Parameter				
8.	Damage age	Important	80.00	0.13
9.	Rehabilitation intensity	Rather important	69.22	0.12
10.	Rehabilitation cost	Important	90.00	0.15
11.	Damage type	Rather important	78.08	0.13

The model is interconnected with four actors, three human actors and a system actor. The human actors are `Expert`, `Religion Dept.` (religion department), and `Plan Bureau`. Ant the system actor is `Religion Dept. MIS` (Religion Department Management Information Systems). This interconnection is depicted by Figure 2 (in usecase diagram).

Five usecases are operated in the model. The usecase `Parameterizing` is related to actor `Expert`. Here, an expert justified parameters' urgency, where they are directly converted to priority values based on concept of fuzzy-logic. The data used in the model coming from MIS of Religion Department. The process of data extraction is done in the usecase `Extracting Data`. Optimization process (in the usecase `Optimizing`) is based on two types of methods, simulated-annealing and hill-climbing. The decision (in the usecase `Generating Decision`) can be identified by actors `Religion Dept.` and `Plan Bureau`. And the usecase `Reporting` is only interconnected to actor `Religion Dept`.

$$\max(P) = \sum_{i=1}^{n} c_i P_i \quad (1)$$

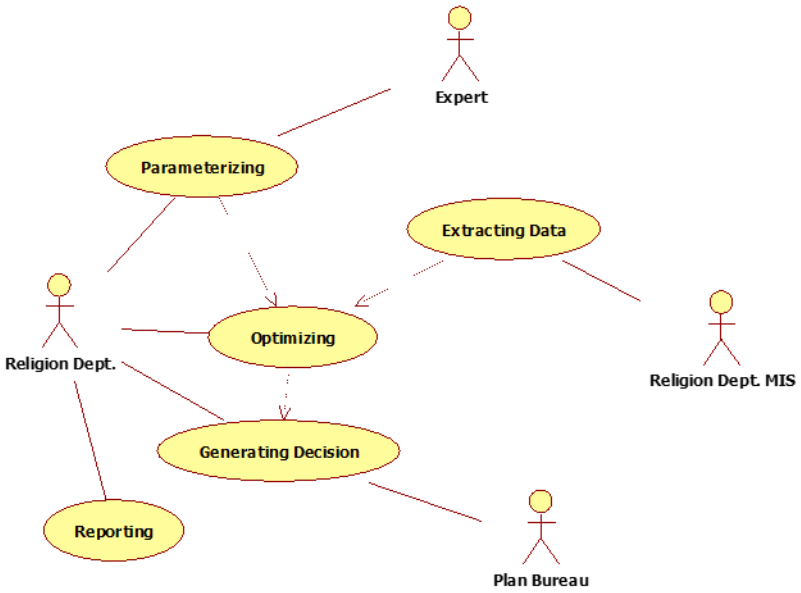

Figure 2. Usecase diagram for the constructed model.

One screenshot example of the constructed model is presented in Figure 3. The model recommends the most objective decision. The decision maker is able to decide which the mosque has to be renovated and rehabilitated first based on the model's suggestion. Principally, two types of optimization methods give a consistent decision, where the model is experimentally executed until a hundred thousand times. The objective function of the optimization process is generically delivered in equation (1), where c represents a value of parameter priority and P is an optimal value of parameter that is obtained by calculating the relative optimal value of it. The optimal value of parameter should be maximum or minimum. For example, to consider the parameter mosque capacity, the higher value of capacity will be more optimal than others.

Numerous laboratory experiments have been done to see the correlation between model execution number and running time. The correlation is represented by the graph in Figure 4. In second unit, the method simulated-annealing consumed 0.0142, 0.0779, 0.1663, 0.9036, 1.9469, 11.5169, and 23.7527 seconds, while the method hill-climbing consumed 0.0064, 0.0356, 0.0790, 0.4385, 0.9844, 5.5252, and 9.9542 seconds for number of model execution 100, 500, 1000, 5000, 10000, 50000, and 100000 times respectively. Here, can be concluded that the method hill-climbing consumes a shorter running time than the simulated-annealing does. Practically, the experiments were conducted in laboratory optimization models and systems for decision support (UIN Syarif Hidayatullah, Jakarta, Indonesia) by using machine with processor Intel® Celeron® CPU B815 @ 1.60GHz (2 CPUs), memory 2048MB RAM, BIOS InsydeH2O V 1.06, and operating system Windows 8.1 Pro 64-bit (6.3, Build 9600).

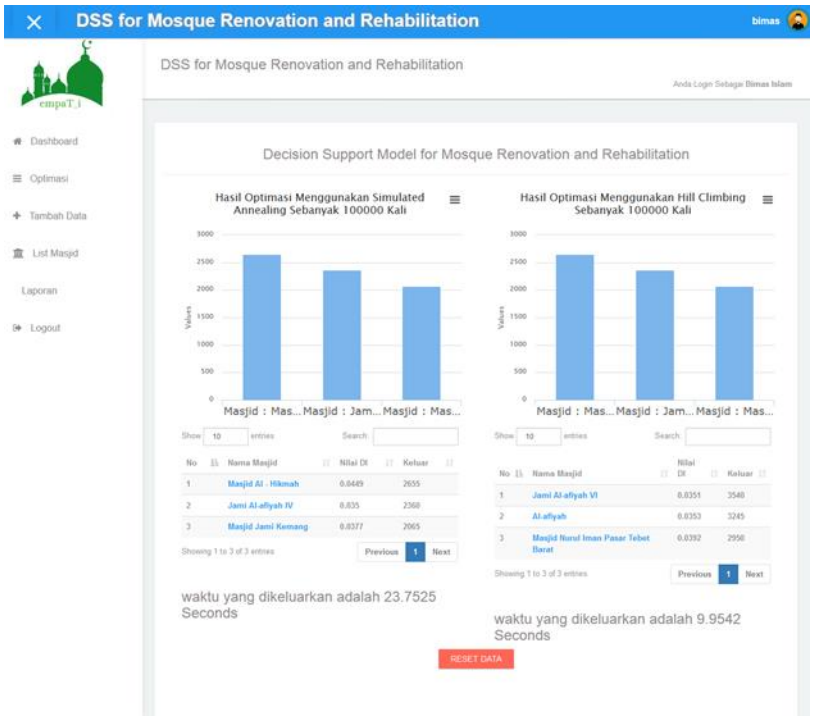

Figure 3. Screenshot example of the constructed model.

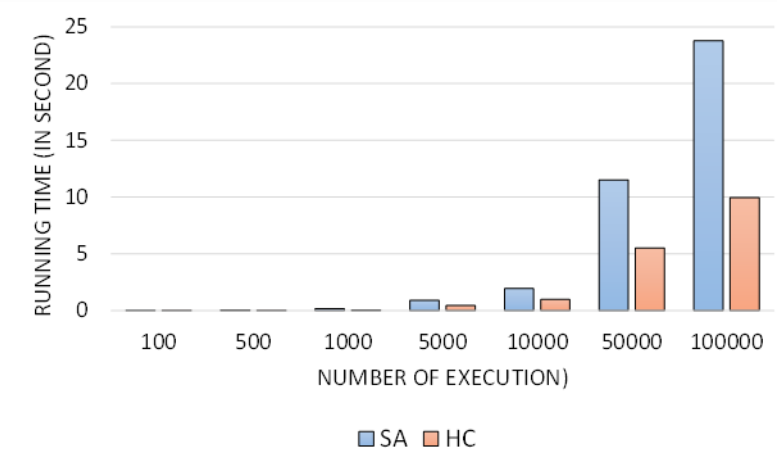

Figure 4. Running Time Comparison of Two Methods Simulated-Annealing (SA) and Hill-Climbing (HC).

4.2. Discussion

Particularly in engineering field, [10], [11], and [12] conducted their research with "mosque" as a main topic. However, no one of them talked regarding renovation and rehabilitation. Differently, in our study, we focused on renovation and rehabilitation aspects, where we constructed the computer based model that can support the decision maker to decide the most objective decision for selecting which mosque has to be renovated and rehabilitated first among a lot of decision alternatives.

5. Conclusion and further works

A decision support model for mosque renovation and rehabilitation was technologically constructed. Eleven selected parameters were considered and two types of optimization method were operated. The constructed model can propose the best mosque alternative to renovated and rehabilitated primarily. The model also can clearly expose the comparison of running time of two methods, where the hill-climbing is more efficient than the simulated-annealing.

If several parameters related to environmental aspect are considered in next study, it will be interesting. They are such as a distance to water source, green condition of the mosque, etc. And also, it will be more fruitful if other heuristic optimization methods are considered in the research, e.g. water flow algorithm, ant colony optimization, etc.

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