Decision Support System for Suppliers of Household Appliance with Analytical Hierarchy Process Method Using Super Decisions Software

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Abstract. Decision Support Systems can be used as problem solving in semi-structured and unstructured conditions. Multi-criteria decision making tools can be solved by the Analytical Hierarchy Process method. The problem that will be examined in this study is about the services of household appliances in the city of XYZ. The household appliances that will be compared in this study are Ace Hardware, Ya Furni, and IJC. There are 5 criteria, 22 sub criteria, and 3 alternatives. This problem was resolved through the application of the AHP method which calculations were carried out manually and using the Super Decisions Software, which was carried out through the distribution of questionnaires to 10 respondents. Processing data begins with making a hierarchy. Hierarchy is used to make the AHP questionnaire consistent with the meaning of one element with other elements equivalent. Then making AHP questionnaires, distributing AHP questionnaires, find priority vector, calculate the consistency ratio, to get the best alternative with manual calculations. Processing data using the Super Decisions Software are create interconnected hierarchies, make a pairwise comparison, and then find results of alternative priority calculations that have been calculated with Super Decisions Software.

1. Introduction

Competition in the business economy in this globalization era is increasingly competitive. This problem supported by the development of science and technology which is also progressing. Therefore, companies are required to continue to innovate and be able to provide satisfaction towards consumers by maintaining product quality and competitive prices in order for businesses can still walk [1]. Household Appliance Supplier is a business entity that sells a variety of household appliances needed by the community to meet their daily needs with advantages and disadvantages both physically and in terms of service. The household appliance services that will be compared in this study are Ace Hardware, Ya Furni, and IJC.

Decision Support Systems are interactive information systems that provide information, modeling, and data manipulation. The system is used for decision making in semi-structured and unstructured situations, where no one knows exactly how decisions should be made. (Decision Support Systems) is support for decision making for both individuals and groups which provides options for better and more consistent decision making in a time-constrained manner. Decision support systems are not intended to automate decision making, but provide interactive tools that enable decision making to
perform various analyzes using models which are available [2]. AHP is an organized multicriteria procedure for sorting out and examining complex choices dependent on numerous models [12]. Analytic Hierarchy Process is a multiple criteria decision-making tool. This is an Eigen value approach to the pair-wise comparisons. It also provides a methodology to calibrate the numeric scale for the measurement of quantitative as well as qualitative performances [3]. Analytical Hierarchy Process (AHP) is one of the right and effective methods in handling complicated decision making so that it can be used to help decision makers in determining priorities and the best decisions, but criteria that have more subjective nature, uncertainty factors numbers are represented in order of scale, making it difficult to determine the exact scale value of importance [4]. AHP can deal with subjective and quantitative elements from dynamic cycle for all intents and purposes, methodically and quickly [13]. A qualified service is a service that economically profitable and procedurally easy and fun so it will create satisfaction. Satisfaction means a content feeling that arise after comparing the perception of results or performance of a service to the expectation [5]. The problem that will be examined in this study is about the services of household appliances in the city of XYZ. Where the three household supply compared here are Ace Hardware, Yafurni, and IJC. There are 5 dimensions that become the assessment of quality, namely tangible, reliability, responsiveness, assurance, and empathy. Al-Allaq & Al-Tali unanimously agreed that tangibility, reliability and responsiveness are constant dimensions, whereas; the criterion of ‘assurance’ includes courtesy, reliability and security [6].

The purpose of this research is to be able to apply the AHP concept in every best decision making of many criteria can increase productivity. This problem was resolved through the application of the AHP method which calculations were carried out manually and using the Super Decisions Software, which was carried out through the distribution of questionnaires to 10 respondents.

2. Method
The study was conducted around the XYZ Housing Complex. The distribution of AHP questionnaires was 10 respondents. The data to be processed is obtained from a summary questionnaire of 10 respondents who are willing to answer the questionnaire. The sampling technique used was Purposive Sampling where respondents were chosen for a specific purpose. Selection of samples with the right method can describe the actual population conditions accurately, and can save research costs effectively. Ideally, the sample really describes or represents the characteristics of the actual population. Because the data obtained from the sample must be able to be used to estimate the population. A sample that can represent the population is called a representative sample. Representative samples have the same or relatively the same characteristics as the population characteristics. Representative level of the sample taken from a particular population depends on the type of sample used, the size of the sample taken, and the method of collection [7]. Sample is a set or part of the number and characteristics possessed by the population. Sampling technique is a sampling technique, where the researcher uses purposive sampling, a technique of determining the sample based on chance, that is, anyone who happens to meet the researcher can be used as a sample, if it is considered that the person met is suitable as a data source [8]. The purposive sampling technique is also a nonrandom technique in which the selection of respondents is based on certain criteria. The selected respondents’ answers are expected to be based on the respondent’s knowledge or experience not based on theory.

The steps taken in the AHP method are defining the problem and determining the desired solution, creating a hierarchical structure starting with the main objective, creating a pairwise comparison matrix that describes the relative contribution or influence of each element to the goal or the criterion level above it, defines the pairwise comparisons so that the total number of raters is obtained as many as \( n \times \left( \frac{(n-1)}{2} \right) \) pieces, where \( n \) is the number of elements being compared, calculating the eigen values and testing their consistency, if it is not consistent then data retrieval is repeated. Repeats steps 3, 4, and 5 for all hierarchical levels. Calculate the eigen vector for each pairwise comparison matrix which is the weight of each element to prioritize the inner elements lowest hierarchical level until it reaches the goal[9]. The results of the super decision processing software are three types of super
matrix tables, namely (1) cluster matrix (criteria), which shows the relationship between clusters/criteria; (2) Super matrix Weights, where each column eigenvector block in a cluster is weighted with priority from the influence of the cluster, which makes the Weights Super Matrix column stochastic; (3) limiting super matrix is obtained by raising weighted super matrix so that the number in each column is one[10]. A nominal value search for liquid waste technology is obtained, where parsecond searches use AHP (Analytical Hierarchy Process) questionnaires to help determine palm oil processing technology based on objective value, criteria, subcriteria and alternative value [11].

3. Result and Discussion

3.1. Manual Calculation

The following is a hierarchy table of Household Appliance Supplier.

Table 1. Hierarchy table of household appliance supplier.

| No. | Criteria       | Sub Criteria                  | Alternative   |
|-----|----------------|--------------------------------|---------------|
| 1.  | Tangible       | Type of Entrance               | 1. ACE HARDWARE |
|     |                | Storage Area                   | 2. IJC         |
|     |                | Type of Cashier                | 3. YAFURNI     |
|     |                | Product Regulatory Pattern     |               |
|     |                | Employee Appearance            |               |
|     |                | Room Cleanliness               |               |
| 2.  | Reliability    | Product completeness           | 1. ACE HARDWARE |
|     |                | Reliability explained          | 2. IJC         |
|     |                | Timely Delivery                | 3. YAFURNI     |
|     |                | Exact Return                   |               |
| 3.  | Responsiveness | Employee Friendliness          | 1. ACE HARDWARE |
|     |                | Employee Attitude              | 2. IJC         |
|     |                | Quick Response                 | 3. YAFURNI     |
|     |                | Fast Services                  |               |
| 4.  | Assurance      | Item Warranty                  | 1. ACE HARDWARE |
|     |                | Security                       | 2. IJC         |
|     |                | Product Testing                | 3. YAFURNI     |
|     |                | Guaranteed Return              |               |
| 5.  | Empathy        | Understand the needs           | 1. ACE HARDWARE |
|     |                | Product Shipping               | 2. IJC         |
|     |                | Promo Notification             | 3. YAFURNI     |
|     |                | Employee Care                  |               |

The steps in processing calculation data manually are as follows:

- From the recapitulation of 10 respondents, the average number of 5 criteria is obtained at level 2 which can be seen in Table 2.
- Add up each column of the comparison matrix. Get the latest matrix by dividing the score by the number of columns. Then find the average of each row for the priority vector result. Normalized Matrix and Row Average for Level 2 Elements can be seen in table 3.
- Calculate the consistency ratio by dividing the CI (Calculation Index) results by the (RCI) Random Consistency Index.
- It can be concluded that if the final result consistency ratio (CR) is less than 0.1, then the respondent's answer is consistent and the response data can be used.
The author takes one example calculation from each level. Level 2, level 3 Assurance Criteria, and level 4 about Sub-alternatives for Product Completeness.

**Table 2.** The calculation of the weighted average for level 2 elements

| Element | Tangible | Reliability | Responsiveness | Assurance | Emphaty |
|---------|----------|-------------|----------------|-----------|---------|
| Tangible | 1,0000   | 1,0000      | 1,8745         | 1,6808    | 4,0461  |
| Reliability | 1,0000  | 1,0000      | 2,4052         | 3,7174    | 4,9633  |
| Responsiveness | 0,5335 | 0,4158      | 1,0000         | 3,0837    | 1,5563  |
| Assurance  | 0,5949   | 0,2690      | 0,3243         | 1,0000    | 1,8541  |
| Emphaty   | 0,2471   | 0,2015      | 0,6426         | 0,5394    | 1,0000  |
| Total     | 3,3755   | 2,8863      | 6,2466         | 10,0213   | 13,4198 |

**Table 3.** Normalized matrix and row average for level 2 elements

| Element | Tangible | Reliability | Responsiveness | Assurance | Emphaty | Priority Vector |
|---------|----------|-------------|----------------|-----------|---------|----------------|
| Tangible | 0,2963   | 0,3465      | 0,3001         | 0,1677    | 0,3015  | 0,2824         |
| Reliability | 0,2963 | 0,3465      | 0,3850         | 0,3709    | 0,3698  | 0,3537         |
| Responsiveness | 0,1581 | 0,1441      | 0,1601         | 0,3077    | 0,1160  | 0,1772         |
| Assurance  | 0,1762   | 0,0932      | 0,0519         | 0,0998    | 0,1382  | 0,1119         |
| Emphaty   | 0,0732   | 0,0698      | 0,1029         | 0,0538    | 0,0745  | 0,0748         |
| Total     | 1,0000   | 1,0000      | 1,0000         | 1,0000    | 1,0000  |

CR = \frac{\text{Random Consistency Index}}{\text{Consistency Index}} = 0.0500/0.0446 = 0.0446 \text{ (consistent)}

**Table 4.** The calculation of the weighted average for level 3 assurance elements

| Element | Item Warranty | Security | Product Testing | Guaranteed Return |
|---------|---------------|----------|-----------------|-------------------|
| Item Warranty | 1,0000  | 1,7118   | 4,2221          | 5,9495           |
| Security  | 0,5842  | 1,0000   | 3,1405          | 4,3556           |
| Product Testing | 0,2368 | 0,3184   | 1,0000          | 1,7118           |
| Guaranteed Return | 0,1681 | 0,2296   | 0,5842         | 1,0000           |
| Total     | 1,9891   | 3,2598   | 8,9468          | 13,0169          |

**Table 5.** Normalized matrix and row average for level 3 assurance elements

| Element | Item Warranty | Security | Product Testing | Guaranteed Return | Priority Vector |
|---------|---------------|----------|-----------------|-------------------|----------------|
| Item Warranty | 0,5027  | 0,5251   | 0,4719          | 0,4571            | 0,4892         |
| Security  | 0,2937  | 0,3068   | 0,3510          | 0,3346            | 0,3216         |
| Product Testing | 0,1190 | 0,0977   | 0,1118          | 0,1315            | 0,1150         |
| Guaranteed Return | 0,0845 | 0,0704   | 0,0653          | 0,0768            | 0,0743         |
| Total     | 1,0000  | 1,0000   | 1,0000          | 1,0000            | 1,0000         |
\[
CR = \frac{0.0040}{0.90} = 0.0044 \text{ (consistent)}
\]

**Table 6.** The calculation of the weighted average for level 4 product completeness elements

| Service     | Yafurni | Ace Hardware | IJC  |
|-------------|---------|--------------|------|
| Yafurni     | 1,0000  | 0,5676       | 2,7339 |
| Ace Hardware| 1,7617  | 1,0000       | 5,2596 |
| IJC         | 0,3658  | 0,1901       | 1,0000 |
| **Total**   | **3,1275** | **1,7577**  | **8,9935** |

**Table 7.** Normalized matrix and row average for level 4 product completeness elements

| Service     | Yafurni | Ace Hardware | IJC  | Priority Vector |
|-------------|---------|--------------|------|-----------------|
| Yafurni     | 0,3197  | 0,3229       | 0,3040 | 0,3156         |
| Ace Hardware| 0,5633  | 0,5689       | 0,5848 | 0,5723         |
| IJC         | 0,1170  | 0,1082       | 0,1112 | 0,1121         |
| **Total**   | **1,0000** | **1,0000**  | **1,0000** | **1,0000** |

\[
CR = \frac{0.0004}{0.58} = 0.0007 \text{ (consistent)}
\]

From Table 8 Calculation of priority vectors, it can be seen that the supplier for the most popular household appliances in XYZ city is Ace Hardware. Then followed by Yafurni and IJC.

**Table 8.** Priority matrix for constructor prequalification

| No | Service   | Priority Vector | Percent | Rank |
|----|-----------|-----------------|---------|------|
| 1. | Yafurni   | 0.2664          | 26.64%  | 2    |
| 2. | Ace Hardware | 0.6130       | 61.30%  | 1    |
| 3. | IJC       | 0.1206          | 12.06%  | 3    |
| **Total** | 1 | 1 | **100%** |

3.2. **Software Super Decisions**

The steps in processing data using the Super Decisions Software are as follows:

- The first step we have to create interconnected hierarchies in the dialog box. Display relationships between nodes can be seen in Figure 1.
- Then make a pairwise comparison display by filling in the matrix for each node. In Figure 2 can be seen the priority vector value and the value of the consistency ratio (CR).
- The author takes one example calculation from each level. Level 2, level 3 regarding Guarantee Criteria, and level 4 about Sub-alternatives for Product Completeness.
Figure 1. Relationships between nodes

Figure 2. Node comparison household appliances supplier

Figure 3. Node comparison assurance
After the data is moved to the dialog box, in the calculation toolbar select Priority. The following are the results of alternative priority calculations that have been calculated with Super Decisions Software. The results of the calculation of the best alternatives chosen using the Super Decisions Software can be seen at Figure 5.

![Figure 4. Node comparison item warranty](image)

![Figure 5. The results of the calculation of the best alternatives chosen using the super decisions software](image)

In accordance with the research objectives and research methodology that can be obtained, the hierarchy is used to make the AHP questionnaire aligned with the meaning of one element with another equivalent element. AHP can provide the best alternative for household appliance suppliers. The best supplier of household appliances among Ace Hardware was 61.30%, then Yafumi 26.64%, and IJC 12.06%.

4. Conclusion
The conclusions based in accordance with the research objective are as follows: Hierarchy is used to make the AHP questionnaire consistent with the meaning of one element with other elements equivalent. The best household appliances supplier among Ace Hardware, Yafumi and IJC was Ace Hardware at 61.30%, then Yafumi 26.64%, and IJC 12.06%. The elements that have the highest priority to the lowest are the Reliability element 35.37%, Tangible 28.24%, Responsiveness 17.22%, Assurance 11.19%, and Emphaty 7.48%. In the consistency ratio (CR) matrix, all respondents answers are stated consistent with CR Qualification 0.1. Processing done by manual calculation and calculation using software has the same results.

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