Managing Intellectual Capital and Innovation for Sustainable and Inclusive Society
27–29 May 2015
Bari • Italy

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TIIM

Management, Knowledge and Learning
Joint International Conference 2015
Technology, Innovation and Industrial Management

APPLY THE ANALYTIC HIERARCHY PROCESS METHOD FOR SELECTING SUPPLIER IN AUTOMOTIVE BUSINESS

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Abstract:
In Thailand automotive industrial have many suppliers who have a capability to produce the components for car manufacturer. Supplier selection is an important process while trying to maintain long term relationships between automobile industry and part manufacture, suitable vendor chosen be select based on individual product characteristic. However, currently most of automobile factory emphasize on three criteria for supplier evaluations: cost, quality and delivery by given each criteria the same priority. This leads to a problem in shop floor where each product is used in different manner. The requirement on part performances is different among product. Therefore, it is better to find a way to identify priority among criteria or sub-criteria based on the operation requirement of each part. In this research, Japanese car manufacturer has been selected as a test case. Therefore, to be able to objectively evaluate supplier performance, the method need address and eliminate subjectively assessment. In this research, the analytic hierarchy process (AHP) method is applied to determine priority in selection suppliers with multiple criteria that's related with the key factors like quality, cost and delivery which have been used for decision making of the main commodity category such as steel bracket, frame, suspension and chassis that are covering more than 90% of metal parts.

Keywords: analytic hierarchy process, supplier evaluation, supplier selection, multi-criteria evaluation

1. INTRODUCTION

In Thailand automotive industrial have many suppliers who have a capability to produce the components for car manufacturer. Supplier selection is an important process while trying to maintain long term relationships between automobile industry and part manufacture, suitable vendor chosen be select based on individual product characteristic. However, currently most of automobile factory emphasize on three criteria for supplier evaluations: cost, quality and delivery by given each criteria the same priority. This leads to a problem in shop floor where each product is used in different manner. The requirement on part performances is different among product. Therefore, it is better to find a way to identify priority among criteria or sub-criteria based on the operation requirement of each part. In this research, Japanese car manufacturer has been selected as a test case. There are many criteria that are related with supplier selection, different companies have a different specification to evaluate supplier. This is not an easy decision the criteria which is the suitable for company, It depends on the performance measurement and content that will be selected for the evaluation which is the 1st 2nd and 3rd priority to be given on each criteria. Therefore, to be able to objectively evaluate supplier performance, the method need address and eliminate subjectively assessment.

2. BACKGROUND

2.1. Supplier selection

To select supplier, the critical decision making activity to obtain competitive advantage and achieve supply chain objective. To achieve the business goal we should apply the best method for selecting supplier to give more accuracy, analyzing and solving supplier selection problem (Liao, C.N. and Kao, H.P, 2010). Basically the step in supplier rating procedure is to establish the criteria for supplier selection. According to Liu and Hai, (2005), there are many criteria for supplier evaluation and selection based various articles with an example case of 60 respondents and the criteria obtained from group decision are separated into 8 categories, Quality, Delivery, Responsiveness, Technical capability, facility and Financial. (Ping-Shun Chen and Ming-Tsung Wu., 2013) used MFMEA method selects six criteria such as cost, quality, delivery, service, technology and productivity. Other criteria from other research are general management capability perspective, manufacturing capability perspective, collaboration capability perspective and agility perspective (Kozan, M. K et. al., 2006; Che, Z. and Wang, H, 2008).

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2.2. Multiple criteria evaluation methods

The multiple criteria have to be given the score that must be used on the evaluation in tern of several objectives. The purpose of the value model is to take to outcomes of each criterion, determine the degree to which they satisfy each of the objectives and then make the necessary to arrive on the ranking for each alternative will be used for decision making.

Hierarchy is a powerful way of classification used by the mind to order information gained from experience or from our own thinking to understand the complexity of the business around us according to the order and distribution of influences that make certain outcomes happen (Saaty, T.L. and Shin, H.S., 2009). Decisions do not occur in isolation there are all sorts of influence that affect the potential outcome of a decision. It can all be regarded as a network of influences of which hierarchies are a special case. To make comparisons, we need a scale of numbers that indicates how many times more important or dominant one element is over another element with respect to the criterion or property with respect to which they are comparing (Saaty,T.L., 2008)

The AHP provided a simple but theoretically sound multiple criteria methodology for evaluating alternatives. The strength of the AHP likes in its ability to structure a complex, multi person and multi attribute problem hierarchically and to investigate each level of the hierarchy separately by combining the results as the analysis progresses (Fuh-Hwa, Franklin Liu and Hui Lin Hai., 2004). The AHP generates relative ratio scales of measurement. The measurement of a set of objects on a standard

scale can be converted to relative scale measurements through normalization (Saaty,T.L., 2008). The normalization and composition of weight of alternative with respect to more than a single criterion measured on the same standard scale leads to nonsensical numbers. The weights must first be composed with respect to all such criteria and then normalized for AHP use.

The level of hierarchy describes a system from the lowest level sets of alternatives through the intermediate levels of criteria and sub criteria to the highest level, general object. Using the AHP methodology, priorities of alternatives are estimated independently for every criterion at each level and the weight of each criterion level.

3. ANALYSIS AND RESULTS

3.1. Supplier Criteria Evaluation

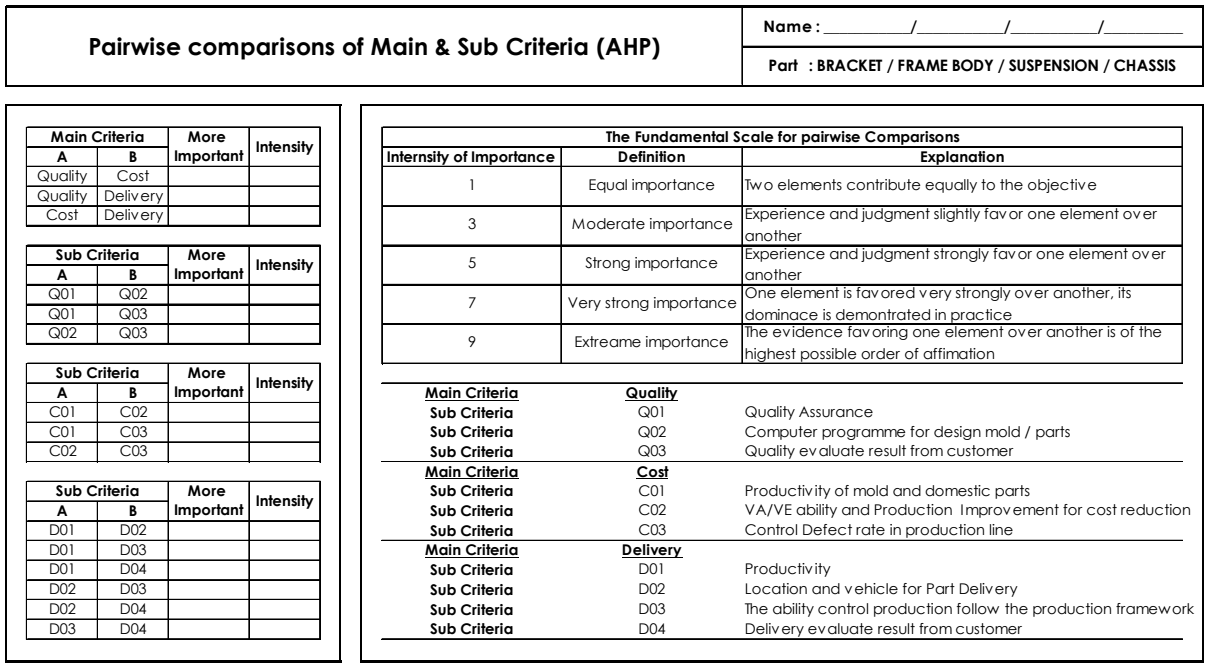
At automobile manufacturer, purchasing department use three main criteria and ten sub-criteria for supplier evaluation. These criteria and sub-criteria are applied to all commodities with the same level of priority (All weight of each main criteria is equal including weight of all sub-criteria). The main criteria are Quality (Q), Delivery (D) and Cost C). The sub criteria are quality assurance (Q01), computer programed for design mold / parts (Q02), quality evaluation from customer (Q03), productivity (D01), location and vehicle for part delivery (D02), ability to control production according to plan (D03) delivery evaluation from customer (D04), productivity of mold and domestic parts (C01), VA/VE ability and production improvement (C02), defect control in production line (C03).

In this research the analytical hierarchy process (AHP) is used to identify and rank the significance of criteria and sub-criteria for four major parts: 1) steel bracket, 2) frame body, 3) suspension and 4) chassis by using pairwise comparison method as shown in Table 1-2.

Table 1: Pairwise comparison scale

Intensity of Importance	Definition	Explanation
1	Equal importance	Two elements contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favor one element over another
5	Strong importance	Experience and judgment strongly favor one element over another
7	Very strong importance	One element is favored very strongly over another, its dominance is demonstrated in practice
9	Extreme importance	The evidence favoring one element over another is of the highest possible order of affirmations

Figure 1: Pairwise comparison form using in this research



Pairwise comparisons of Main & Sub Criteria (AHP)

Name : _____/_____/_____/_____

Part : BRACKET / FRAME BODY / SUSPENSION / CHASSIS

Main Criteria		More Important	Intensity
A	B		
Quality	Cost		
Quality	Delivery		
Cost	Delivery		

Sub Criteria		More Important	Intensity
A	B		
Q01	Q02		
Q01	Q03		
Q02	Q03		

Sub Criteria		More Important	Intensity
A	B		
C01	C02		
C01	C03		
C02	C03		

Sub Criteria		More Important	Intensity
A	B		
D01	D02		
D01	D03		
D01	D04		
D02	D03		
D02	D04		
D03	D04		

The Fundamental Scale for pairwise Comparisons		
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Main Criteria	**Quality**	
Sub Criteria	Q01	Quality Assurance
Sub Criteria	Q02	Computer programme for design mold / parts
Sub Criteria	Q03	Quality evaluate result from customer
Main Criteria	**Cost**	
Sub Criteria	C01	Productivity of mold and domestic parts
Sub Criteria	C02	VA/VE ability and Production Improvement for cost reduction
Sub Criteria	C03	Control Defect rate in production line
Main Criteria	**Delivery**	
Sub Criteria	D01	Productivity
Sub Criteria	D02	Location and vehicle for Part Delivery
Sub Criteria	D03	The ability control production follow the production framework
Sub Criteria	D04	Delivery evaluate result from customer

Table 2: Summary of Main Criteria Pairwise Comparison

		BRKT		FRAME		SUSPENSION		CHASSIS	
Main Criteria		More Important	Intensity	More Important	Intensity	More Important	Intensity	More Important	Intensity
A	B								
Quality	Cost	A	5	A	3	A	3	A	3
Quality	Delivery	A	3	B	3	A	5	A	5
Cost	Delivery	B	3	B	5	A	3	A	3

Table 3: Example of Sub-criteria Pairwise Comparison

		BRKT		FRAME		SUSPENSION		CHASSIS	
Sub Criteria		More Important	Intensity	More Important	Intensity	More Important	Intensity	More Important	Intensity
A	B								
Q01	Q02	A	5	A	3	A	1	A	1
Q01	Q03	A	3	A	5	B	3	B	3
Q02	Q03	B	3	A	3	B	3	B	3

The next step is the calculation of a list of the relative weights, importance, or value, of the factors. In this case, Saaty's Analytic Hierarchy Process weight calculation method is used to identify both weights of main criteria and sub criteria as shown in Table 4. The AHP structure the weight of each main criterion and sub criteria, each criterion will be estimated and determined by using the

measurement or experimentation of team and finally the bottom level of the hierarchy contains the alternatives will be given the weight and the result of all part categories.

Table 4: Weights of the 10 sub criteria of all cases

Main Criteria	Sub Criteria	Weight			
		Steel Bracket	Steel Frame	Suspension	Chassis
Quality 0.6369	A01	0.406	0.159	0.127	0.165
	A02	0.067	0.065	0.127	0.067
	A03	0.165	0.026	0.382	0.406
Cost 0.1048	A04	0.025	0.010	0.027	0.052
	A05	0.009	0.024	0.066	0.052
	A06	0.070	0.061	0.165	0.155
Delivery 0.2583	A07	0.023	0.172	0.021	0.021
	A08	0.012	0.370	0.008	0.008
	A09	0.071	0.077	0.021	0.021
	A10	0.152	0.036	0.055	0.055
	Sub Total	**1.000**	**1.000**	**1.000**	**1.000**

3.2. Supplier Selection

This step requires the team (subjects in this research) to assess the performance of all suppliers on the ten sub criteria identified in previous step. Team agrees to identify all performance score would be based on five points grade scale as shown in Table 5 for each sub-criteria.

Table 5: Supplier criteria score guideline

Grade	Very dissatisfied	Poor	Acceptable	Good	Very satisfied
Scores	1	2	3	4	5

Once the score is given by team for all sub criteria factors the result would be calculated by “Weight x Score” and the supplier rating is equivalent to the summation of sub-criteria score as shown in Table 6. The highest total score of all sub criteria among all candidates should be regarded as the best performing supplier and would be selected to be supply base of each commodity and in this case

Table 6: Example of Supplier Rating Score for steel bracket

Main Criteria	Sub Criteria	Weight	Supplier 1		Supplier 2		Supplier 3	
			Scores	Sub-Total	Scores	Sub-Total	Scores	Sub-Total
Quality	A01	0.406	5	2.0280	4	1.6224	4	1.6224
	A02	0.067	5	0.3340	4	0.2672	3	0.2004
	A03	0.165	5	0.8225	4	0.6580	4	0.6580
Cost	A04	0.025	5	0.1270	3	0.0762	3	0.0762
	A05	0.009	5	0.0460	4	0.0368	4	0.0368
	A06	0.070	5	0.3510	5	0.3510	5	0.3510
Delivery	A07	0.023	4	0.0912	4	0.0912	5	0.1140
	A08	0.012	3	0.0366	3	0.0366	5	0.0610
	A09	0.071	5	0.3560	5	0.3560	5	0.3560
	A10	0.152	5	0.7605	5	0.7605	5	0.7605
		1.000	47.000	4.953	41.000	4.256	43.0	1.236

4. CONCLUSION AND DISCUSSION

In this research, four part categories (Steel bracket, Steel frame, Suspension and Chassis) which represents about 90% of metal parts are used to test AHP application for supplier selection. The three main criteria are quality, cost and delivery along with the ten sub criteria are used to evaluate supplier performance. But unlike current evaluation system, where only main criteria with equal weight is applied. In this research, AHP is used to identify priority among criteria and sub criteria in order to identify suitable supplier for a given product based on the characteristic of product.

Table 7: Weight and rank (priority comparison) between current supplier evaluation and AHP technique

Category	Current weight			New weight		
	Supplier 1	Supplier 2	Supplier 3	Supplier 1	Supplier 2	Supplier 3
Steel Bracket	4.750	4.083	4.222	4.953	4.256	4.236
Steel Frame	4.917	4.583	4.611	4.826	4.766	4.406
Suspension	4.917	4.611		4.978	4.877	
Chassis	4.056	4.167		4.137	4.113	

Category	Rank			Score		
	Supplier 1	Supplier 2	Supplier 3	Supplier 1	Supplier 2	Supplier 3
Steel Bracket	Same	Up	Down	0.203	0.173	0.014
Steel Frame	Same	Up	Down	(0.091)	0.182	(0.205)
Suspension	Same	Same		0.061	0.266	
Chassis	Up	Down		0.081	(0.054)	

Comparing with the current weight of each criterion with the result of using the analytical hierarchy process to determine the new weight, we found the evaluation result is totally different for each commodities table 5., the result shows that the weight of key factors are different, in case of Steel bracket, Suspension and chassis show the quality is the most important factor for evaluation, steel frame the most important factor is delivery, therefore each part categories have their own key factor and weight of each criteria up to the result team discussion that input into the analytical hierarchy process. The table 6 shows the result of supplier selection in tern of ranking and score that would be changed under applying the new weight of main criteria and sub criteria in table 5. All part categories have a changing of score such as steel bracket and suspension all suppliers are given the higher performance comparing with the current weight, steel frame supplier 2 is given the higher performance but supplier 1 and 3 are given the lower performance and chassis supplier 1 is given the higher performance but supplier 2 is given the lower performance compare with the current one. In tern of ranking, chassis is the only product that that effect directly to the business that will be given to supplier because under the new weight criteria supplier 1 performance is over the supplier 2 that is different from the result of using the current weight.

In conclusion, this research apply the multi-criteria decision making technique (AHP) for supplier selection in automobile industry. By applying AHP, weight (priority) of each factor are more than the current criteria priority leading to better supplier selection.

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