Selection of Attribute Combinations of SSW Wheels using QFD and ANP Super Decision at PT. Stamford Tyres Distributor Indonesia (PT. STDI)

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Abstract. The selection of attribute combinations of SSW wheels is very important to avoid errors in the procurement of goods, so it is necessary to select a model using a methodological-based processing process. This study uses Quality Function Deployment (QFD) based on Voice of Customer (VoC) and Analytic Network Process (ANP) Super Decision to determine the order of selecting the best combination of SSW wheels. The criteria for selecting of attribute combinations of SSW wheels consist of four, namely models/designs (A), specifications (B), weight (C), color finishing (D) and the sub criteria for good model/design (A_1), poor model/design (A_2), good specifications (B_1), poor specifications (B_2), light weight (C_1), heavy weight (C_2), special color finishing (D_1) and standard color finishing (D_2). The criteria and the results obtained showed that criteria models/designs were selected as the first rank and follow by specifications, weight, and color finishing. The sub criteria and the results obtained showed that combination good model/design, good specification, lightweight, and special color finishing ($A_1B_1C_1D_1$) was selected as the first choice because all the sub-criteria were good, and the last choice is combination of poor model/design, poor specification, heavy weight, and standard finishing ($A_2B_2C_2D_2$) because all the sub-criteria were not good.
Keywords: Attribute, QFD, Super Decision, Voice of Customer, Wheels

Introduction

Procurement is a pro-active and strategic corporate activity to ensure a continuous supply of goods and services to enable world-class organizational performance [1]. Procurement of goods, in this case SSW wheels, requires several competencies, namely being able to predict the wheel model or design, wheel specifications, wheel color, and wheel weight which will become a trend according to market demand so that it will provide good sales for PT. STDI. In addition, it should be noted regarding the brand position with similar competitors. With the existing limitations, PT. STDI only has one source for procuring SSW wheels, namely the SSW wheel factory in Thailand, so an in-depth analysis and selection is needed regarding the limitations that exist from supply chain sources.

The process of analysis and selection is needed to choose the best option from these limitations while considering market desires. The process of procuring SSW wheels by PT. STDI so far has only relied on individual perspectives that play a role in the process of procuring SSW wheels and not based on survey data or user wish questionnaires (Voice of Customer). PT. STDI with limitations in supply chain sources must continue to procure the best goods to obtain sales in the market.

PT. STDI can determine the best option from several alternatives available from limited supply chain sources based on the wants and needs of the car wheel market in Indonesia.

This research will examine the selection approach for selecting SSW wheels at PT. STDI uses a combination of Quality Function Deployment (QFD) and Analytical Network Process (ANP) Super Decision. First, starting by collect the Voice of Customer (VoC) through questionnaires, then designing the QFD by using House of Quality. Since the voice of the customer (VoC) could be of core importance for an organisation's success, it is of high significance to identify the motivating and demotivating factors that influence the customers' intention to provide or not to provide feedback on service quality

[2]. The goal of QFD is to identify customer needs and ensure that those needs are accommodated effectively in the product design. Designers and planners in a QFD system are led to focus on the product attributes that are most important to the customer it involves [3]. Conventionally, VoC is extracted as input from QFD through customer survey methods, questionnaires, and interviews [4].

After finding what the customer needs in QFD then proceed with ANP Super Decision to determine the rank of attribute combination of SSW wheels. Analytical Network Process (ANP) is a problem-solving method that depends on the relationship between elements. The concept of ANP was developed from AHP theory which is based on the interdependence relationship between several components. AHP allows interaction and feedback from elements within a cluster (inner dependencies) and between clusters (outer dependencies). AHP is expected to reduce errors for system users in making decisions [5].

Methods

The method of collecting data in this study, namely using survey methods or questionnaires to correspondents that including old customers, potential customers, and sales team. STDI. The questionnaire will contain the level of customer preference in deciding to buy SSW. After received data from correspondents then proceed with validity and reliability test to see which data that valid and reliable that will be used for processing data using by QFD and ANP Super Decision.

23.1. QFD

In QFD there are 3 main stages namely.

a. Voice of Customer (VoC) collection stage
b. The stage of preparing a quality house, House of Quality (HOQ)
c. Analysis and interpretation stage

House of Quality (HOQ) is part of QFD which uses a series of matrix diagrams that resemble connected houses [6]. The first matrix, dubbed the house of quality, transforms customer requirements into product design characteristics. As shown in Figure 1, the quality house has six sections: customer requirements section, competitive assessment section, design characteristics section, relationship matrix, trade-off matrix, and the target values section.

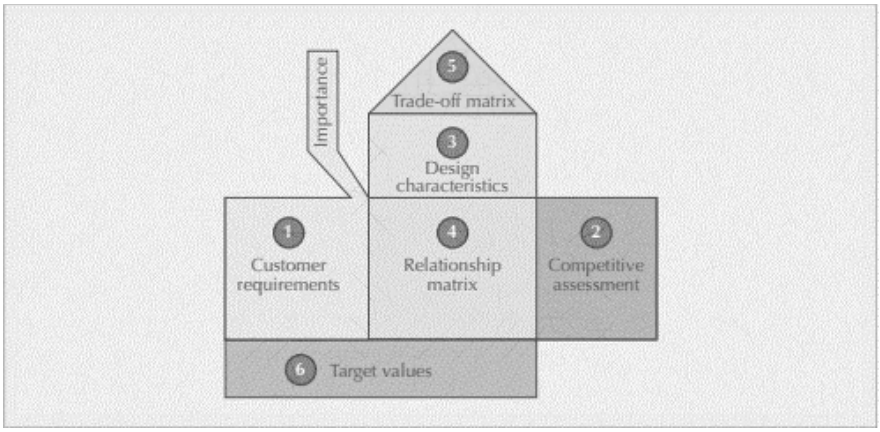

Figure 1. House of quality (HOQ) matrix [5]

Matrix target values is the target to be achieved from this Quality Function Deployment process which uses the House of Quality as a matrix in concluding and finding solutions.The QFD method has become a reliable method in quality improvement research, which is based on the attributive classification of customer needs based on esthetic perception, enabling product improvement to increase customer satisfaction [7].

23.2. ANP

ANP turns the decision problem into a network and performs pairwise comparisons to weight network elements and rank alternatives. Only one-way hierarchical relationships are represented with AHP. ANP allows for multifaceted relationships between decision levels and attributes. The steps involved in the Analytical Network Process (ANP) are presented below [8];

1. Identification of criteria and sub-criteria for ranking alternatives.
2. Build the ANP model.
3. Level of preference.
4. Do pairwise comparisons to determine priority criteria and sub-criteria.
5. Do pairwise comparisons to determine the priority of alternatives.
6. Check for inconsistency ratios.
7. Create an unweighted, weighted, and limit matrix.
8. Rank the alternatives according to the priorities synthesized.

ANP considers the relationships among criteria, drawing a complex network that can help in reducing subjectivity and uncertainty [9]. ANP technique has the advantage of working with tangible and intangible elements by considering the interdependencies among them [10]. Super Decision implements the Analytic Network Process developed by Professor Thomas Saaty [11]. Super Decision which is used for decision making with dependence and feedback. Super decision itself is an Open Source based enterprise management software. This software is used to make decisions with dependencies and feedback (implementing analytical network processes with various additions) that often occur in companies.

Results and Discussions

The results of the questionnaires distributed to 40 correspondents with a return response of 34 questionnaires or 85%. The results of the questionnaire that has been tested for validity and reliability can be seen in Table 1.

Table 1. The results of questionnaires

Statement	Code	Score	Result
The model / design of the wheel is more important than the specification of the wheel	MD_1	64.71%	Agree
The model / design of the wheel is more important than the color of the wheel	MD_2	71.18%	Agree
Wheel specifications are more important than wheel weight	S_3	77.06%	Agree
Wheel weight is more important than wheel specifications	W_2	51.76%	Neutral
Wheel weight is more important than wheel color	W_3	62.35%	Agree
Wheel color is more important than the wheel model / design	CF_1	51.18%	Neutral
Wheel color is more important than wheel specification	CF_2	48.24%	Neutral
Wheel color is more important than wheel weight	CF_3	61.18%	Agree

On the Table 1, the score range start from 0% until 19.9% for strongly disagree, 20% - 39.9% for disagree, 40% - 59.9% for neutral, 60% - 79.9% for agree and 80% - 100% for strongly agree. The results from correspondent's opinion agree that the model / design of the wheel is more important than specification and color with score 64.71% and 71.18%, the specifications are more important than wheel weight with score 77.06% then the wheel weight is equally as important as the wheel color with score

62.35% for weight and 61.18% for wheel color. Another three statements result neutral with score around 50% range.

3.1 QFD

Based on the results in Table 1, this research is continued using QFD by determining matrix number 1 for the HOQ, namely customer needs (what) which are the four criteria of the SSW wheel combination, namely models/designs (A), specifications (B), weight (C), color finishing (D) and arrange them according to the level from the highest to the lowest. The highest level is models/designs with score 5 then specifications with score 4 then weight and color finishing with same score 3.

Row #	Weight Chart	Relative Weight	Customer Importance	Maximum Relationship	Customer Requirements (Explicit and Implicit) \ Functional Requirements	Developing New Design based on market demand	A356	Lower cost production	Made in Thailand	Promoting brand through social media, etc	Developing spesifiations based on market demand	Developing colors based on market demand	Casting, Low Pressure, Flow Forged	Developing lightweight designs
1	||| 14%	5	9	Design up to date	●		○		○	●	●	○	○
2	||| 14%	5	9	Good materials quality	○	●	▽	●	●	○	○	○	●
3	||| 14%	5	9	Affordable price	○	○	●	▽	▽	○	○	●	●
4	||| 11%	4	9	Manufacturing Country	○		○	●	●	○	▽	▽	○
5	||| 11%	4	9	Brand reputation	●	○	○	●	●	○	●	●	○
6	||| 11%	4	9	Spesification	●	○	○		○	●	●	○	●
7	||| 8%	3	9	Good finishing / colors	●		●	●	○	●	●	▽	○
8	||| 8%	3	9	Manufacturing Technology	○	▽	●	●	○	○	●	●	●
9	||| 8%	3	9	Weight	●	●	●	●	○	●	▽	●	●
					Target	Developing New Design based on market demand	A356	Lower cost production	Made in Thailand	Promoting brand through social media, etc	Developing spesifiations based on market demand	Developing colors based on market demand	Casting, Low Pressure, Flow Forged	Developing lightweight designs
					Max Relationship	9	9	9	9	9	9	9	9	9
					Technical Importance Rating	616,67	316,67	505,56	563,89	488,89	550	577,78	511,11	633,33
					Relative Weight	**13%**	7%	11%	**12%**	10%	**12%**	**12%**	11%	**13%**

Figure 2. The House of Quality (HOQ) in QFD analysis

Based on Figure 2, the target rank for HOQ first are developing new design base on market demand and developing lightweight design with relative weight 13% then developing specifications and colors based on market demand with relative weight 12%.

3.2 ANP Super Decision

ANP Super Decision starting by make combinations from four criteria of SSW wheel. The 16 combinations shown in Table 2.

Table 2. The combinations of four attributes of SSW wheel

No	Combination	M/D	Specification	Weight	Color Finishing
1	$A_1B_1C_1D_1$	Good	Good	Light	Special
2	$A_2B_1C_1D_1$	Less	Good	Light	Special
3	$A_1B_1C_1D_2$	Good	Good	Light	Standard
4	$A_2B_1C_1D_2$	Less	Good	Light	Standard
5	$A_1B_1C_2D_1$	Good	Good	Heavy	Special
6	$A_2B_1C_2D_1$	Less	Good	Heavy	Special
7	$A_1B_1C_2D_2$	Good	Good	Heavy	Standard
8	$A_2B_1C_2D_2$	Less	Good	Heavy	Standard
9	$A_1B_2C_1D_1$	Good	Less	Light	Special
10	$A_2B_2C_1D_1$	Less	Less	Light	Special
11	$A_1B_2C_1D_2$	Good	Less	Light	Standard
12	$A_2B_2C_1D_2$	Less	Less	Light	Standard
13	$A_1B_2C_2D_1$	Good	Less	Heavy	Special
14	$A_2B_2C_2D_1$	Less	Less	Heavy	Special
15	$A_1B_2C_2D_2$	Good	Less	Heavy	Standard
16	$A_2B_2C_2D_2$	Less	Less	Heavy	Standard

These combinations will be used as alternatives in ANP Super Decision besides that this research determines the objectives and criteria of the ANP Super Decision. The objective of this paper is to determine the rank from highest to lowest for attributes combination of SSW wheel. The criteria are models/designs (A), specifications (B), weight (C), color finishing (D).

ANP Super Decision software version 3.2.0 shown in Figure 3 that consist of network with node and judgments pairwise comparison.

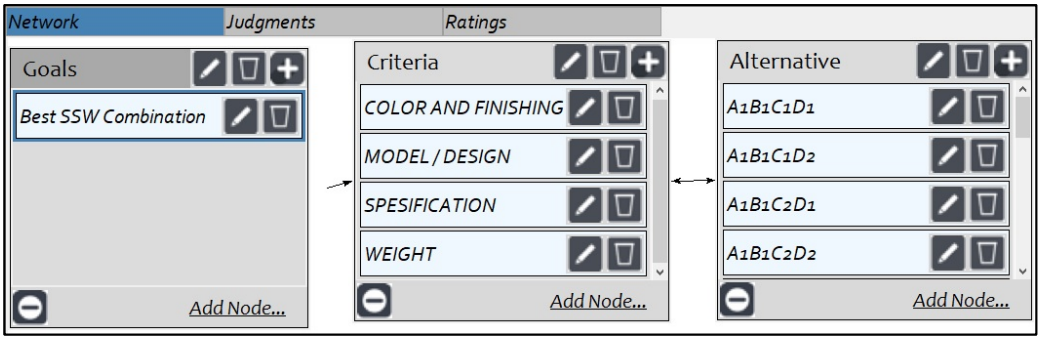

Figure *3*. Network Process of ANP Super Decision Software

After running computations of ANP Super Decision, the result is importance rank for criteria and attributes combinations of SSW wheel as shown in Table 3 and Table 4.

Table 3. The result of ANP Super Decision for Criteria

Criterias	Normalized by Cluster
Models/Designs	0.27576
Spesifications	0.24774
Weight	0.24537
Color Finishing	0.23113

The criteria and the results obtained showed that criteria models/designs was selected as the first rank and follow by specifications, weight, and color finishing.

Table 4. The result of ANP Super Decision for Attributes

Alternatives	Total	Normal	Ideal	Rank
$A_1B_1C_1D_1$	0.0911	0.1821	10.000	1
$A_1B_2C_1D1$	0.0497	0.0993	0.5452	2
$A_2B_1C_1D_1$	0.0497	0.0993	0.5452	3
$A_1B_1C_1D_2$	0.0493	0.0985	0.5409	4
$A_1B_1C_2D_1$	0.0492	0.0985	0.5407	5
$A_2B_1C_1D_2$	0.0258	0.0517	0.2837	6
$A_1B_2C_1D_2$	0.0255	0.0509	0.2796	7
$A_2B_2C_1D_1$	0.0253	0.0505	0.2775	8
$A_1B_1C_2D_2$	0.0253	0.0505	0.2775	9
$A_1B_2C_2D_1$	0.0253	0.0505	0.2775	10
$A_2B_1C_2D_1$	0.0250	0.0501	0.2749	11
$A_2B_1C_2D_2$	0.0133	0.0265	0.1455	12
$A_2B_2C_2D_1$	0.0129	0.0257	0.1413	13
$A_2B_2C_1D_2$	0.0129	0.0257	0.1413	14
$A_1B_2C_2D_2$	0.0129	0.0257	0.1413	15
$A_2B_2C_2D2$	0.0071	0.0142	0.0782	16

The sub criteria and the results obtained showed that $A_1B_1C_1D_1$ was selected as the first choice because all the sub-criteria were good and the next rank was respectively $A_1B_2C_1D_1$, $A_2B_1C_1D_1$, $A_1B_1C_1D_2$, $A_1B_1C_2D_1$ with 3 sub-criteria were good and 1 sub-criteria was not good, then follow by $A_2B_1C_1D_2$, $A_1B_2C_1D_2$, $A_2B_2C_1D_1$, $A_1B_1C_2D_2$, $A_1B_2C_2D_1$, $A_2B_1C_2D_1$ with 2 sub-criteria were good and 2 sub-criteria was not good, then follow by $A_2B_1C_2D_2$, $A_2B_2C_2D_1$, $A_2B_2C_1D_2$, $A_1B_2C_2D_2$ with 1 sub-criteria was good and 3 sub-criteria were not good, and the last choice is $A_2B_2C_2D_2$. This ranking order is the basis for consideration in procuring SSW wheels when faced with several choices of SSW wheels with different combinations of attributes.

Conclusion

This research has successfully determined the rank of preference Voice of Customer on selecting SSW wheels through questionnaires and QFD. House of Quality helps QFD analysis to determine the target design. The last process ANP Super Decision determines the best selection of attributes combinations of SSW wheels with the rank details from highest to the lowest choices. The advantage of combining

SSW wheels with detailed rank is to directing the procurement of goods according to the interests of the customer's voice when faced with choices of SSW wheels with different combinations of attributes by prioritizing combinations that have a higher rank and avoid combinations that have a lower rank. The conducted study, although providing valuable insights, has several limitations which should be noted such as there are still not enough expert correspondents who don't buy SSW wheels to represent the voice of the customer. Some suggestions for further research, such as included expert correspondents who did not purchase SSW, entering the attribute selling price / market price positioning based on competition with competitors who have not been included in this study, fashion trend factors that can be included for future research and more in-depth research to compare the attributes of SSW wheels combinations that have the same rank.

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