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Product Development Of Knock-Down Wardrobe Using Combination Of Quality Function Deployment And Value Analysis (QFDVA) Tools

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Abstrak

Proses Quality Function Deployment (QFD) mengkuantifikasikan kebutuhan eksplisit dan implisit dari konsumen, menghubungkan kebutuhan tersebut dengan engineering requirements. Proses Value Analysis (VA) membuat alokasi sumber daya secara optimal menurut level kepentingan dari fungsi produk. Dengan mengkombinasikan aplikasi tools QFD dan VA, yang dinamakan QFDVA, maka akan mungkin membuat alokasi biaya yang optimum untuk setiap engineering requirements yang sesuai dengan kebutuhan konsumen. QFDVA juga memungkinkan evaluasi biaya dari setiap fungsi produk. Lebih jauh lagi, metodologi QFDVA dapat digunakan untuk mendukung pengambilan keputusan dalam pengembangan produk dan meningkatkan nilai dari produk tersebut. Penelitian skripsi ini menerapkan QFDVA pada pengembangan produk lemari pakaian di PT. XYZ. Penerapan QFDVA dilakukan dengan menggali setiap kebutuhan implisit dan eksplisit dari konsumen terhadap produk, mengetahui tingkat kepentingan setiap kebutuhan dan menerjemahkannya ke dalam engineering requirements, serta menentukan alokasi biaya yang optimum untuk memenuhi setiap kebutuhan konsumen. Penerapan QFDVA ini telah meningkatkan nilai produk lemari pakaian dari sisi pemenuhan terhadap kebutuhan konsumen dan sisi pengalokasian sumber daya perusahaan untuk memenuhi kebutuhan konsumen tersebut.

Kata Kunci : *Pengembangan Produk, Quality Function Deployment (QFD), Analisis Nilai, Lemari pakaian.*

Abstract

Quality Function Deployment (QFD) process quantifies customer explicit and implicit needs, relating them with engineering requirements. Value Analysis (VA) process establishes an optimal allocation of resources according to the importance level of product functions. By combined application of QFD and VA tools, here named QFDVA, it is possible to establish optimum cost values for each engineering requirement according to the customer needs. It is also possible to evaluate the cost of each product function. Furthermore, the methodology provides a tool that supports decision making in product development and enhance value of products. This study applied QFDVA in product development of wardrobe at PT. XYZ. Application of QFDVA is done by identifying every implicit and explicit needs of the customer, finding the importance level of every needs, translating the needs into engineering requirements, and determining the optimum costs allocation to fulfill every customer needs. The application of QFDVA has improved the value of the wardrobe from the aspect of customer needs' fulfillment and company's resources allocation to fulfill the needs.

Keywords: *Product development, Quality Function Deployment (QFD), Value Analysis (VA), Wardrobe*

1. Introduction

Companies today are facing a variety of challenges, such as global competition, increased labor costs, raised customer expectations, shorter product life cycles, and increased government regulations. The older techniques of coping with short-term fixes in reactionary modes for product developments have not been enough, so

more and more companies are focusing on precautionary measures while developing their products.

By designing and manufacturing products that reflect the customer's desires and tastes, customers can see the benefits and are willing to purchase the products. However, product development not only concern about customer's needs and tastes, but also about the ability of the company to fulfill them. If both aspects are concerned well, the customer's needs will be fulfilled and the company will have a big opportunity to get the expected profit. [1]

Quality Function Deployment (QFD) process quantifies customer explicit and implicit needs, relating them with engineering requirements. On the other hand, Value Analysis (VA) process establishes an optimal allocation of resources according to the importance level of product functions. By combined application of QFD and VA tools, here named QFDVA, it is possible to establish optimum cost values for each engineering requirement according to the customer needs. It is also possible to evaluate the cost of each product function. Furthermore, the methodology provides a tool that supports decision-making in product development and enhances value of products. [2]

The goals of this study are to get the importance level of customer's explicit and implicit needs on wardrobe, to give consideration that supports decision making in product development and enhances value of products, and also to get a new product that has higher value than the similar product that has been produced before.

2. Methods

The methods of this study are:

1. Doing functional approach on the product that want to be developed (wardrobe), using Function Analysis System Technique (FAST) Diagram.
2. Making first questionnaires (half-opened) based on FAST Diagram, to identify customer's needs and wants on wardrobe.
3. The first questionnaires are filled in by women respondents as the market's target, age range by 20 until 65 years, in Bogor and Jakarta. It is important to obtain sufficient data statistically. [3]
4. The first questionnaires that have been filled in are being processed to get information of customer's explicit and implicit needs (in the form of function).
5. Making second questionnaires (in the form of pair comparison) to find the relative importance level of the customer's needs (from the first questionnaires).
6. The second questionnaires are filled in by the respondents in the same area with the first respondents. It is important to obtain sufficient data statistically.
7. The second questionnaires that have been filled in are processed in Mudge Diagram that results in relative importance percentage from every customer's need (functions).
8. Making product's engineering requirements that suits with the customer's needs.
9. Making relationship matrix that relate the customer's needs with the engineering requirements. This matrix is the important part of House of Quality in QFD first stage. In this matrix, calculations are also made as a consideration to decide product development.
10. The result of the relationship matrix is used to establish engineering requirements for the new product design.
11. Making the new product design, including size, performance, materials and accessories that are used to create the product.
12. Making relative cost for the new product design using Resource Consumption Matrix. Resource Consumption Matrix divides product's components cost in every fulfilled function. As a result, relative cost for every customer requirement can be determined.

13. Making comparison graphic between relative importance of needs with relative costs, and making calculation to determine index global value to evaluate product's value which is developed by the equation [2]:

$$IGV = 1 - \sum_{n=1}^{N} ABS(RCf - RNf) \qquad (1)$$

where :
IGV = Index Global Value
RC = Relative Cost (%)
RN = Relative Importance of Needs (%)

14. Making alternatives to improve the value of the new product design without changing the entire design, and then evaluating the value.
15. Making relative costs for similar product that has been produced by the company, using Resource Consumption Matrix.
16. Making comparison graphic between relative importances of needs with relative costs, and then calculate index global value to evaluate this old product value.
17. Making comparison between new product value and its alternatives with the old product value, from the aspects of the customer needs' fulfillment and company's costs to fulfill the needs.

The combination process of QFD and VA (QFDVA) in this study can be seen in figure 1.

3. Results and Discussion

FAST Diagram is used as a technique to identify and analyze wardrobe's functions (use function and aesthetic function). [4] FAST Diagram for knock-down wardrobe can be seen in figure 2.

The result of FAST Diagram becomes a basic for developing product, but it only sees the product's function from the side of the producer (the researcher and company). Product's development is aim and focus on the customers. Because of that, survey to the customers is needed to identify their needs and wants for the wardrobe. The survey is done through the first questionnaire.

The result of the first questionnaire is 32 functions that are needed and wanted by the customers, but not all of these functions are put in the second questionnaire, they are classified to make the fulfillment of the second questionnaire easier. The result from the functions' recapitulation can be seen in table 1.

The aim of the second questionnaire is to find the relative importance from the customer's needs and wants. This pair comparison's questionnaire is using the scale 1, 2, and 3. The bigger scale shows the more important function. The customer's scaling is processed and presented in Mudge Diagram. [2] This diagram is made for every questionnaire to make the process easier. One of the examples of Mudge Diagram can be seen in figure 3. From all of the Mudge Diagram, we obtain the weight of every function that compared to the overall weight in percentage. This percentage value represents the relative importance of every function.

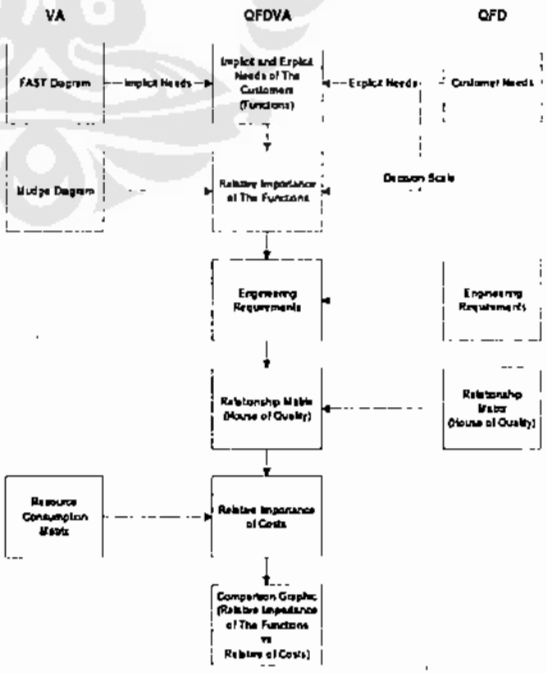

Figure 1.
QFDVA Process

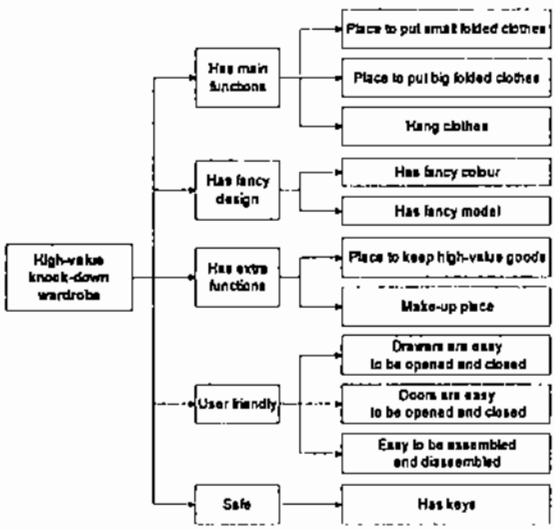

Figure 2.
FAST Diagram

Table 1.
Recapitulation of Functions

Easy to be shifted (moved, assembled and diassembled)	A
Strong (sturdy and durabely)	B
Model (shape and performance)	C
Equiped by mirror	D
Colour	E
Doors and drawers are easy to be opened and closed	F
Has keys	G
There are places to put shoes,ties,bags	H
There are places to keep high-value goods and paper	I
Hang clothes	J
Places to put big and small folded clothes	K

	A	B	C	D	E	F	G	H	I	J	K	Total
A	.	B1	A2	O2	A1	A3	G1	A2	A3	J2	A2	13
B		.	B1	B2	B1	B2	G1	B2	B2	B3	B2	16
C			.	D2	C2	C2	G3	H2	C1	J1	K2	5
D				.	D2	D2	G3	H2	D2	J1	K1	10
E					.	F1	G3	H2	E1	J1	E1	2
F						.	G3	H1	F1	J2	F1	3
G							.	G3	G3	G3	G3	26
H								.	H2	J1	H2	11
I									.	J2	I1	1
J										.	J2	12
K											.	3
												102

Figure 3.
Example of Mudge Diagram (1 questionnaire)

The functions that are needed and wanted by the customers, with their relative importance, are then elaborated more specific. It is done so that the making process of engineering requirements easier. The classified functions at the second questionnaire are elaborated.

Engineering requirements that has been made is put in the relationship matrix to be processed. In this relationship matrix, every engineering requirement is evaluated with interval linear scale 1,3,5. The bigger scale shows the bigger engineering requirements influence to the accomplishment of the customers' needs in the form of functions. [5] We also done calculation using relative importance value of every function (result of the second questionnaire) and sale points (value given by the company based on the sell ability of the functions). Result of the relationship matrix (house of quality) can be seen in figure 4.

From the relationship matrix, we obtain considerations in making the decisions of the new wardrobe development. In this study, researcher and the company decide to apply 14 engineering requirements to the new wardrobe design.

Besides considering the engineering requirements, the making of product design must also consider the efficiency of the resources that are used to make the product. For this purpose, we must consider the size and the model of the product. Result of wardrobe product design can be seen in figure 5 and figure 6.

Product must be elaborated into its components to get the cost of the product design. The cost of the components then is calculated based on material, process, and accessories that used to make the product. Products of PT. XYZ are made every 1000 product, so the cost calculation is also made in 1000 product.

To evaluate the value of the new product, we need to compare relative importance of product's function (customers' requirements) with the relative cost to fulfill the functions. Resource Consumption Matrix (RCM) divides product's components cost in every fulfilled function. From the RCM, we will obtain the relative cost to fulfill the functions that the customers need and want. [2] The result of RCM can be seen in table 2 and table 3.

The comparison of relative importance with the relative cost can be seen clearer in comparison graphic in figure 7. The way to evaluate product value is to determine how close the relative cost curve (manageable) is from the relative importance curve (unmanageable). Every different position of the both curves points depreciates the product value. The product value can be calculated by IGV equation.

Then we can make alternatives to improve the value of the new product's design without changing the entire design. The first alternative is changing accessories used, the second is reducing components used, and the third is the doing the both alternatives. These alternatives are evaluated in the same way.

Evaluation is also done to the old product that has been produced by the company. The election of the old product that will be evaluated is done based on similarities of design, process, materials and accessories. The old one is evaluated in the same way.

Old and new wardrobe (and the alternatives) are compared from the aspect of price (every 1000 product) and the value of product (IGV) based on the fulfillment of the functions needed by the customers. The comparison result can be seen in table 4.

From the table, we can see that new wardrobe design that finally has 18.53%-19.43% increase of product value compared with the old design. This is reached only with 0.51%-4.02% increase of price. Thereby, product development using combined application of QFD and VA (QFDVA) has produced product with higher value and lower price.

	Function	Customer Importance		Engineering Requirements: Shoes for wardrobe's feet	Assembly instruction	Strong and snugger knockdown	Simple design	Innovative design	Big mirror inside the wardrobe	Woody colour	Ergonomic handle	Good hasp	Good drawer rail	Keys for doors and drawers	Ties hanger (also cloak hanger)	Big drawer	Locked drawer inside the wardrobe	Big rack	Small drawer	Clothes hanger	Sum	Sale point	Weight	MW
A	Easy to be moved	3.78%	3.02%	5	1																6.00	1.5	0.27	2.85%
	Easy to be assembled and disassembled		0.76%		5	3						1	1								10.00	1.2	0.09	0.96%
B	Strong (sturdy and durable)	13.59%	13.59%	5	1	5						3	1								13.00	1.5	2.65	27.78%
C	Simple model	8.21%	5.25%																		6.00	1.2	0.50	5.98%
	Unique model		0.98%					5	3						3	1				3	15.00	1.5	0.21	2.25%
D	Equiped by mirror	3.84%	3.84%																		6.00	1.2	0.29	3.07%
E	Natural colour	3.32%	3.32%																		6.00	1.2	0.26	2.81%
F	Doors are easy to be opened and closed	9.53%	9.19%			1					5	5									11.00	1	1.01	10.58%
	Drawer are easy to be opened and closed		0.34%			1							6								8.00	1.2	0.02	0.26%
G	Has keys	13.79%	13.79%											5							5.00	1.2	0.83	8.67%
H	There is a place to put ties	7.26%	3.23%																		17.00	1.5	0.53	5.58%
	There is a place to put bags		2.42%													5		3			8.00	1	0.18	2.03%
	There is a place to put shoes		1.61%													5					5.00	1.2	0.10	1.01%
I	There is a place to keep high-value goods and papers	10.60%	10.60%											3			5				8.00	1	0.85	8.88%
J	Hang clothes	14.64%	14.64%																	5	5.00	1	0.73	7.67%
K	Place to put big folded clothes	13.43%	7.18%													3		5			8.00	1	0.57	6.02%
	Place to put small folded clothes		6.25%													1		3	5		8.00	1	0.56	5.89%
			AI	0.56	0.20	0.80	0.38	0.05	0.22	0.48	0.87	0.16	1.01	2.03	0.82	0.53	0.65	0.44	0.76	7.81		9.55	
			RI	7.07%	2.56%	10.09%	4.82%	0.63%	2.78%	6.01%	11.09%	2.03%	12.74%	22.40%	8.59%	6.70%	8.24%	5.54%	9.67%				

Figure 4.
Relationship Matrix (House of Quality)

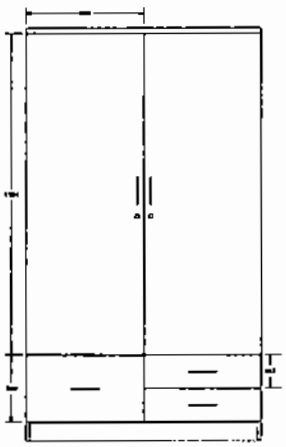

Figure 5.
Wardrobe Design (Front Side)

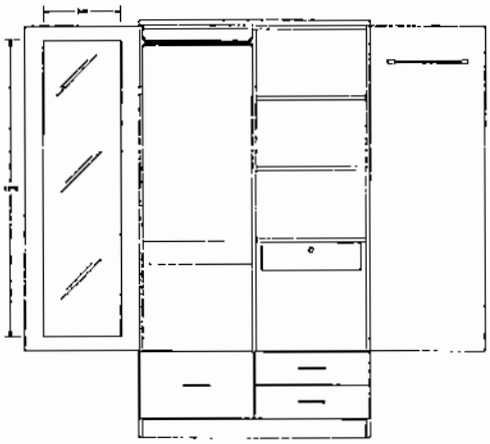

Figure 6.
Wardrobe Design (Inside)

Table 2.
Resource Consumption Matrix

		Easy to be moved	Easy to be assembled and dassembled	Strong (sturdy and durable)	Simple model	Unique Mode	Equiped by mirror	Natural colour	Doors are easy to be opened and closed	Drawers are easy to be opened and closed
NO	COMPONENTS	A		B	C		D	E	F	
1	Frame	Rp6,986,398	Rp6,986,398	Rp90,583,148				Rp6,986,398	Rp13,932,792	
2	Rack					Rp2,155,612		Rp2,155,612		
3	Profile				Rp8,499,037	Rp5,649,133		Rp649,904		
4	Door				Rp16,880,091			Rp2,180,011	Rp6,330,034	
5	Mirror					Rp2,769,520	Rp11,054,080			
6	Dowel (hanger)									
7	Tie Hanger					Rp150,000				
8	Inside Drawer							Rp1,164,396		Rp1,164,396
9	Big Outside Drawer					Rp1,214,012		Rp1,214,012		Rp1,214,012
10	Small Outside Drawer					Rp1,740,086		Rp1,740,086		Rp1,740,086
NO	ACCESORIES									
1	Spanner	Rp115,950	Rp115,950	Rp2,089,100						
2	Connecting	Rp721,000	Rp721,000	Rp12,257,000	Rp721,000					
3	Rack Pen					Rp8,000				
4	Nail			Rp225,000						
5	Cylinder Key									
6	Hasp			Rp640,000					Rp12,160,000	
7	Straight Key Pad									
8	U Key Pad									
9	Silver Plastic Handle 4C				Rp475,000	Rp237,500			Rp4,037,500	
10	Mirror Nippers					Rp480,000	Rp4,320,000			
11	Hanger									
12	Plastic Shoes	Rp990,000		Rp110,000						
13	Wood Dowel			Rp880,000						
14	Red Plastic Fisher			Rp180,000						
15	Plastic Drawer Rel									Rp4,800,000
16	Assembling Picture		Rp500,000							
17	Carton		Rp8,160,000	Rp8,160,000			Rp4,080,000			
TOTAL RELATIVE COST		Rp8,793,348	Rp16,483,348	Rp114,902,248	Rp24,575,128	Rp14,595,863	Rp19,454,080	Rp16,000,418	Rp36,460,326	Rp8,818,495
PERCENTAGE		2.11%	3.95%	27.66%	5.90%	3.50%	4.67%	3.84%	8.76%	2.14%

Table 3.
ResourceConsumptionMatrix (continued)

		Has keys	There is a place to put ties	There is a place to put bags	There is a place to put shoes	There is a place to keep high-value goods and papers	Hang clothes	Place to put big folded clothes	Place to put small folded clothes	
NO	COMPONENTS	G	H			I	J	K		TOTAL
1	Frame						Rp13,902,792			Rp139,227,917
2	Rack			Rp4,311,224		Rp2,155,612		Rp28,022,959	Rp4,311,224	Rp43,112,244
3	Profile									Rp12,928,073
4	Door	Rp12,660,068	Rp4,220,023							Rp42,200,228
5	Mirror									Rp10,817,600
6	Dowel (hanger)						Rp2,975,000			Rp2,975,000
7	Tie Hanger		Rp1,350,000							Rp1,500,000
8	Inside Drawer	Rp2,328,793				Rp18,630,341				Rp23,287,926
9	Big Outside Drawer			Rp4,858,047	Rp9,712,095			Rp4,858,047	Rp1,214,012	Rp24,280,237
10	Small Outside Drawer		Rp3,460,173						Rp28,101,295	Rp34,801,727
NO	ACCESORIES									
1	Spanner									Rp2,310,000
2	Connecting									Rp14,420,000
3	Rack Pen							Rp72,000	Rp42,000	Rp120,000
4	Nail									Rp225,000
5	Cylinder Key	Rp8,720,000				Rp2,880,000				Rp9,600,000
6	Hasp									Rp12,800,000
7	Straight Key Pad					Rp100,000				Rp100,000
8	U Key Pad	Rp285,000								Rp285,000
9	Silver Plastic Handle 4C									Rp4,750,000
10	Mirror Nippers									Rp4,800,000
11	Hanger						Rp1,500,000			Rp1,500,000
12	Plastic Shoes									Rp1,100,000
13	Wood Dowel									Rp680,000
14	Red Plastic Fisher									Rp180,000
15	Plastic Drawer Rel									Rp4,800,000
16	Assembling Picture									Rp500,000
17	Carton									Rp20,400,000
TOTAL RELATIVE COST			Rp9,050,196	Rp9,187,272	Rp9,712,095	Rp23,765,953	Rp18,407,792	Rp32,951,006	Rp31,698,532	Rp416,879,953
PERCENTAGE			2.17%	2.20%	2.33%	5.70%	4.42%	7.90%	7.60%	100.00%

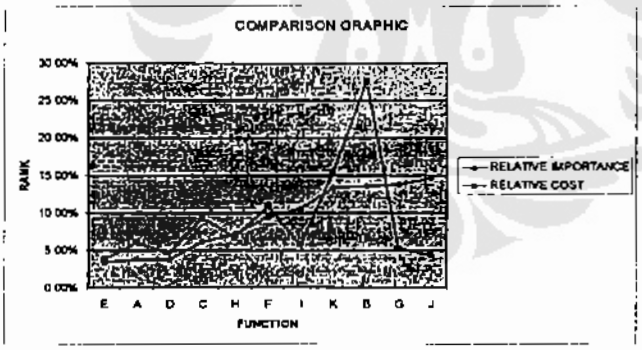

Figure 7.
Comparison Graphic (Relative Cost and Relative Importance)

Table 4.
Comparison of Price and Value of Old and New Product (every 1000 Products)

		Price	Increase of Price	IGV	Increase of Value
Old Wardrobe		Rp400,769,123.00		0.331	
New Wardrobe	Proposed	Rp416,879,952.99	4.02%	0.516	18.53%
	Alternative 1	Rp411,563,952.99	2.69%	0.522	19.10%
	Alternative 2	Rp408,137,504.10	1.84%	0.519	18.84%
	Alternative 3	Rp402,821,504.10	0.51%	0.525	19.43%

4. Conclusion

According to the goals of this study, there are some conclusion can be made :

1. There are 11 classified customer's needs to wardrobe with different level of importance.
2. Considerations that support decision making in product development and enhance value of products can be obtained from Relationship Matrix (House of Quality), Resource Consumption Matrix (RCM) and Comparison Graphic that are made as application of QFDVA.
3. From the result of product development using QFDVA, we can get new product with 18.53%-19.43% increase in product value compared to the similar product that has been produced. This is reached only with 0.51%-4.02% increase of price.

QFDVA has reached success application on wardrobe product, but it needs enough resources and time to obtain optimal result. QFDVA will be very appropriate to be applied when customers of a certain product become very demanding and when the differentiation level of a product becomes very important to them.

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