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Application of Subcontractor Selection Using Analytical Hierarchy Process Method in Ritz Garment

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Abstract

This research was conducted in Ritz Garment to determine the level of importance of the criteria and sub-criteria that are used for subcontractor selection for Ritz Garment, assess the performance of current and alternative subcontractors, and provide recommendation for Ritz Garment based on the subcontractor selection. To determine the importance of the criteria and sub-criteria and also to score alternatives towards each of the sub-criteria, decision makers which are the manager and owner of Ritz Garment are interviewed as respondents to get their expert judgement. The interview will generate pairwise comparison for each criteria and sub-criteria from each respondent that will be averaged using geometric mean to get the numbers that will be used to calculate the weight of each criteria and sub-criteria. From the result of this research that is conducted using AHP method with the Expert Choice software, level of importance for each criterion and alternatives are obtained. The order of importance of criteria is Quality (0.296), Cost (0.290), Reliability (0.273), Delivery (0.080), and Flexibility (0.061). The sequence for sub-criteria Global Weight is Defect Rate (0.156), Trustworthy (0.154), Internal Cost (0.153), Conformance Quality (0.140), Product Price (0.137), Product Reliability (0.119), Customization (0.051), Compliance with Quantity (0.045), Compliance with Schedule (0.035), and Product Volume Changes (0.010). For the alternatives, the order of importance is Alternative Subcontractor 1 (7.667), Alternative Subcontractor 2 (0.7.314), Alternative Subcontractor 3 (7.099) and Current Subcontractor (6.266). From the result, it is concluded that Alternative Subcontractor 1 is the best subcontractor to replace Current Subcontractor.

Keywords: garment industry, subcontractor selection, analytical hierarchy process, criteria, sub-criteria, best subcontractor, case study

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1. Introduction

Most of the clothing needs in Indonesia is fulfilled by Indonesian Textile and Textile Products (TPT) Industry by 46 percent [1]. The Indonesian textile industry also still plays a significant role in the national economy because in 2006 this industry contributed 11.7 percent of the total national exports, 20.2 percent of the national trade surplus, and 3.8 percent of the formation of National Gross Domestic Product (GDP), while the

absorption capacity of the industry for labor is also quite large, reaching 1.84 million workers [2]. The influence of the textile industry on the national economy is also inseparable from the role of the garment industry (apparel) as one of the sectors in the textile industry as garment industry has a big contribution for national reserves and this industry export has been increasing for 20 years. From the garment industry, export profits have been huge since the New Order. The market share of this industry worldwide contributes up to 1.57% with average value of US$3.9 annually. Garment industry has dominantly contributed in TPT industry with more than 6.5 billion US dollars or 58% from 11.2 billion US dollars TPT industry total export value. Based on the data that are provided, we can conclude that the garment industry has a high rate of competitiveness [3]. Moreover, the garment industry is one of the highest export earners. Export values from 2008 until 2013 have always reached US $ 6 billion. In 2012, the export value of the garment industry reached US $ 7.18 billion or 57.65% of the total exports of the national textile industry. In addition, the textile industry is listed as a large employment provider industry in Indonesia, especially apparel (garment). Labor absorbed by large and medium scale industries in 2012 reached 1.53 million people in the TPT sector, and 520,000 people in the apparel sector (garment). This reflects the textile industry, especially the apparel industry is still one of the main drivers for the national economy [4]. As the garment industry increases, finding alternative strategy to develop small businesses into strategic sectors in Indonesia's economic system through subcontracting relationships for decentralization of production is done seriously by the experts and policy makers in this field. This subcontract system will help principal to fulfill the demand that cannot be met. Although, this system will also create problem between the subcontractor and the principal. One of the problems relates to the control of the subcontractor products. Considering the efficiency factors and limited human resources, the control of the techniques and the quality of subcontractor work cannot be carried out directly, in the sense of visiting each subcontractor. Therefore, the principal should form a special division that controls every product entered by subcontractors. Products that do not meet the standards are returned to the subcontractor for repair. In this case, there is often a process of returning products that are repeated, which takes time [5]. That problem also becomes urgent because quality is an important factor in business to be manage well because having higher or better product quality can also be used as a product differentiation strategy in the marketplace and be more profitable [6]. So, it becomes important to be able to manage subcontractors to maintain the quality of the products.

The same problem occurs at Ritz Garment which is a business unit that is included in the garment industry. As a Small and Medium-Sized Enterprise, Ritz Garment receives demand more than it can fulfill every week. To overcome this problem, they do subcontract to businesses in South Jakarta and also small towns like Kebumen or Pekalongan to fulfill their demand because it will cost lower than if they force to maximize their business by hiring new labors or invest on new machines. Even though this is a good solution, it also creates problem. Products that are produce by the subcontracts are often defected. The defects can be caused by the damages on the clothes or the final products do not meet the standards that the customers want and have to be repaired by the subcontractors or the company. If they cannot be repaired, then the products cannot be sold to the customers and have to be thrown away. This action will be resulting in the increase of the cost and time to produce the products and in the end, it will decrease the profit that is gained by Ritz Garment. Moreover, it can also decrease customers' trust toward Ritz Garment because it cannot fulfill the demand that has been promised from the beginning and that will harm the customers. This problem happens because Ritz Garment never has system or specific method to select their subcontractors. Therefore, they choose their subcontractors without any clear basis or knowledge about the subcontractors' performance before and causing the subcontractors to perform not according the company's standard. Although, properly select subcontractors is important because when subcontractor or supplier is selected inappropriately, it will cause high costs associated to the orders' repetition, supply time that will be extended and damage to the procurement that will increase harm [7]. Other than that, subcontractor or supplier selection is important because in the end it will affect the business performance of firm as it carries out resources while simultaneously impacting inventory management, production planning and control, cash flow requirement, and product quality activities as the subcontractor or supplier will involve in those activities [8].

To overcome this problem, the manager of Ritz Garment wants to replace one of their current subcontractors, because it is the most efficient and effective way to solve this problem as replacing the subcontractors can immediately decrease the defect products if the subcontractors is chosen appropriately to ensure that they can produce products according to the requirements. Other than that, replacing the subcontractors will not risk the company because the alternative subcontractors are chosen properly to be able to produce products as standards and will be in the same area as the current subcontractors, so the switching cost will be low because the company can just switch the subcontractors and there are no binding contracts. The current subcontractor that will

be replace is the subcontractor in Pekalongan that has the most defect rate around 3.5% while the other subcontractors defect rate is 1.1% and 1.8% according to the company. The company wants to replace it with one of the three alternatives of subcontractor that also located in Pekalongan that has performance according to their standards, so the quality of their products will be improved. In doing so, subcontractor selection has to be done. One of the methods that can be used to select subcontractor is Analytical Hierarchy Process (AHP). As a decision-making method that is used when there are various criteria that have to be considered, AHP is developed to prioritize alternatives and enable decision makers to solve complex problems into a hierarchy or set of integrated levels. Therefore, AHP can group complex and unstructured problems into a hierarchy before entering numerical values as a replacement of human perceptions of relative comparison. With a synthesis, it will be able to establish which element has the highest priority [9]. According to the problem that is stated above, this research aims to identify the level of importance of each criterion and sub-criterion that affect the subcontractor performance in Ritz Garment and used for the subcontractor selection. Afterwards, current subcontractor and each of the alternative subcontractors can be evaluated to know their performance based on the criteria and the performance of each subcontractors can be compared to know which subcontractor that should be selected. Therefore, the company can improve their future quality as they will select their subcontractors based on a clear basis by applying Analytical Hierarchy Process method that are commonly used in selection process of subcontractors.

2. Literature Review

2.1. Subcontractors

Subcontractor is a construction company that contracts with a main contractor to undertake specific tasks on a project as part of the overall contract and may supply laborers, materials, equipment, tools, and designs [10]. This subcontractor is required to provide necessary materials and to execute all the orders without receiving pre-payment [11]. Similar with subcontractor, suppliers are also companies or individuals who are able to provide resources, both in the form of goods or services needed by other companies [12]. In the supply chain concept, subcontractor and suppliers are one of the important supply chains and have an influence on the existence of a plant as the design concept of improvement in order to increase the productivity of the company is no longer only served at the plant but also the subcontractor or supplier [13]. Other than that, one

factor that has a role in maintaining competitive advantage is the selection of the right supplier as in the supply chain concept, the supplier is one of the supply chain parts that is very important and influences the survival of a factory [14]. The factory as a system that runs production activities must require raw materials, which of course are imported from suppliers. If the supplier is less responsible and responds to the fulfilment of the request, it will cause problems such as the occurrence of stockouts and the length of the lead time. Therefore, companies that have many alternative suppliers must be selective in choosing suppliers.

2.2. Subcontractors Selection

Subcontractor or supplier is an important component in the field of logistics and production management. To obtain a supplier that is able to fulfil goods or services on demand, a process for selecting a good supplier is needed. The purpose of supplier selection is to get the right supplier so that it can reduce the cost of purchasing goods or services. The selection of the wrong supplier can harm the company. For that supplier selection is an important component that must be done in a company. Supplier selection task becomes important need because business environment is currently unstable, due to rapid changes in market conditions, customer needs, and competitors' actions, the increasing globalization of world trade and the availability of communication facilities through the internet provide opportunities for buyers to find material sources abroad, and suppliers need to be assessed based on several sometimes-conflicting criteria. Comparisons between these criteria are sometimes needed because each supplier is usually different [12]. Moreover, supplier selection is an important process because this process aims to find the suppliers that are able to provide the buyer with the right quality products and/or services at the right price, at the right quantities and at the right time [15]. That being said, this process traditionally conducts by selecting suppliers according their capability to meet the quality requirements, delivery schedule and the price offered. However, in modern management, there are many other factors that have to be considered in selecting suppliers that has the objective to develop a long-term relationship with suppliers [16].

2.3. Subcontractors Selection Criteria

The process of selecting and evaluating suppliers will always be based on criteria according to the standards set by the company. These criteria will be used as a

benchmark for assessment and evaluation. Moreover, along with the increasing number of demands in fulfilling raw materials, supplier assessment criteria will be increasingly more complex and complicated [14]. In this research, the criteria that are used are Quality, Cost, Delivery, Flexibility, and Reliability from literature review that also use these criteria for supplier selection as shown in Table 1. For the sub-criteria, there are two sub-criteria that are used to explain each criterion that are also obtained from literature review that are shown in Table 2.

TABLE 1: Literature Review for Criteria.

Criteria	Author
Quality	[13, 14, 17–25]
Cost	[13, 14, 17–23, 25, 26]
Delivery	[13, 14, 18–21, 23, 25, 26]
Flexibility	[13, 18, 20, 23, 26]
Reliability	[13, 18, 21, 25]

TABLE 2: Literature Review for Sub-criteria.

Sub-criteria	Author
Conformance Quality	[14, 22, 23]
Defect rate	[14, 19, 23]
Product Price	[14, 18, 19, 22, 23]
Internal Cost	[18, 19, 22, 23]
Compliance with Schedule	[14, 19, 23]
Compliance with Quantity	[14, 19]
Product Volume Changes	[13, 18, 20]
Customization	[18]
Trustworthy	[18]
Product Reliability	[13]

2.4. Subcontractors Selection Method

Supplier selection method is the model or approach used to carry out the supplier selection process. The method chosen is very important for the entire selection process and has a significant effect on the election results. It is important to understand why a company chooses one method (or a combination of different methods) over another [12]. For many years, the development and classification of some well-known selection methods is done by many scientists. Usually, an integration of a few different methods

that have different strengths is produced when a company decides to develop or choose a supplier selection method to achieve the requirement to select specific company. Therefore, exploring a variety of different selection methods and discussing the various application differences is important [12]. These criteria are divided into two groups, namely quantitative and qualitative. Since 2003, more attention has been paid to qualitative criteria so that as a consequence supplier selection method have also changed. Over the past few years, attention is needed to change the size of qualitative and quantitative criteria. Based on the explanation above, the supplier selection methods can be grouped as in Table 3.

TABLE 3: Subcontractor or Supplier Selection Methods [12].

Approach	Category	Method
Quantitative	Multi Attribute Decision Making (Linear Weighting Models)	Categorical Model
		Weighted Point Model
	Multi Objectives Optimization (Mathematical/Linear Programming Models)	Linear Programming
		Integer Programming
		Goal Programming
		Multi Objective Programming
	Statistical/Probabilistic Approaches	Principal Component Analysis
		Multiple Attribute Utility Theory
		Data Envelopment Analysis
	Intelligent Approaches	Artificial Neural Network
		Fuzzy Theory
	Other (Cost based Method)	Cost Ratio
		Total Cost of Ownership
Quantitative and Qualitative	Analytical Hierarchy Process (AHP) and its Integration	Analytical Hierarchy Process
		AHP – Linear Programming
		Voting AHP
		Fuzzy AHP
		Analytical Network Process

In this research, the method that will be used for the subcontractor selection is Analytical Hierarchy Process. This method is able to solve problem with various criteria like subcontractor selection and commonly used in various studies in this topic in different countries and industries as shown in Table 4. Therefore, this method is chosen as it is suitable to be used in this research to solve the problem.

Table 4: Previous Studies of Subcontractor Selection Using AHP.

Author	Country	Industry
[9]	Indonesia	Construction and Engineering
[12]	Indonesia	Cement
[19]	India	Service
[20]	India	Built Environment
[21]	India	Pharmaceutical
[22]	Turkey	Vehicle glass repair and replacement
[23]	India	Automobile
[24]	India	Manufacturing
[25]	Serbia	Irrigation
[26]	India	Toy Manufacturing

2.5. Analytical Hierarchy Process

Analytical Hierarchy Process (AHP) method that was introduced by Thomas Saaty (1980) is an effective tool when facing a complicated decision making that is possible to support the decision maker to place their prime concern and produce the best decision. In a decision, AHP assists in engaging both sides of subjective and objective by minimizing complicated decision to a sequence of pairwise comparisons before synthesizing the results. Other than that, a practical approach to ensure the consistency evaluation made by the decision maker include in to decrease the bias in the decision-making process. A set evaluation criteria and alternative choices in the middle of the best decision to be decided also reviewed by AHP. As a few criteria is different, the fact that the one which optimize every criterion rather than the one which reaches the most acceptable exchange among the contrast criteria is the best alternative is not true has to be remembered. Every criteria of evaluation in the AHP is produced based on the pairwise comparisons of the criteria of the decision maker, a criterion becomes more important when the weight is higher. In addition, the AHP allocates a score for every alternative based on the pairwise comparisons of the alternatives according to the criterion of the decision maker for a fixed criterion. Same as the previous, the performance of the alternatives based on the evaluated criterion is better when the score is higher. At the end, AHP integrates the weight of the criteria and the alternatives score to establish every alternative global score and the resulting ranking. For every alternative, the global score is produced from the weighted sum of the score that is resulted from every criterion [27].

The score and final ranking that are gained from the criteria and the alternatives delivered by the user pairwise relative evaluation makes AHP becomes a versatile and robust tool. AHP is considered a tool that is capable to interpret both the decision maker's qualitative and quantitative evaluations to become a multicriteria ranking because the knowledge of the decision maker that always assists the calculations that AHP produces. Moreover, with the absence of the requirement to construct a complicated expert system with the placement of decision maker's expertise, AHP becomes an easy to use tool. Even though it is possible for AHP to need a lot of user's evaluations, mainly for many criteria and alternatives problem, each evaluation is easy because it just demands the decision make to communicate the comparation of every alternative and criteria. Although, it may be an irrational work as the amount of pairwise comparisons increases quadratically with the number of criteria and alternative. Nevertheless, AHP can be entirely and partially automated to decrease the work of the decision maker by stating the acceptable thresholds to make some pairwise comparisons decided automatically [27].

3. Methodology

As it has been mentioned before, the method that will be used in this research is Analytical Hierarchy Process (AHP). This method is chosen because it can sort the alternative problem solving according the experts' judgment towards the criterion used. Therefore, this method can solve the problem regarding subcontractor selection that is happening in Ritz Garment as it needs to choose the best alternative of subcontractor based on chosen criteria. The steps in this research method is shown below.

Figure 1: Research Method Steps.

3.1. Establish the Analytical Hierarchy Process (AHP) Model

The Analytical Hierarchy Process (AHP) Model for subcontractor selection in Ritz Garment is shown in Figure 2. As seen in the figure, this model consists of three levels of hierarchy. Level 0 is the goal for this decision, which is to select the best subcontractors for Ritz Garment.
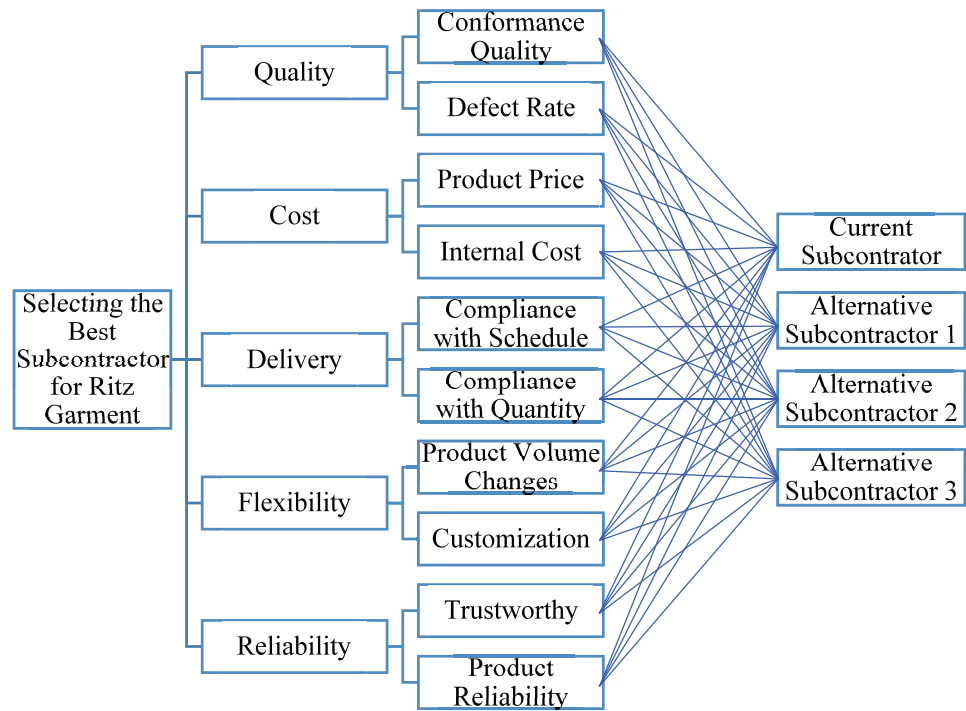
Figure 2: Analytical Hierarchy Process Model.

Level 1 of this hierarchy consists of criteria used in the subcontractor selection that are obtained from literature review as shown in Table 1 and validation from the company. The definition for each of the criteria is shown in Table 7. Level 2 of this hierarchy consists of sub-criteria that are used to explain the criteria. The sub-criteria are obtained from discussion with the company to decide the sub-criteria from the literature review that is shown in Table 2 that are suitable for their needs to explain each criterion. The definition of each sub-criteria is showed in Table 7.

Level 3 of this hierarchy is the alternatives that will be chosen as the best subcontractor for Ritz Garment. These alternatives consist of the current subcontractor that wants to be replace and the other three alternative subcontractors to replace it. All of these subcontractors located in Pekalongan as the current subcontractor that wants to be replaced located here and the company wants to replace it with subcontractor that also located here. These alternatives will be compared to know whether the current subcontractor should be replaced or not, and if it should be, which one of the three alternatives is the best to replace it.

Table 5: Criteria and sub-criteria definition.

Criteria	Definition	Sub-criteria	Definition
Quality	The level of quality of the products produced by each subcontractor	Conformance Quality	Conformity of products quality with standards
		Defect Rate	Average number of defect products
Cost	All of the cost incurred to use each subcontractor	Product Price	Price of products produced
		Internal Cost	Other cost that occurred to get the products
Delivery	Punctuality and accuracy of the amount of delivery of each subcontractor	Compliance with Schedule	Accuracy with the agreed delivery schedule
		Compliance with Quantity	Accuracy with the agreed delivery quantity
Flexibility	Level of flexibility of each subcontractor towards changes in orders	Product Volume Changes	Flexible to a change in product volume ordered
		Customization	Ability to make orders with various models
Reliability	Level of confidence for each subcontractor to be trusted and able to fulfil orders.	Trustworthy	Trustworthiness of the subcontractor
		Product Reliability	Trust in conformity of the products produced

3.2. Criteria Weights Calculation

The calculation of criteria weights is done according to the equation that has been mentioned previously in the discussion of Analytical Hierarchy Process method using Expert Choice software. Before the criteria weights can be calculated, the pairwise comparison among all criteria should be done through separate interview with manager and owner of Ritz Garment as the decision makers and experts. In the interview, the interviewees will do a pairwise comparison procedure for each criterion based on the scale that is shown in Table 8. After the data are collected, they should be averaged using geometric mean that has been explained before to get one answer using Expert Choice software. For example, if the Respondent 1 is giving score 5 for Criteria 1 towards Criteria 2 in the pairwise comparison and Respondent 2 is giving score 3 for the Criteria 2 in the same pairwise comparison, then the calculation of the geometric mean will be as below.

$$\left[(5) \times \left(\frac{1}{3} \right) \right]^{1/2} = 1.2909$$

The result of the calculation is 1.2909, which determine the score of pairwise comparison of Criteria 1 towards Criteria 2. After the score for all of the pairwise comparison is established through geometric mean calculation, the weight of the criteria can be calculated according to the equation that has been mentioned previously in the discussion of Analytical Hierarchy Process method using Expert Choice software.

TABLE 6: The fundamental scale [28].

Intensity of importance on an absolute scale	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance of one over another	Experience and judgment strongly favour one activity over another
5	Essential or strong importance	Experience and judgment strongly favour one activity over another
7	Very strong importance	An activity is strongly favoured and its dominance demonstrated in practice
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between the two adjacent judgments	When compromise is needed
Reciprocals	If activity i has one of the above numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i	

3.3. Sub-criteria Weights Calculation

The calculation of sub-criteria weights is done according to the equation that has been mentioned previously in the discussion of Analytical Hierarchy Process method using Expert Choice software. Before the sub-criteria weights can be calculated, the pairwise comparison between sub-criteria in each criterion should be done through interview with the decision makers and experts which are the owner and manager of Ritz Garment. In the interview, the interviewees will do a pairwise comparison procedure for each sub-criterion based on the scale that is shown in Table 8. After the data are collected, they should be averaged using geometric mean to get one answer by multiplying each value produced from the assessment by each other, then the product of multiplication is raised by 1 / n (n = number of respondent) using Expert Choice software [28]. Then, the weight of the sub-criteria can be calculated according to the equation that has

been mentioned previously in the discussion of Analytical Hierarchy Process method using Expert Choice software. Afterwards, the global weights of each sub-criteria can be determined by multiplying the local weight of the comparison between criteria with the local weight of the comparison between sub-criteria.

3.4. Checking the Consistency

The consistency is calculated for every pairwise comparison to ensure that the assessment is consistent. This calculation will be done using Expert Choice software to establish the consistency ratio (CR) which should be less than 0.1 for the assessment to be consistent. If not, the criteria should be reassessed.

3.5. Scoring the Alternatives

The alternatives are scored by the decision makers that are owner and manager of Ritz Garment through interview. In the interview, the interviewees will score each alternatives capability towards each sub-criterion based on the scale 1 until 10 with 1 as the minimum score and 10 as the maximum score.

3.6. Ranking the Alternatives

To rank the alternatives, the overall score of each alternative should be calculated. As the global weights are determined, the overall score of each alternative can be done by multiplying the global weights of each sub-criteria with the score of each alternative. After that, the result of each alternatives is added to get the overall score. As the overall score for each of the alternatives will be calculated, the ranking of alternatives can be determined and it will establish the alternative that has the highest score. Afterwards, the alternative with the highest score will be selected as the best subcontractor for Ritz Garment.

4. Discussion

The decision model for subcontractor selection in Ritz Garment has been established before that resulted in the Analytical Hierarchy Process Model in Figure 2. As seen in the figure, this model consists of three levels of hierarchy. Level 0 is the goal for this decision, which is to select the best subcontractors for Ritz Garment. Level 1 of this

hierarchy consists of criterion used in the subcontractor selection, which are Quality, Cost, Delivery, Flexibility, and Reliability. Level 2 of this calculation consists of sub-criteria that explain each of the criteria. These sub-criteria are Conformance Quality and Defect Rate for Quality, Product Price and Internal Cost for Cost, Compliance with Schedule and Compliance with Quantity for Delivery, Product Volume Changes and Customization for Flexibility, and Trustworthy and Product Reliability for Reliability. For Level 3 of this hierarchy, it consists the alternatives that will be chosen as the best subcontractor for Ritz Garment. These alternatives are Current Subcontractor, Alternative Subcontractor 1, Alternative Subcontractor 2, and Alternative Subcontractor 3.

4.1. Criteria Weights Calculation

Data that are used for pairwise comparison for each criterion are collected from conducting interviews. From the interview, questionnaires are fulfilled regarding the judgement of the owner and manager of Ritz Garment as the decision makers towards each criterion. After the assessment from the respondents are collected, the result is averaged using geometric means. This calculation is done to establish one pairwise comparison matrix that is needed. For example, for pairwise comparison of Quality towards Cost the calculation is shown below.

$$\left[(2) \times \left(\frac{1}{3}\right)\right]^{1/2} = 0.816$$

The number 2 is obtained from the pairwise comparison done by Respondent 1 that score 2 for Quality towards Cost. For the number $\frac{1}{3}$, it is obtained from scoring 3 for Cost by Respondent 2 for pairwise comparison of Quality towards Cost. The result from this calculation is 0.816, which determine the score for Quality towards Cost in the pairwise comparison. For other geometric mean calculation, the result is shown in Table 9.

TABLE 7: Pairwise comparison matrix in terms of all criteria.

Criteria	Quality	Cost	Delivery	Flexibility	Reliability
Quality	1	0.816	3.873	5.477	1.155
Cost	1.225	1	3.464	5	0.816
Delivery	0.258	0.289	1	1.225	0.316
Flexibility	0.183	0.2	0.816	1	0.258
Reliability	0.866	1.225	3.162	3.873	1

Based on the pairwise comparison matrix above, the weight of each of the criteria can be calculated. After that, the priority of each criteria can be established according

to the weight. The result of this calculation that determine weights and priority of each criteria is shown in Table 10.

TABLE 8: Weights and Priority of all criteria.

Criteria	Weight	Priority
Quality	0.296	1
Cost	0.290	2
Delivery	0.080	4
Flexibility	0.061	5
Reliability	0.273	3

According to the Table 10 above, it can be concluded that the most important criteria for Ritz Garment in selecting subcontractor is Quality with the highest weight of 0.296. This result is in accordance with the goal of the company to provide good quality products to the customers because subcontractors that are able to produce quality products are needed to achieve this goal and also this result is similar with the result in previous studies that conclude in their research that the most important criteria for subcontractor selection is Quality [9, 13, 14, 19–21, 23, 24, 28]. The second and third most important criteria in selecting subcontractor for Ritz Garment is Cost and Reliability with a weight of 0.290 and 0.273 respectively. These criteria have weights that are not far from the Quality criteria as these criteria also important for the company. The company wants to provide a good service for the customers and one of the factors to achieve it is to give the customers an affordable price, and this goal can be achieved if the company has subcontractors that will cost them appropriately. Other than that, to be able to perform the best, Ritz Garment will have to be sure with who they cooperate with, especially with the subcontractors that will supply products to them. Therefore, Reliability also becomes one of the most important criteria for Ritz Garment to select subcontractors because they have to be sure that the subcontractors will be able to fulfill their needs. The fourth and fifth priority of criteria for Ritz Garment to select subcontractors are Delivery and Flexibility with a 0.080 and 0.061 weight respectively. The result shows that these criteria are not the main criteria that concern the company to select subcontractors, because even though they need subcontractors that have good delivery and flexible, they realize it will be hard as they are doing business in the low price and high in volume area that makes them more tolerant for inaccuracy in delivery and inflexibility, as long as the products will eventually delivered as ordered. Therefore, these criteria are not as important as the others. The order of priority for the criteria also has been discussed with the owners and managers of Ritz Garment, and they have validated that the priority is in accordance with their needs in selecting subcontractors.

4.2. Sub-criteria Weights Calculation

Similar with the calculation for sub-criteria weights, for sub-criteria, pairwise comparison for all sub-criteria in each criterion has to be done. Data that are used for the pairwise comparison are also collected from conducting interviews that fulfill questionnaires regarding the judgement of the owner and manager of Ritz Garment as the decision makers towards each sub-criterion. The result of the weight calculation for each sub-criterion is shown in Table 11.

TABLE 9: Global Weights.

Criteria	Local Weight	Sub-criteria	Local Weight	Global Weight
Quality	0.296	Conformance Quality	0.472	0.140
		Defect Rate	0.528	0.156
Cost	0.290	Product Price	0.472	0.137
		Internal Cost	0.528	0.153
Delivery	0.080	Compliance with Schedule	0.436	0.035
		Compliance with Quantity	0.564	0.045
Flexibility	0.061	Product Volume Changes	0.167	0.010
		Customization	0.833	0.051
Reliability	0.273	Trustworthy	0.564	0.154
		Product Reliability	0.436	0.119

According to the Table 11, it can be concluded that for Quality, Defect Rate is a more important sub-criteria with a weight of 0.528 than Conformance Quality with 0.472 weight. Even though the difference is little, the result shows that it is more important for Ritz Garment to have subcontractors that have a low rate of defect than to those who produce products according to the standards. This result is also has been validated by the company as they said that most defect products cannot be sold and will harm the company more than the products that are not according to the standards. For Cost, Internal Cost is a more important sub-criteria with a weight of 0.528 than Product Price with 0.472 weight. Even though the difference is little, the result shows that it is more important for Ritz Garment to have subcontractors that have an appropriate internal cost than the product price. This result is also has been validated by the company as they said that most subcontractors have similar price for the products that they produce, and the differences with the cost will be the internal cost that are other cost that occurred like transportation cost and service cost. Therefore, the internal cost becomes more important in differentiate the subcontractors in Cost. In Delivery criteria, Compliance

with Quantity is a more important sub-criteria with a weight of 0.564 than Compliance with Schedule with 0.436 weight. Even though the difference is little, the result shows that it is more important for Ritz Garment to have subcontractors that are compliance with Quantity than to those who are Compliance with Schedule. This result is also has been validated by the company as they said that they need subcontractors to always have the accuracy of the quantity that are delivered more than their accuracy in schedule to maintain their profitability.

For Flexibility, Customization is a more important sub-criteria with a weight of 0.833 than Product Volume Changes with 0.167 weight. The difference between the sub-criteria is big with Customization become the first priority that has the meaning that it is more important for Ritz Garment to have subcontractors that have flexibility in customization of products that the changes of product volume. This result is validated by the company as it is in accordance with the company profile that is a garment manufacturer that produce various kind of clothing that will need subcontractors that are able to produce many kinds of clothing more than subcontractors that flexible with product volume changes as the volume of the products usually constant. The last criteria, Reliability, Trustworthy is a more important sub-criteria with a weight of 0.564 than Product Reliability with 0.472 weight. Even though the difference is little, the result shows that it is more important for Ritz Garment to have subcontractors that are Trustworthy than to those who produce products that can be reliable to be in accordance with the standard. This result is also has been validated by the company as they said that Trustworthy subcontractors are more reliable to fulfill their demands because they will be loyal and commit to their works more than subcontractors that produce reliable products, and the company needs that kind of subcontractors that they believe will not ignore their orders. After the weight of the criteria has been determined, the Global Weight for each sub-criterion can be calculated. The result of the Global Weights calculation is also shown in Table 11. From the result, the Global Weights will be used to calculate overall score of alternatives.

4.3. Checking the Consistency

After the weights of the criteria and sub-criteria have been determined from the pairwise comparison, the consistency of each assessment has to be calculated to ensure that it is consistent. The consistency is calculated using Consistency Ratio (CR), which is calculated for all of the pairwise comparison made in the assessment that have to be

more than 0.1 for the assessment to be consistent and can be used. The result of the CR calculation is showed in Table 12.

TABLE 10: Consistency Ratio (CR).

Pairwise Comparison	CR	Note
All criteria	0.01	Consistent
All sub-criteria in terms of Quality	0.00	Consistent
All sub-criteria s in terms of Cost	0.00	Consistent
All sub-criteria in terms of Delivery	0.00	Consistent
All sub-criteria in terms of Flexibility	0.00	Consistent
All sub-criteria in terms of Reliability	0.00	Consistent

According to the Table 12, it shows that all of the consistency ratio is more than 0.1. So, it can be concluded that all of the assessment is consistent. Therefore, reassessment will not be needed as all of the assessment can be used.

4.4. Scoring the Alternatives

The scoring of the alternatives is done by respondents to score each alternatives capability towards each of the sub-criteria in the questionnaires that has been shown before. From the result, the score of each alternative in each sub-criterion is concluded in Table 13.

TABLE 11: Alternatives scoring towards sub-criteria.

	Current Subcontractor	Alternative Subcontractor 1	Alternative Subcontractor 2	Alternative Subcontractor 3
Conformance Quality	6	9	8	7
Defect Rate	6	8	7	7
Product Price	7	7	7	8
Internal Cost	6	7	7	7
Compliance with Schedule	6	7	7	7
Compliance with Quantity	6	7	8	8
Product Volume Changes	7	8	8	9
Customization	6	9	7	8
Trustworthy	6	7	7	6
Product Reliability	7	8	8	7

Based on the Table 13, it shows the capability of each of the alternatives towards each sub-criterion. This result will be used for calculating the overall scores of each

alternative. From the calculation, the overall scores will be determined to establish the ranking of each alternatives.

4.5. Ranking the Alternatives

As the global weights and alternatives scores have been determined, the overall score of each of the alternatives can be calculated. This calculation is done by multiplying the global weights of each sub-criteria with the score of each alternative towards the sub-criteria, and the result of each alternatives are added to get the overall score. The result of the overall score is shown in the Table 14. From this overall score, the rank of the alternatives is also established.

TABLE 12: Overall Scores and Priority for Alternatives.

Alternatives	Overall Score	Priority
Current Subcontractor	6.266	4
Alternative Subcontractor 1	7.667	1
Alternative Subcontractor 2	7.314	2
Alternative Subcontractor 3	7.099	3

According to the Table 14, Alternative Subcontractor 1 has the highest overall score of 7.667, followed by Alternative Subcontractor 2 with overall score of 7.314, and Alternative Subcontractor 3 and Current Subcontractor with 7.099 and 6.266 overall score. Based on this result the overall decision for Ritz Garment can be made, which is to replace the Current Subcontractor as it has the lowest score. Moreover, the best subcontractor to replace the Current Subcontractor is Alternative Subcontractor 1 as it has the highest overall score that makes it the best alternative to be selected as Ritz Garment subcontractor. As the second priority of subcontractor with second highest overall score, Alternative Subcontractor 2 should be selected by Ritz Garment as their subcontractor when Alternative Subcontractor is unable to fulfill the demand. Alternative Subcontractor 3 is the third priority of subcontractor to be chosen by Ritz Garment, and should be chosen when Alternative Subcontractor 1 and Alternative Subcontractor 2 are not enough to fulfill the company's demand. When three of the alternatives are unable to fulfill Ritz Garment demand, then the Current Subcontractor can be selected as the last priority of subcontractor.

5. Conclusion

According to the research objective and the result of the research that has been conducted, it can be concluded that there are five criteria that are considered for subcontractor selection in Ritz Garment that are obtained from literature review and validation from the company. The level of importance for each these criteria is Quality (0.296), Cost (0.290), Delivery (0.080), Flexibility (0.061), and Reliability (0.273). Therefore, the most important criterion is Quality, followed by Cost, Reliability, Delivery, and Flexibility. There are ten sub-criteria with two sub-criteria for each criterion that are explaining each of them. These sub-criteria are obtained from discussion with the company regarding sub-criteria that suit the company needs from literature review. The Global Weight for each of these sub-criteria is Conformance Quality (0.140), Defect Rate (0.156), Product Price (0.137), Internal Cost (0.153), Compliance with Schedule (0.035), Compliance with Quantity (0.045), Product Volume Changes (0.010), Customization (0.051), Trustworthy (0.154), and Product Reliability (0.119). Therefore, the sequence of importance for sub-criteria is Defect Rate, Trustworthy, Internal Cost, Conformance Quality, Product Price, Product Reliability, Customization, Compliance with Quantity, Compliance with Schedule, and Product Volume Changes. The overall score that shows the overall capability for each alternative is Current Subcontractor (6.266), Alternative Subcontractor 1 (7.667), Alternative Subcontractor 2 (7.314), and Alternative Subcontractor 3 (7.099). Therefore, the best alternative of subcontractor to select is Alternative Subcontractor 1, followed by Alternative Subcontractor 2, Alternative Subcontractor 3, and Current Subcontractor. The best option for Ritz Garment to increase their performance is to replace Current Subcontractor with Alternative Subcontractor 1.

Recommendations for Ritz Garment that are obtained from data analysis and the conclusions are to increase company's performance, Ritz Garment should replace Current Subcontractor with Alternative Subcontractor 1 which has the highest overall score and capability to meet the company's criteria for subcontractor. The replacement is the best option because it is the most possible and fastest way to increase the performance because the both of the subcontractors are located in the same area and there are no binding contracts as the subcontractor is small and conventional. Therefore, the are no significant switching cost if Ritz Garment replace its subcontractor. Other than that, the company should always use subcontractor selection method to select their subcontractors to maintain their performance as this method can sort subcontractors' capability according to the level of importance of each criterion that are needed by the company to meet the requirements. In addition, the company can use the criteria

that are used in this research for similar purpose in the future or use other criteria that are more relevant and suitable for the company's future needs. Other than that, if the company has other multi criteria problems, they can use Analytical Hierarchy Process method as the tools to solve the problem. For future research, researcher can use other criteria that are more relevant to the research to conduct subcontractor selection according to the researched company's policy and needs. For the method, Analytical Hierarchy Process can be used to conduct subcontractor selection as it is proven to be consistent based on this research. Moreover, application of subcontractor selection in the future has to always be in accordance with the subject company' needs and always be validated along the assessment. Therefore, the result from the research will be suitable for the company and solve the problem.

Acknowledgements

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