# PACKAGING SUPPLIER SELECTION MODEL BASED ON THE ANALYTICAL HIERARCHY PROCESS (AHP) METHOD OF A PHARMACEUTICAL COMPANY

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## ABSTRACT

Suppliers selected based on a simple evaluation tend not to pay attention to the selection according to a particular method or system so that sometimes the process takes a lot of time and what has been decided is not in accordance with what is expected by the company as a consumer who buys the company's needs. This study aims to prove that the use of the AHP method helps the decision-making process faster and in accordance with the needs of pharmaceutical companies. The data used is primary data collected from employees of pharmaceutical companies. Data were collected using survey and interview techniques. The research analysis tools used are Analytical Hierarchy Process and Expert Choice v.11. The results showed that the use of the AHP method was proven to help in the selection of drug packaging suppliers in pharmaceutical companies more quickly and according to the company's needs.

**Keywords**: Analytical Hierarchy Process, Pharmaceutical Company, Supplier Selection

## 1. INTRODUCTION

In the current era of globalization, the progress of the manufacturing industry is very rapid, this is supported by the development of science and technology which has also made significant progress so that competition between companies is getting tighter. In the context of a competitive market, consumers demand cheaper and higher quality products, on-time delivery and good after-sales service.

The condition of competitive business competition is also felt in the manufacturing industry in the pharmaceutical sector. As an industry that produces products that are vital to people's lives, the demand for quality products at affordable prices is very high. Therefore, the selection of suppliers in this industry is also vital.

In supply chain management, the problem of supplier selection is not new. In particular, supplier selection has been assumed to have a strategic role in determining the competitiveness of companies, especially in complex industries where suppliers play an important role in the creation of added value (Bruno, Esposito, Genovese and Passaro, 2011). In general, there are several criteria that influence the selection of suppliers, for example in terms of quality including price, quality of the goods themselves, delivery and service. But according to Ellram, who researched supplier selection issues using case studies of companies involved in buyer-supplier relationships, he concluded that no single criterion model fits every situation. The decision criteria used for supplier selection may differ depending on the size of the organization, needs, objectivity, type of transaction and availability of company resources.

The rapid development is not only hardware and software technology, but computing methods are also developing. Many methods can be used in decision making. In this context, the most widely used methodology is represented by the Analytical Hierarchy Process (AHP). Of course apart from AHP, there are a number of other methods that can be used in this regard. However, AHP makes the selection process very transparent. In addition, the advantages of using the Analytical Hierarchy Process over other methods lie in its simplicity, flexibility and dedicated software (i.e. Expert Choice, SuperDecisions, etc.) that allows quick priority calculations. In terms of finding and selecting potential suppliers, it must be determined by the people who have an interest in making these decisions. So that decision makers must have good experience in evaluating suppliers of raw materials or products they produce.

## 2. LITERATURE REVIEW

### 2.1. Decision Making

Decision making is a systematic approach to the nature of a problem, collecting facts and data, making a thorough determination of the alternatives faced and taking the action that according to calculations is the most appropriate action. The purpose of the decision is to achieve a specific target or action to be taken.

The decision-making process is the selection of an alternative from various alternatives so as to produce the best choice based on several optimization criteria. The criteria here are measures, rules, and standards to help the decision-making process. Before carrying out the decision-making process, the set of alternatives and criteria must first be determined.

The decision-making process starts from the reality that happens around us and includes the stages and processes by which we make a decision. This process consists of 4 phases, namely:

1) Data collection phase. This phase is the process of tracing and detecting the scope of the problem and the process of identifying the problem. Input data is obtained, processed and tested in order to identify problems.
2) Design phase. This phase is the process of finding, developing and analyzing alternative actions that can be taken. This stage includes the process of understanding the problem, deriving solutions and testing the feasibility of the solution.
3) Selection phase. In this phase, the selection process is carried out among various alternative actions that may be carried out. This stage includes searching, evaluating, and recommending suitable solutions for the model that has been made. The solution of the model is a specific value for the outcome variable in the selected alternative.
4) Implementation. The results of the election are then implemented in the decision-making process.

### 2.2. Multi Criteria Decision Making (MCDM)

The decision-making process of a complex system, the "multiple criteria" approach is used to describe the decision situation. Multiple Criteria Decision Making (MCDM) is considered as a term for all models and techniques related to multiple objective decision making (MODM) or multiple attribute decision making (MADM). MODM involves more than one criteria with many alternatives, while MADM is a problem of selecting the best alternative.

A problem is classified as MCDM if and only if there are at least two conflicting criteria and involves two alternative solutions. Conflicting criteria means that the satisfaction of choosing an alternative based on a certain criterion will differ based on other criteria. Meanwhile, non-conflicting criteria show that there is a strong dominance of another alternative being compared.

### 2.3. Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) is a decision-making method for prioritizing alternatives when several criteria must be considered. This method allows decision makers to structure complex problems in the form of a hierarchy, or a set of integrated levels. Generally, the hierarchy has at least three levels: objectives, criteria, and alternatives for supplier selection problems, the goal is to select the best overall supplier. This method has been applied to various decision areas, including research and development project selection, evaluating alternative product formulations, and selecting microcomputers.

In detail, there are three basic principles of AHP, namely:
1) Decomposition
2) Comparative Judgment

   In preparing this importance scale, the basic scale benchmark in Table 1. is used.

Table 1. Basic AHP Scale and Its Definition

| Skala | Definisi dari "*Importance*" |
|---|---|
| 1 | Sama pentingnya (*Equal Importance*) |
| 3 | Sedikit lebih penting (*Slightly more Importance*) |
| 5 | Jelas lebih penting (*Materially more Importance*) |
| 7 | Sangat jelas penting (*Significantly more Importance*) |
| 9 | Mutlak lebih penting (*Absolutely more Importance*) |
| 2, 4, 6, 8 | Ragu-ragu antara  dua nilai yang berdekatan (*Compromise values*) |
| 1/1,3,5,7,9 | Tidak dapat dijelaskan |

3) Synthesis of Priority

Some of the benefits of the AHP method are explained as follows:
1) Can solve complex problems, and the structure is irregular, even problems that are not structured at all.
2) The AHP method is easy to use and understand.
3) The incompleteness of written data and quantitative data regarding the problem does not affect the smoothness of the decision-making process because the assessment is a synthesis of the thoughts of various respondents' points of view.
4) In accordance with the basic human ability to assess something so as to facilitate the assessment and measurement of elements.

In general, the basic steps of AHP are briefly described as follows:
1) Define the problem and set goals.
2) Arrange problems in a hierarchical structure. Every complex problem can be viewed from a detailed and structured side. As in Figure 1. below.
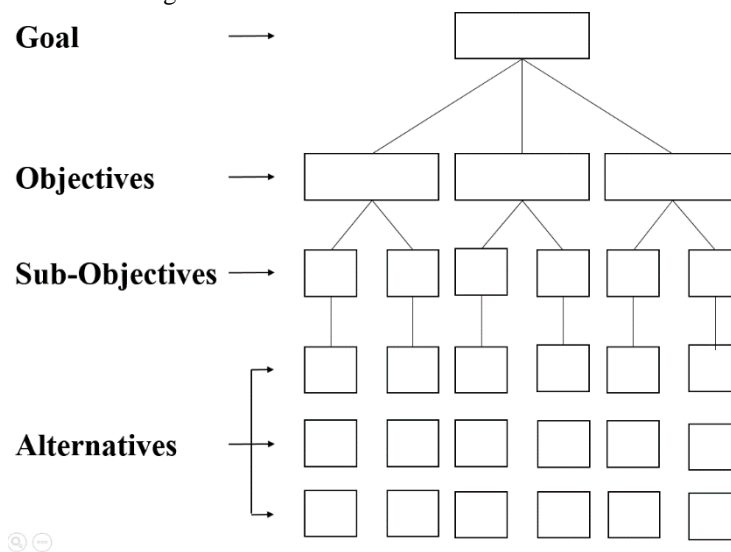


Figure 1. AHP Hierarchical Structure

3) Set priorities for each element of the problem at the hierarchical level.
4) Conduct consistency tests on comparisons between elements obtained at each level of the hierarchy.

Data analysis was carried out after data processing was completed. The final result of this data processing is the selection of one supplier and the emergence of criteria and sub-criteria that become the priority of supplier selection.

## 3. METHODOLOGY

The data used in this study are the criteria needed by pharmaceutical companies in selecting drug packaging suppliers. The criteria were obtained based on interviews with pharmaceutical company employees. Data were collected by using a questionnaire technique from three (3) sections, namely the production, purchasing, and R&D divisions. The data was then processed using Analytical Hierarchy Process (AHP) and Expert Choice v.11 analysis tools.

## 4. RESULTS AND DISCUSSION

In this study, the authors focus on the selection of suppliers of product packaging used because the selection of the right product packaging has the same importance as the selection of product raw materials. The packaging used can affect the quality of the pharmaceutical products it packs and the selection of the right packaging can increase competitiveness and income for the company.

The data in this study were obtained by conducting a survey on a pharmaceutical company located in the Cibitung area from January 2015. The analytical tool used was the Analytical Hierarchy Process (AHP) method and the Expert Choice v.11 application for the selection of packaging suppliers for health products. The Counter (OTC) expectorant cough warm medicine (OBH). Primary data was collected by distributing a questionnaire (adapted from the basic AHP scale) which was divided into 3 parts, namely determining the

weight of criteria, sub-criteria and alternatives. The three sections cover 5 criteria, namely cost (K-1) with 2 sub-criteria (SK-1 and SK-2), quality (K-2) with 2 sub-criteria (SK-3 and SK-4), delivery (K- 3) with 2 sub-criteria (SK-5 and SK-6), service (K-4) with 3 sub-criteria (SK-7, SK-8, and SK-9), and supplier relations (K-5) with 3 sub-criteria (SK-10, SK-11, and SK-12). There are 3 alternative drug packaging suppliers in this study, namely PT. A, PT. B, and PT. C. The relationship between objectives, criteria, sub-criteria, and alternatives is illustrated in Figure 2. below.
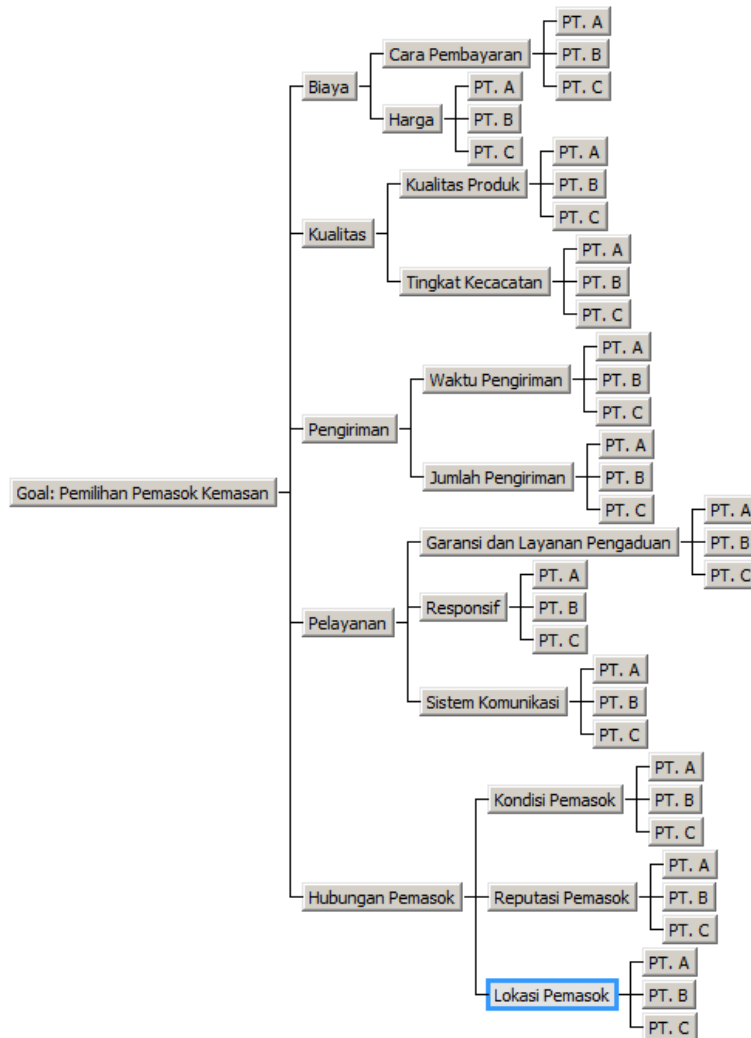


Figure 2. Decomposition of the Packaging Supplier Selection Problem

After the relationship between all components has been unraveled, then it is calculated using pairwise comparison to give weight to each component. The recapitulation of the results of the research on determining the weight of the criteria can be seen in Table 2., sub-criteria in Table 3., and alternatives in Table 4.

Table 2. Pairwise Matrix of Criteria Weighting

|  | K-1 | K-2 | K-3 | K-4 | K-5 |
|---|---|---|---|---|---|
| K-1 | 1 | 0,5 | 2 | 3 | 0,5 |
| K-2 | 2 | 1 | 5 | 5 | 3 |
| K-3 | 0,5 | 0,2 | 1 | 2 | 0,33 |
| K-4 | 0,33 | 0,2 | 0,5 | 1 | 0,2 |
| K-5 | 2 | 0,33 | 3 | 5 | 1 |
| Jumlah | 5,83 | 2,23 | 11,5 | 16 | 5,03 |

Table 3. Pairwise Matrix for Determining the Weight of Sub-criteria

a.    Cost Criteria

|  | SK-1 | SK-2 |
|---|---|---|
| SK-1 | 1 | 0,5 |
| SK-2 | 2 | 1 |
| Jumlah | 3 | 1,5 |

b.    Quality Criteria

|  | SK-3 | SK-4 |
|---|---|---|
| SK-3 | 1 | 2 |
| SK-4 | 0,5 | 1 |
| Jumlah | 1,5 | 3 |

c.    Shipping Criteria

|  | SK-5 | SK-6 |
|---|---|---|
| SK-5 | 1 | 3 |
| SK-6 | 0,33 | 1 |
| Jumlah | 1,33 | 4 |

d.    Service Criteria

|  | SK-7 | SK-8 | SK-9 |
|---|---|---|---|
| SK-7 | 1 | 3 | 3 |
| SK-8 | 0,33 | 1 | 2 |
| SK-9 | 0,33 | 0,5 | 1 |
| Jumlah | 1,66 | 4,5 | 6 |

e.    Supplier Relationship Criteria

|  | SK-10 | SK-11 | SK-12 |
|---|---|---|---|
| SK-10 | 1 | 2 | 0,33 |
| SK-11 | 0,5 | 1 | 0,33 |
| SK-12 | 3 | 3 | 1 |
| Jumlah | 4,5 | 6 | 1,66 |

Table 4. Pairwise Matrix of Alternative Weight Determination

| Kriteria Biaya – Subkriteria Cara Pembayaran | | | |
|---|---|---|---|
|  | PT. A | PT. B | PT. C |
| PT. A | 1 | 0,33 | 0,5 |
| PT. B | 3 | 1 | 2 |
| PT. C | 2 | 0,5 | 1 |
| Jumlah | 6 | 1,83 | 3,5 |
| **Kriteria Biaya – Subkriteria Harga** | | | |
|  | PT. A | PT. B | PT. C |
| PT. A | 1 | 5 | 2 |
| PT. B | 0,2 | 1 | 0,2 |
| PT. C | 0,5 | 5 | 1 |
| Jumlah | 1,7 | 11 | 3,2 |
| **Kriteria Kualitas – Subkriteria Kualitas Produk** | | | |
|  | PT. A | PT. B | PT. C |
| PT. A | 1 | 3 | 2 |
| PT. B | 0,33 | 1 | 0,33 |
| PT. C | 0,5 | 3 | 1 |
| Jumlah | 1,83 | 7 | 3,33 |
| **Kriteria Kualitas – Subkriteria Tingkat Kecacatan** | | | |
|  | PT. A | PT. B | PT. C |
| PT. A | 1 | 0,5 | 2 |
| PT. B | 2 | 1 | 3 |
| PT. C | 0,5 | 0,33 | 1 |

| Jumlah | 3,5 | 1,83 | 6 |
|---|---|---|---|
| **Kriteria Pengiriman – Subkriteria Waktu Pengiriman** | | | |
|  | PT. A | PT. B | PT. C |
| PT. A | 1 | 0,5 | 2 |
| PT. B | 2 | 1 | 2 |
| PT. C | 0,5 | 0,5 | 1 |
| Jumlah | 3,5 | 2 | 5 |
| **Kriteria Pengiriman – Subkriteria Jumlah Pengiriman** | | | |
|  | PT. A | PT. B | PT. C |
| PT. A | 1 | 2 | 0,5 |
| PT. B | 0,5 | 1 | 0,5 |
| PT. C | 2 | 2 | 1 |
| Jumlah | 3,5 | 5 | 2 |
| **Kriteria Pelayanan – Subkriteria Garansi dan Layanan Pengaduan** | | | |
|  | PT. A | PT. B | PT. C |
| PT. A | 1 | 5 | 3 |
| PT. B | 0,2 | 1 | 0,33 |
| PT. C | 0,33 | 3 | 1 |
| Jumlah | 1,53 | 9 | 4,33 |
| **Kriteria Pelayanan – Subkriteria Responsif** | | | |
|  | PT. A | PT. B | PT. C |
| PT. A | 1 | 3 | 0,33 |
| PT. B | 0,33 | 1 | 0,2 |
| PT. C | 3 | 5 | 1 |
| Jumlah | 4,33 | 9 | 1,53 |
| **Kriteria Pelayanan – Subkriteria Sistem Komunikasi** | | | |
|  | PT. A | PT. B | PT. C |
| PT. A | 1 | 3 | 0,33 |
| PT. B | 0,33 | 1 | 0,2 |
| PT. C | 3 | 5 | 1 |
| Jumlah | 4,33 | 9 | 1,53 |
| **Kriteria Hubungan Pemasok – Subkriteria Kondisi Pemasok** | | | |
|  | PT. A | PT. B | PT. C |
| PT. A | 1 | 0,5 | 0,33 |
| PT. B | 2 | 1 | 0,5 |
| PT. C | 3 | 2 | 1 |
| Jumlah | 6 | 3,5 | 1,83 |
| **Kriteria Hubungan Pemasok – Subkriteria Reputasi Pemasok** | | | |
|  | PT. A | PT. B | PT. C |
| PT. A | 1 | 3 | 2 |
| PT. B | 0,33 | 1 | 0,5 |
| PT. C | 0,5 | 2 | 1 |
| Jumlah | 1,83 | 6 | 3,5 |
| **Kriteria Hubungan Pemasok – Subkriteria Lokasi Pemasok** | | | |
|  | PT. A | PT. B | PT. C |
| PT. A | 1 | 0,33 | 3 |
| PT. B | 3 | 1 | 5 |
| PT. C | 0,33 | 0,2 | 1 |
| Jumlah | 4,33 | 1,53 | 9 |

Furthermore, each pairwise comparison matrix (pairwise comparison) in the previous stage is calculated eigenvector values to find out what elements according to their relative importance with research objectives that are really needed / prioritized by the company. Priority determination can be done by sorting the

elements based on their eigenvector values. The following table presents the results of determining the priority criteria in Table 5., sub-criteria in Table 6., and alternatives in Table 7.

Table 5. Determination of Priority Criteria

| Kriteria Pemasok | *Eigenvector* | Hasil Penelitian |
|---|---|---|
| Biaya (K-1) | 0,17 | Prioritas 3 |
| Kualitas (K-2) | 0,43 | Prioritas 1 |
| Pengiriman (K-3) | 0,09 | Prioritas 4 |
| Pelayanan (K-4) | 0,06 | Prioritas 5 |
| Hubungan Pemasok (K-5) | 0,25 | Prioritas 2 |

Table 6. Priority Determination of Sub-criteria

| Subkriteria Pemasok | *Eigenvector* | Hasil Penilaian |
|---|---|---|
| **Biaya** | | |
| Cara Pembayaran (SK-1) | 0,33 | Prioritas 2 |
| Harga (SK-2) | 0,67 | Prioritas 1 |
| **Kualitas** | | |
| Kualitas Produk (SK-3) | 0,67 | Prioritas 1 |
| Tingkat Kecacatan (SK-4) | 0,33 | Prioritas 2 |
| **Pengiriman** | | |
| Waktu Pengiriman (SK-5) | 0,75 | Prioritas 1 |
| Jumlah Pengiriman (SK-6) | 0,25 | Prioritas 2 |
| **Pelayanan** | | |
| Garansi dan Layanan Pengaduan (SK-7) | 0,59 | Prioritas 1 |
| Responsif (SK-8) | 0,25 | Prioritas 2 |
| Sistem Komunikasi (SK-9) | 0,16 | Prioritas 3 |
| **Hubungan Pemasok** | | |
| Kondisi Pemasok (SK-10) | 0,25 | Prioritas 2 |
| Reputasi Pemasok (SK-11) | 0,16 | Prioritas 3 |
| Lokasi Pemasok (SK-12) | 0,59 | Prioritas 1 |

Table 7. Determination of Alternative Priority

| Alternatif Pemasok | *Eigenvector* | Hasil Penilaian |
|---|---|---|
| **Kriteria Biaya – Subkriteria Cara Pembayaran** | | |
| PT. A | 0,16 | Prioritas 3 |
| PT. B | 0,54 | Prioritas 1 |
| PT. C | 0,3 | Prioritas 2 |
| **Kriteria Biaya – Subkriteria Harga** | | |
| PT. A | 0,56 | Prioritas 1 |
| PT. B | 0,09 | Prioritas 3 |
| PT. C | 0,35 | Prioritas 2 |
| **Kriteria Kualitas – Subkriteria Kualitas Produk** | | |
| PT. A | 0,52 | Prioritas 1 |
| PT. B | 0,14 | Prioritas 3 |
| PT. C | 0,33 | Prioritas 2 |
| **Kriteria Kualitas – Subkriteria Tingkat Kecacatan** | | |
| PT. A | 0,3 | Prioritas 2 |
| PT. B | 0,54 | Prioritas 1 |
| PT. C | 0,16 | Prioritas 3 |
| **Kriteria Pengiriman – Subkriteria Waktu Pengiriman** | | |
| PT. A | 0,31 | Prioritas 2 |
| PT. B | 0,49 | Prioritas 1 |
| PT. C | 0,2 | Prioritas 3 |

| Kriteria Pengiriman – Subkriteria Jumlah Pengiriman | | |
|---|---|---|
| PT. A | 0,31 | Prioritas 2 |
| PT. B | 0,2 | Prioritas 3 |
| PT. C | 0,49 | Prioritas 1 |
| **Kriteria Pelayanan – Subkriteria Garansi dan Layanan Pengaduan** | | |
| PT. A | 0,63 | Prioritas 1 |
| PT. B | 0,11 | Prioritas 3 |
| PT. C | 0,26 | Prioritas 2 |
| **Kriteria Pelayanan – Subkriteria Responsif** | | |
| PT. A | 0,26 | Prioritas 2 |
| PT. B | 0,11 | Prioritas 3 |
| PT. C | 0,63 | Prioritas 1 |
| **Kriteria Pelayanan – Subkriteria Sistem Komunikasi** | | |
| PT. A | 0,26 | Prioritas 2 |
| PT. B | 0,11 | Prioritas 3 |
| PT. C | 0,63 | Prioritas 1 |
| **Kriteria Hubungan Pemasok – Subkriteria Kondisi Pemasok** | | |
| PT. A | 0,16 | Prioritas 3 |
| PT. B | 0,3 | Prioritas 2 |
| PT. C | 0,54 | Prioritas 1 |
| **Kriteria Hubungan Pemasok – Subkriteria Reputasi Pemasok** | | |
| PT. A | 0,54 | Prioritas 1 |
| PT. B | 0,16 | Prioritas 3 |
| PT. C | 0,3 | Prioritas 2 |
| **Kriteria Hubungan Pemasok – Subkriteria Lokasi Pemasok** | | |
| PT. A | 0,26 | Prioritas 2 |
| PT. B | 0,63 | Prioritas 1 |
| PT. C | 0,11 | Prioritas 3 |
| **Terhadap Tujuan Utama (*Ultimate Goal*)** | | |
| PT. A | 0,39 | Prioritas 1 |
| PT. B | 0,32 | Prioritas 2 |
| PT. C | 0,29 | Prioritas 3 |

The following in Figure 3. is an image of the results of data processing using Expert Choice v.11 software.
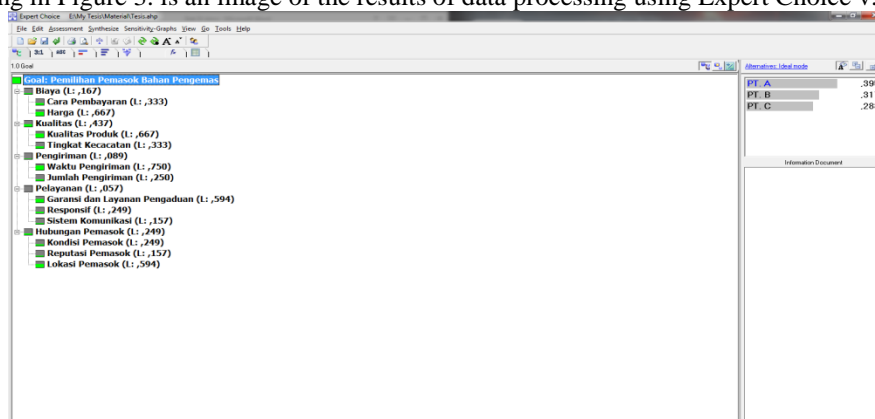


Figure 3. The Final Result of the Chosen Decision

## 5.    CONCLUSION AND SUGGESTION

Based on research conducted on the selection of drug packaging suppliers in pharmaceutical companies, it is concluded that the application of the Analytical Hierarchy Process (AHP) method with the help of the Expert Choice v.11 application makes the process of selecting packaging suppliers in pharmaceutical

companies faster and provides accurate reporting. Based on the supplier's assessment using the AHP method in the selection of drug packaging suppliers, it was found that the quality criteria had the highest priority. This is then followed by the criteria for supplier relations, cost, delivery and service. For drug packaging suppliers, the results showed that PT. A is the best choice of drug packaging supplier for pharmaceutical companies, followed by PT. B then PT. C.

In conducting this research, the author has several limitations, namely in collecting data, the process takes a long time and is disturbed by the surrounding conditions. There are other elements that cannot be included in this study, namely interviews with suppliers due to company policy.

The suggestions that the author wants to convey related to the results of this study are the supplier assessment in this study needs to be carried out periodically to determine the influence that can change decision-making policies. This research can be developed further with a variety of research focuses, data sharpening in terms of criteria, sub-criteria and research alternatives, as well as various research tools. This research can be used as a reference material for similar research activities as long as the method used is the Analytical Hierarchy Process (AHP).

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