Determination of criteria and sub-criteria for selection of spare parts raw material supplier using the Delphi method

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Abstract. Spare parts are goods that consist of several components that form a single unit and have certain functions. The development of the number of motorized vehicles in Indonesia from 2012-2017 has always increased, with a growth rate of 31.88%. The selection of the right supplier is not only profitable for the company but also can increase customer satisfaction. Therefore in the selection of suppliers the company must have a system of selection and evaluation of suppliers of raw materials and components. This research was carried out on car spare parts production companies with raw materials in the form of rubber. This study aims to obtain criteria and subcriteria in selecting suppliers of spare parts raw materials by using Delphi Method. The results of the Delphi Method obtained 9 supplier selection criteria, namely: Quality, Delivery, Guarantee and Complaint Service, Price, Manufacturing Capability, Quality Management System, Documentation and Self Audit, Development Design Capability, and Cost Reduction. Based on the 9 criteria obtained 55 sub-criteria that can be used by companies in selecting suppliers of spare parts raw materials.

1. Introduction

Spare parts are goods that consist of several components that form a single unit and have certain functions. The development of the number of motorized vehicles in Indonesia from 2012-2017 has always increased, with a growth rate of 31.88%. Along with the increasing number of Indonesian motorized vehicles, the demand for motor vehicle spare parts will increase. Supplier selection is a strategic activity in purchasing management in the supply chain. Many criteria need to be considered in selecting suppliers [1]. Dickson said that there were 23 criteria in choosing suppliers. However, not all of these criteria will be used by the company. Some of the commonly used criteria are quality, price, quantity, accuracy, and speed of delivery [2]. In the case of supplier selection, the selection is not only necessary to consider traditional criteria such as price and quality, but long-term criteria also need to be considered such as "strategic fit" and an assessment of future manufacturing capabilities [3].

This research was conducted at a manufacturing company engaged in car spare parts with rubber raw materials. In this study the problems that occur are the difficulty of the company in selecting suppliers based on criteria that are in accordance with the company and the company chooses suppliers to supply raw materials based solely on the list of suppliers who are willing in the price agreement offered by the company with suppliers. The company only considers the factors of raw material prices, and does not consider other factors such as the ability of suppliers to meet demand, ease of filing complaints, distance of delivery, quality and others in part. To make it easier for companies to select suppliers based on criteria according to the company, criteria and subcriteria are needed in selecting suppliers of spare parts raw materials, so companies can select suppliers according to the criteria desired by the company and can be taken into consideration in selecting suppliers.
2. Method
The questionnaire is a number of written questions that are used to obtain information from the respondent in the sense of reports about his person, or things he knows. The main purpose of making a questionnaire is to obtain information that is relevant to the research objectives. In designing a good questionnaire, it is necessary to understand the principles related to how to write questions (wording of questions), how to categorize, scale and encode (categorized, scaled and coded) answers from respondents and the general appearance of the questionnaire [4].

The Delphi method is a systematic method of gathering opinions from a group of experts through a series of questionnaires, where there is a mechanism feedback through rounds of questions held while maintaining anonymity of respondents' responses [5]. The Delphi method is a modification of brainwriting and survey techniques. In this method, the panel is used in communication movements through several questionnaires contained in the writing. This technique is applied in various fields, for example for forecasting technology, analysis of public policy, educational innovation, planning programs and others [6].

This research was conducted from February 2019 to April 2019. The object of research is supplier of car spare parts raw materials. Variables used in determining criteria and subcriteria are identified using the delphi method. Then the next variable is identified based on the criteria that most influence supplier selection. The variables used in this study are the Dickson supplier selection criteria. Data collection in this study was conducted using a questionnaire consisting of open and closed questionnaires, about determining criteria, subcriteria in the selection of spare parts suppliers. The stages of conducting research are:

- Preliminary studies are conducted to identify problems found in the company, production process, observations and other information. Study the study of literature and supporting theories to find solutions to problem solving.
- Determination of the population of respondents, namely several managers, section heads, and staff of 15 people.
- Calculation of the number of research samples using Gay opinions as many as 5 people, namely factory manager, head of production, head of raw materials, production staff, and staff of raw materials.
- Data collection determines the criteria and subcriteria used in selecting suppliers with the Delphi concept by using open and closed questionnaires to obtain criteria and subcriteria from five respondents.
- The first stage uses a questionnaire in the form of a supplier criteria determination questionnaire. This questionnaire was made based on the determination of Dickson's supplier criteria and additional literature that will be used in supplier selection.
- The second stage uses a semi-open questionnaire in the form of a subcriteria determination questionnaire. This questionnaire is adjusted to the conditions of the company.
- Analysis of the results of the Delphi method
- Draw conclusions and give suggestions for further research problem solving analysis begins by getting the criteria used as considerations in selecting suppliers and subcriteria used as an assessment in supplier selection.

3. Results and discussion
The questionnaire was given to respondents who represented research among experts in the field of raw material supplier selection. The questionnaire was distributed based on the Delphi principle by gathering opinions from a group of experts through a questionnaire where feedback was carried out through gathering in a complete collection of questions from related literature and supported by experts. Expert data can be seen in Table 1.
Table 1. Respondent data.

| No | Respondent                     | Total |
|----|--------------------------------|-------|
| 1  | Production manager             | 1     |
| 2  | Head of Production Section     | 1     |
| 3  | Head of Raw Materials Section  | 1     |
| 4  | Production Section Staff       | 1     |
| 5  | Staff of Raw Materials Section | 1     |
|    | **Total**                      | **5** |

The results of criteria and sub-criteria selection for supplier selection based on the results of open and closed questionnaires can be seen in Table 2.

Table 2. Open and closed questionnaire results.

| No | Criteria                  | Subcriteria                                                                 |
|----|---------------------------|------------------------------------------------------------------------------|
| 1  | Quality (K1)              | Compliance with desired specifications (SK1)                                 |
|    |                            | Quality cost reduction (SK2)                                                 |
|    |                            | Acceptance inspection (SK3)                                                  |
|    |                            | Quality inspection (SK4)                                                     |
|    |                            | Quality performance (SK5)                                                    |
|    |                            | Delivery performance (SK6)                                                   |
| 2  | Delivery (K2)             | Scheduling system (SK7)                                                      |
|    |                            | Just In Time Delivery (SK8)                                                  |
|    |                            | Delivery system (SK9)                                                       |
| 3  | Warranties and Claim Policies (K3) | Service Performance (SK10)                                             |
|    |                            | Response to dealing with complaints (SK11)                                  |
|    |                            | Ability to respond to company problems (SK12)                               |
|    |                            | Material price (SK13)                                                       |
|    |                            | Cost estimation system (SK14)                                                 |
| 4  | Price (K4)                | Cost monitoring system (SK15)                                                 |
|    |                            | Cost structure information (SK16)                                             |
|    |                            | Repair costs (SK17)                                                          |
|    |                            | Achievement of Target Costs (SK18)                                           |
|    |                            | Ability to fulfill requests (SK19)                                           |
| 5  | Technical capability (K5)  | Capability Process (SK20)                                                    |
|    |                            | Production Material Control System (SK21)                                   |
|    |                            | Production planning and control (SK22)                                       |
|    |                            | Standard Operating Procedure (SK23)                                          |
|    |                            | Elimination of Waste produced (SK24)                                        |
|    |                            | Quality Planning (SK25)                                                      |
|    |                            | Quality responsibility (SK26)                                                |
|    |                            | Prevention of defects (SK27)                                                  |
| 6  | Quality Manajemen System (K6) | Approach to Plan, Do, Check, Act (SK28)                              |
|    |                            | ISO Certification (SK29)                                                      |
|    |                            | Material purchase documentation (SK30)                                       |
|    |                            | Material control by sampling technique (SK31)                                |
Based on the results of an open and closed questionnaire with the Delphi method, it can be concluded that on average all respondents agree with 9 criteria and 55 subcriteria offered for use in supplier selection.

4. Conclusion
Respondents used in the study are experts who are experts in the field of supplier assessment and selection, namely the production manager, head of raw materials, head of production, staff of raw materials, and production staff. The criteria chosen for selecting spare parts suppliers using the delphi method are quality criteria (K1), shipping (K2), warranty and complaint services (K3), price (K4), manufacturing capability (K5), quality management system (K6), audit documentation and examination (K7), design and development capabilities (K8), and cost reduction (K9). While the sub-criteria obtained there are 55 sub-criteria of each criterion that is considered in selecting and selecting suppliers.

References
[1] Chopra, S., and Meindl, P 2001 Supply Chain Management: Strategy, Planning, and Operation. New Jersey-Prentice Hall
[2] Wu D 2009 Expert System With Application 36.
[3] Dickson G W 1966 Journal of purchasing 2 5-17
[4] Ginting R 2015 Kuesioner (Medan: USU Press)
[5] Linstone H A 2002 The Delphi Method (New Jersey: New Jersey Institute of Technology).
[6] Lau H C W, Lee C K M, Ho G T S, Pun K F and Choy K L International Journal of Business Performance Management 8 132–151