Supplier selection and determination of quantity of raw material orders using analytical hierarchy process (AHP) and linear programming: A preliminary study

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Abstract. This article discusses the preliminary study about the selection and determination of order quantities of raw materials using the Analytical Hierarchy Process (AHP) and Linear Programming methods. AHP is used to carry out the weighting of each criterion and sub-criteria so that suppliers are found to be in accordance with the company, while linear programming is used to determine optimal raw material orders from each supplier that has been sorted. The purpose of writing this article is to provide a basis for the research that will be conducted. The method used in writing this article is a review literature. Based on inductive studies it can be concluded that the research that will be conducted has a difference with previous similar studies, namely the method used and the criteria set.

1. Introduction
There are three dominant industries that affect Indonesia’s economic growth, namely manufacturing, mining, and agriculture. The manufacturing industry contributes to Indonesia’s economic growth including employment, exports, and the National Gross Domestic Product. In 2013, the contribution of the manufacturing industry to the National Gross Domestic Product was 20.8% [11]. The number of companies in the manufacturing sector has led to the need for globalization and technology because it affects the manufacturing system and improves the company’s business performance [3].

Higher business performance makes multi-product companies must be prepared for changes where there is a dynamic demand for agility, flexibility and product quality [6]. Now many processes, activities and services are outsourced to external providers to support the dynamic business environment in which the organization operates, thus increasing the complexity of inter-organizational and supply chain activities. Supply Chain Management (SCM) is intended to improve organizational sustainability and performance, and is supported by top management because it supports the execution and integration of suppliers, companies, customers and distribution networks [14].

Increasing competition and to continue to add value, places special emphasis on integration with suppliers, where suppliers assist with product and product innovation that is sustainable [16]. Then from the five main things in the Purchasing Supply Management (PSM), supplier management has the highest value of 0.72, then cross-functional integration 0.71, strategy development 0.68, human resource management 0.70, PSM control 0.71 [8].

The company must choose the most appropriate supplier, because the selection of suppliers that significantly reduces raw material costs and increases the competitiveness of the company, but
inaccurate supplier selection can cause financial and operating problems. On the other hand, supplier selection can make the company more efficient and can produce higher quality products [17].

The problem of supplier selection and evaluation can be solved by several methods such as the total cost approach, mathematical programming methods, statistical methods, artificial intelligence methods, and linear weighting methods [12]. Based on the literature survey it can be explained that among the various methods and techniques for solving the problem of the supplier selection process, a model based on AHP and its combination is the most extensive method in the literature. The literature survey also explains that the AHP-based model can be combined with many other methods [1].

Other research on supplier selection and order allocation was carried out [9]. The purpose of the study was to use fuzzy analytic hierarchy process (AHP) to choose the best supplier company that gave the highest satisfaction for the specified criteria.

In a Turkish case study, purchasing managers from producers of goods were interviewed and given questionnaires to calculate the most important criteria managers use when choosing suppliers. To compare supplier companies, Fuzzy AHP is used. To create a good relationship between buyer's company policy and supplier selection, the Dynamic Total Value Purchase Model is recommended [5]. This model indicates the number of orders to suppliers so that the total value of purchases (Total Value Purchasing) becomes maximum using integrated AHP and linear programming. This model also allows management to tradeoff between several real and unreal factors with different priorities.

Then the next study discusses the selection of green suppliers and the allocation of orders using discounts. Where this research is the availability of suppliers each period varies. The use of methods in this study using fuzzy TOPSIS for each weighting criterion then order allocation and discount are determined using integer linear programming [7].

The integrated approach of the analytical hierarchy process is enhanced by a multi-objective mixed linear integer program and the fuzzy set theory is proposed to determine the number of suppliers and the number of orders allocated to these suppliers simultaneously in several products, several sources, with supplier capacity constraints and several criteria. In this context, the supplier offers a discounted price for the total volume of the order [18].

Therefore, the research that will be carried out is about choosing suppliers using a method different from the others, namely the AHP method for decision making at suppliers, then for optimal order allocation, it is done using Linear Programming.

2. Research method
The method used in this study is the literature review. The review was conducted by exploring 18 papers related to the topic of the research to be conducted.

3. Result and discussion
This section discusses literature studies and the theoretical foundation used in the research that will be conducted. In addition, it presents a summary of the results of research that has been done before by other researchers who have links with this research.

3.1. Deductive study
3.1.1. Supply chain management (SCM)
Supply chain management requires traditionally separate material functions to be conveyed to an executive who has the responsibility to coordinate all process materials, and requires joint relationships with suppliers at various levels. Supply chain management is a concept that aims to manage and integrate material, flow, and material control with a total system perspective at various levels of suppliers and various functions. (Monczka et al., 1998).

According to Pujawan [13], the main activities included in the SCM classification are activities to design new products (product development), activities to obtain raw materials (procurement, purchasing, and or supply), activities for planning production and inventory (planning & control),
conducting activities production (production), activities to carry out delivery / distribution (distribution), return management activities (return).

3.1.2. Purchasing
In the field of purchasing, purchase planning is done to determine the actions to be taken for future needs and actions taken to meet those needs. Purchasing planning is a cycle process of integrating overall purchases in the company’s planning system.

Purchase planning is the formulation and implementation of a purchasing strategy. The purchasing strategy consists of the source, time, and life-cycle strategies. The source strategy is to pay more attention to the type and number of vendors they will use in the procurement of goods. The time strategy is more directed to the problem when the item will be received and the volume of goods to be accommodated in the company. Life-cycle strategy more adjusts the behavior when purchasing in the condition that the product will reach the consumer share [15].

3.1.3. Analytical hierarchy process
The AHP method is a framework used in making decisions for complex problems by simplifying and speeding up the decision making process. The trick is to solve the problem into parts, then these parts are arranged in a hierarchical manner, then provide numerical values for subjective considerations about the importance of each variable and synthesize these subjective considerations to determine which variable has the highest priority and influences the results.

The AHP method helps solve complex problems by structuring a hierarchy of criteria, stakeholders, results and by taking considerations to develop priorities or weights. The AHP method combines the power of logic and feeling in a variety of problems, then synthesizes considerations into results that are intuitively predictable [4].

3.1.4. Linear programming
Linear programming is a mathematical technique used to find optimal solutions to problems that can be expressed using inequalities and linear equations. If the problem can be represented mathematically from a linear program accurately, this method will find the best solution. In a series of linear functions, there are only a few complicated problems that can be perfect. A linear program will provide a realistic representation of various problems, if little creativity is applied in the mathematical formulation of the problem [2].

3.2. Inductive study
Inductive studies contain affirmation of the state of the art or positioning of the research conducted compared to similar or previous research. The differences confirmed here can be reviewed based on the method used or supplier selection criteria. Differences from similar studies can be explained through Table 1.

| No | Author | Method | Criteria |
|----|--------|--------|----------|
| 1  | [9]    | Fuzzy AHP | product performance, cost, quality |
| 2  | [5]    | AHP Fuzzy & Linear Programming | Supplier flexibility, price, probability of sending supplier error |
| 3  | [7]    | Fuzzy TOPSIS, Integer Linear Programming | Cost, flexibility, shipping, quality, payment method |
| 4  | [18]   | Two-phase fuzzy & multi-objective linear programming (FMOLP). | Purchase fees, quality message fees, delivery time |
4. Conclusions
The research that will be carried out is about choosing suppliers using a method different from the others, namely the AHP method for decision making at suppliers, then for optimal order allocation, it is done using Linear Programming. AHP is used to carry out the weighting of each criterion and sub-criteria so that suppliers are found to be in accordance with the company, while linear programming is used to determine optimal raw material orders from each supplier that has been sorted. Based on inductive studies it can be concluded that the research that will be conducted has a difference with previous similar studies, namely the method used and the criteria set.

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