Product Design Development For Modular Computer Table To Support Green Lifecycle Engineering

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Abstract. *To win the furniture market, producer has been developing a lot of kind design variation and material to fulfill consumer needs. Until recently there is a new design trend for furniture product and design has changes a lot of time to follow the trend.*
To solve these problems, so we must develop modular design system for furniture product as the effective problem solving. In this research we use the functional base product development which is concerning the voice of customer to make. But with so many components from furniture products content, with so many forms and material variation, it is become new problem for the producer.
How to choose and pick up the material and the component with the least pollutant content. In this research the technical attribute was added to help designer making decision which product is going to be make, when the product still in preliminary ideas stage to support green lifecycle engineering. With algorithm genetic it is very helpful to find our the shortest path from assembly line for each component and the mechanism of making the computer table. The result is we find that the computer table with glass and aluminium 100% recycled is the best material for computer table with the least pollutant affected to the environment.
Further more to fit up that the product is the green product, so the product must has green material analysis. Finally we can get the design alternatives which is use the green material and can recommend which alternatives must be make first.

Keywords : *Computer Table Modular Design, Green Life Cycle Engineering, Genetic Algorithm, Green Analysis*

1. INTRODUCTION

In order to minimize the environmental burden and cost for the entire Life cycle of engineering for a product, appropriate design is needed because the whole product including its components will go to its Life cycle through the same process. For example, disassembly, maintainability, upgrades ability, reuse ability, and recycle ability (Umeda, Fukushige, Tonoike, 2008).

In this several year's community realize the importance of environmental protection and give more attention to the environment. Some indicated concern with the way people recycle a product that is damaged, how to reuse products, but how this is how long that still negatively impacts the environment (Tseng, 2008). The consumer is called "responsible consuming" urged the industry to produce a green product or they will not buy products that is produced by producers.

On the other hand, product competition that increasingly, forces producers to always make a lot of innovation and produce a tailored design to fit the market needs and trend. If manufacturers continue to make product without considering the environment

then its activity will add the burden of the environment. Therefore strategic thinking is required to consider how the end of life products and development thinking early in the design stage (Ishii, 1998) and it is very important to maximize the use of resources and minimize the damage to the environment can be incurred in the initial phase of product design will be created.

Such as this activities is called Life cycle engineering design (Otto & Wood, 2001, and Tseng, et.al., 2008). Product life cycle is the total amount of time needed from the selection of materials, manufacturing, assembly, the use by consumers, until the end of the product, and the green Life cycle activities are on the final two stages of the product use and disposal or recycle (Tseng , 2008).

Much research has been take the issues of Sustainable Product Development from among the various sides of the Design for Environment (DFE), Design for Recycle (DFR) and Design for Disasembly (DFD) (Ishii, 1998). But the facts show that the use of the structure of modular design can significantly increase the activity of product life cycle, modularity plays the most important action among all the product life cycle approach (Tseng, 2008). Module not only improve the general efficiency of the reuse and easier operational recycling (recycle), but with the modules system consumers can choose their own (by custom), to improve the ease of maintenance, ease of product diagnosis, repair, disposal and so forth (Kimura et.al, 2001).

In the case of this research study was a case study is on the product, in this case we use furniture product, modular computer tables. As already mentioned above there are many differences to measure the effectiveness of the modularity, modularity is measured in the research the most appropriate to the needs of consumers with the voice of the customer notice to find exactly what is needed and desired by consumers to indicate the level of interest "interesting", "should be have "or" one dimensional ". From the measurement of a modular approach of the seventh over, the most relevant needs and desires is a sound approach to consumer approach that is based on the first function (function-based modular design) (Tseng, 2008). Attribute-attribute of a successful vote was unearthed from the consumer and this is developed a system module design based on sound consumer, where the needs of the product needs to search critically use Quality Function Deployment (QFD) to get any technical needs that must be present in the product. Next to find the product functions in the split components and modules used method to get the FAST modules are prepared in accordance with the product functions.

The problem of this research are

1. How do I develop design for computer tables, modular products based on the needs of consumers.
2. How do I evaluate the effects on the environment component of the product that is designed, and sought the components which are most pollutant to help designers make decisions, whether the components that contain pollutant material must be replaced or must be changed on the whole components.
3. Optimization method is used to get the assembly line for each module that is optimized to shorten the distance from the assembly of each module is created.

As for research purposes who want to achieve are:

1. Develop architectural design computer desk, modular products that match consumer needs.
2. Search for product design components that cause the pollutant at least based on data from the Eco Indicator 99.
3. Pollutant reduces the value of products with a material change or change the order of component products for the architectural design for a computer desk according to the green life cycle engineering.

This research is expected to provide the following benefits helping designers to reduce the environmental burden by reducing the risk of accumulation waste products designed start the first stage of the product made. To help companies to decide the number of component modules for the most effective and produced at least pollutant cause. To optimize the function of each component module to help the consumer in adjust and develop the modules according to the needs of consumers. But in this research we make limitation of problems that are firstly this research is limited on the development of product design for industrial products, in this case are modular computer tables. And secondly the criteria to developed product design modularity are only product design for computer desk.

2. LITERATURE REVIEW

2.1 Modular Products

According to Hata, Kato and Kimura (2001), the development of modular product structure can often be reduced assembly cost and management product

family. From the point of view of manufacturing, modular are not efficient because it has multiple types of products with minor differences. Modular structure is used to re-organize a product family. However, the sharing module that is common in the product family can make production more efficient.

In addition, products with a modular structure can be more suitable for Lifecycle management compared with products that do not have a modular system. Upgrades and maintenance can also more easily done if the product has a modular functions which are designed for the standard module can be used again during the condition is still good (Hata, Kato and Kimura, 2001).

The module itself has a meaning and a goal difference. In this research, the structure of modular products for Lifecycle management structure aimed at preparing the modular product architecture is used as a method in accordance with the development of green Lifecycle engineering.

2.2 Quality Function Deployment and implementation On Product Design

QFD's come from Mitsubishi Heavy Industries Kobe Shipyard in Japan from the end of the 1960s where QFD was first used to facilitate the development of cross-functional products (Day, 1993 in Lee, Sheu and Tsou, 2008). QFD is a concept that provides a thorough comprehension of the requirement of technical requirement to obtain the right at any stage of product development and production. QFD needs triggered by two goals to each other (Sauerwein, Bailom, Matzler, Hinterhuber, 1996). The goals of this beginning of the sound consumer products and end products by the producer or to change Consumer's Voice (Voice of the Customer) to the sound engineer (Voice of the Engineer) through a matrix called the House of Quality (HOQ). HOQ's basic format consists of six activities: (1) get the attributes of consumer interests and the relationship level, (2) develop a design requirement for a consumer attributes, (3) planning matrix, (4) intercorrelation between the customer requirement and design requirement, (5) the relationship between the design requirement, and (6) action plan (Sauerwein, Bailom, Matzler, Hinterhuber, 1996)

2.3. Product Development Based on Function

All products have functions. There are always become the reasons behind the existence of a product that is a function of the product. Product features and functions of the two restrictions such as "price should be affordable", but this restriction is not part of the functionality of the product itself. What is it function? Functionality of the product is all that is required of the existence of the product that is what must be done by the product. Based on the overall function is breaking down into sub function, this process is called functional decomposition. Sub function of product is the components of the product. A function on the whole is divided into several subfungsion identified and related to the implementation of the subtask. Relationships between several sub functions and one functions on the whole set with some constraint and input-output relationship.

Influences such as certain restrictions must be observed. It is very necessary to examine the relationship between the various sub-functions, and consider logical steps, in some interconnect consistency between input and output interfaces on the system and subsystem, and the validity of the physical. Abstraction is a process regardless of what the things incidental and explain the general and essential, in short a generalization to indicate a problem.

For all basic functional method, the construction principle called "black box", called "black" because the process involved in it is still not known. Constraint becomes a statement which the boundaries of product criteria to be able to fulfilled by the product and requires the whole thinking of a product to explain the value of the criteria given.

2.4. Functional Tree using the FAST method

Method Functional Analysis System Technique (FAST) (VAI, 1993 in Otto and Wood, 2001) is used to define, analyze and understand the function of a product, how a product functions related with one another and explore the function which must be developed to get the value of the product. FAST is used to show the logical steps, to create and test the level of priority of its boundaries.

2.5.Life Cycle Design

It is important to realize that research on sustainable product Lifecycle system has been able to drastically reduce the burden of the environment, reduce resource consumption, waste management and a good standard and is able to increase profit company. For this purpose, product Lifecycle design integrates the views of:

1. Business strategies, including post-production and

services.
2. Lifecycle strategies, such as reduce, reuse, and recycling.
3. Process and Product Lifecycle
4. Lifecycle Management

Design For Environment Eco design or the existing, widely focused on aspects such as disassembly, recyclability, and reusability, and LCA (Life Cycle Assessment). The key to successful design is the accuracy of the Lifecycle election strategy Lifecycle. Lifecycle in the development of design on the product design level, there are two basic design methodologies, they are:

1. Design for upgradability

Upgrade, is an effective method of choice to extend the lifetime value of a product. This method provides a framework to upgrade and become a method for product modularity from the point of view function of a product change in the future.

2. Modular Design Tool

Modular design is a method of choice in addition to upgrading the product. By using the modular method, the components will be easier to re-organized.

3. METHODOLOGY

Next stage is the search for customer requirement using the Kano Model is used as the basics for developing modular product design.

step 1: Identify the product requirement
At this stage Kano questioner to search for product requirement with the investigation. In this phase also analyzed the need of the consumer, not just consumer desire.

Step 2: Constructions for Kano questioner

Conditions must be one dimensional, attractive requirement be classified using the questioner. For each question there are five answers that is like, must be, neutral, live with, and dislike. Consumers had been asked to select one best answer. Then they must combine the answers for two questions from the functional (positive) with questions for dysfunctional for a product(negative), the product features can be classified and arranged in a table of Kano evaluation requirement of the consumers consists of attractive (A), must be (M), Reverse (R) , One dimensional (O), questionable (Q), Indifferent (I). In the list of questioner answer, then consumers are also requested to make the rank on the use of the product.

Step 3: Administration of consumer interview
Interview using a standard questioner method and oral interview

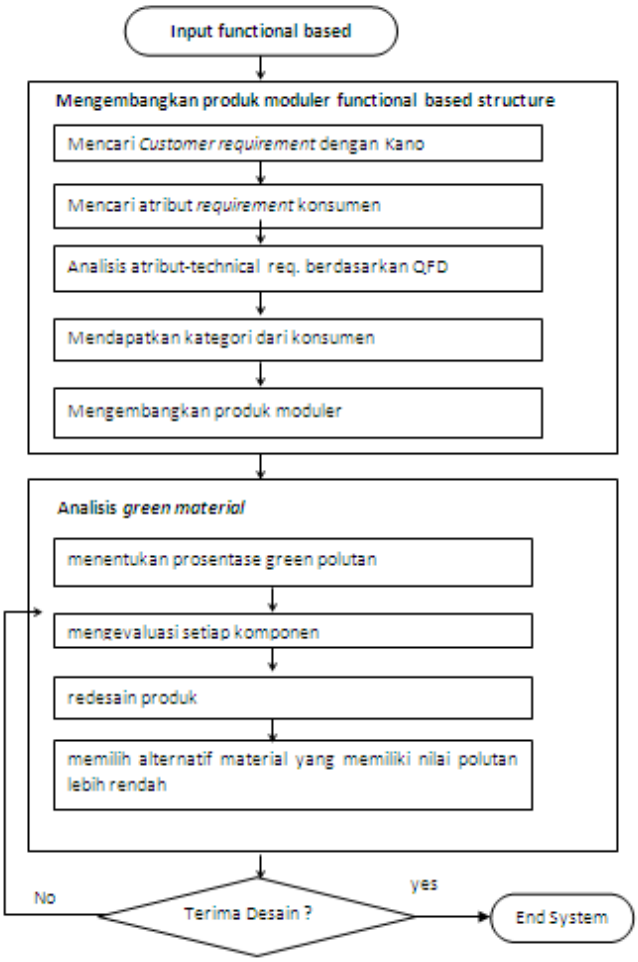


Figure 3.1 Flowchart diagram of research methodology

is the most effective method in the Kano model (Sauerwein, Bailom, Matzler, Hinterhuber, 1996).

Step 4: Evaluation and Interpretation

Questioners then evaluated in three steps, first evaluate the frequency of use and interpret the answers. Secondly evaluation rules with M> O> A> I, then the results obtained features what must have and does not need to have. This phase also sought coefficients customer satisfaction (CS Coefficient). After the specified quality improvement index (QI-Ratio) with the following formula:

QI = relative Importance x (evaluation of own product - evaluation of competitors's product)

If the value of QI is small, then the development steps must be taken. At this phase also mapped the portfolio of consumer satisfaction.

Then after we get result from Kano model, next

step is combining Kano model result and QFD are as follows. This is the methodology used to develop a green product in a modular design detail : Level 1: Develop a modular product structure based functional

Search for customer requirement with the Kano Model

Search for attribute requirement with consumers looking for a target level of customer satisfaction and customer dissatisfaction to measure the level of satisfaction and its weighting using the Kano model

Classify attribute analysis based on QFD

Obtain from the consumer category

Develop a modular product

Level 2: green material analysis Percentage green determining pollutant

Evaluate each component

Redesign product

Select an alternative material that has a value lower pollutant

4. RESULTS AND DISCUSSION

To search for data attribute ranking method used cuisine based on the Kano model, namely to get the data attributes that are really needed by the computer user's desk. This is a very important product because of computer desks that have a lot of computer components table at this time does not become a useful function for users, because the table is not able to adjust purchased with the needs of users vary. To get the attributes of this distributed randomly sample 30 respondents to the adult with the age of 20-40 years, with a minimum educational background or graduate students.
To achieve the attributes that are really important, first step is determining the attributes-attributes that are often used early in the development of computer design table. Attribute is the result of this initial discussion with the author's research and development team in the industry. The results obtained 21 attributes of the initial design of a reference desk computer. The attributes are:

1. Comfortable, with enough surface area
2. Corner of the table is not sharp
3. Strong and durable
4. Easy to move
5. Easy to install
6. Easy to arrange according to office space
7. Save place
8. Strong table covering (not easily to peel)
9. Design is support with the latest computer technology
10. Design can be arranged according to the needs of product support
11. Desk drawer
12. Cupboard storage
13. There is a special place for the keyboard
14. There is a special place for the CPU
15. There is a special place for the CD
16. There is a special place for the printer
17. There is a special place for Stavolt
18. Fixed cable tidy
19. Height of a table can be adjusted
20. Can be converted into office desk
21. Materials used are environment-friendly

Kano model is used to find the satisfaction level of users, in this Kano model explore user satisfaction with the requirement with some product categories, requirements Must Be, is this criteria can not be met, then this criteria will not be able to increase user satisfaction, if the criteria is met then the user can increase satisfaction. This must be a basic criteria of the product. One dimensional requirements, to meet this criteria, the user satisfaction will be more proportional, the higher the level of requirement is the higher level of user satisfaction and vice versa. These criteria become the actual criteria desired by the user. Attractive requirements, this criteria is the criteria which the product which has the largest influence how an attribute can increase user satisfaction, while the attribute is given on the product.

These criteria are to be expected by the user, but if this criteria is not able to be fulfilled then there is no frustration of the user. Preparation step by using the criteria Kano Model:
1. The first step: Identify the product criteria

The first step in preparing the Kano questioner criteria to search for ways to use this focus group discussion, in this case that determines the criteria are considered expert in the product development team, namely research and development of industry. The idea in this stage, the main concern is for the user's problem of what the desired user.

2. Step two: Make Questionare Kano model

Must be the criteria, one dimensional, and attractive identified with the use Questionare. For each product features a pair of questions formulated to explore the reaction from the consumer side of that is functional and dysfunctional form of Questionare. The next step is, how to combine the answers in the table such as the following evaluation, the criteria of the product can be classified as follows, if the answer to the question of the functional, such as "Do you already feel comfortable with your computer table, whether the area is enough?" And he responded "I Like" and disfungsional the question "Do you not feel comfortable with your computer desk, if the area is not enough , how you feeling? "and he replied" I can

live with that ", then a combination of answers to this category is the category A. If the answers fall on the combination of answers "I" or indifferent, it means there is a change in the criteria or not the same level in his satisfactory. Category "Q" is questionable; in this case the question asked is not understood by the user. Category "R" means the reverse, in this case, a category that is expected on the category, from the categories offered. In the questioner preparation, will be very helpful if the user requested to rank the criteria for individual products on the products they use at this time. This helps in weighting the priority of the search product development.

3. Step three: Administration of the interviews results with consumers
In this research, the methods of collecting data with the interview respondents one by one so that the level of turning back the questioner can reach 100%.

Step four: Evaluation and Interpretation

Questioner results is evaluated with four stages. to get the answers after the results from a combining the function and disfungsional answers, the overall answers will be arranged as in the table below. Rules evaluation using the Kano model is M> O> A> I. The determination of results is very important in product development, product criteria, which will affect the quality of the product. Customer Satisfaction Coefficient (CS coefficient) provides a user level of satisfaction can be improved if the criteria given product in accordance with user needs. CS coefficient indicates how strong this product features can affect the level of user satisfaction or dissatisfaction.

Calculations of satisfaction: $\frac{A + O}{A + O + M + I}$

Calculations dissatisfaction: $\frac{O + M}{A + O + M + I}$

The minus sign is put in front of the dissatisfaction CS coefficient, indicating a negative influence on the level of user satisfaction if the criteria are not met. Positive value of the CS coefficient in the range 0-1, the approximate value of 1, the higher the influence of criteria on user satisfaction. After getting the results from the calculations above, arranged to map the portfolio satisfaction criteria are most important in product development, and the criteria which need not be used in product development

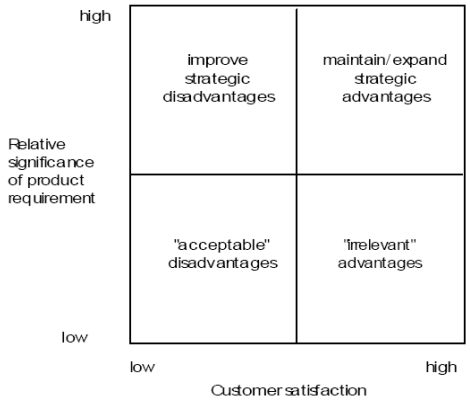
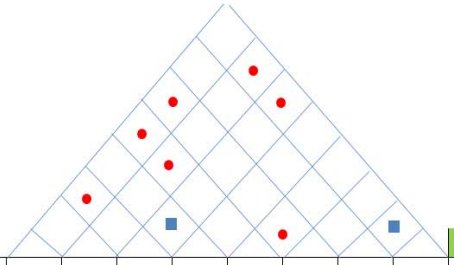


Figure 4.1 Satisfaction portfolio
(Source Homburg / Rudolf, 1995)

Table 4.1: Results from Rating Questioner With Kano Model

PRODUCT REQUIREMENT	A	O	M	I	satisfaction	dissatisfaction
CR 1		4	26		0.13	-1.00
CR 2	19	3	2	6	0.73	-0.17
CR 3	1	5	24		0.20	-0.97
CR 4	2	20	6	2	0.73	-0.87
CR 5	7	23			1.00	-0.77
CR 6	4	15	11		0.63	-0.87
CR 7	5	13	11	1	0.60	-0.80
CR 8	6	5	1	15	0.37	-0.20
CR 9	8	2	2	16	0.33	-0.13
CR 10	4	3	1	14	0.23	-0.13
CR 11	3	4	2	14	0.23	-0.20
CR 12	3	2	3	13	0.17	-0.17
CR 13	12	8	10		0.67	-0.60
CR 14	5	6	7	12	0.37	-0.43
CR 15	6	7	6	11	0.43	-0.43
CR 16	9	7	4	10	0.53	-0.37
CR 17	6	5	4	11	0.37	-0.30
CR 18	6	15	9		0.70	-0.80
CR 19	17	8	3	2	0.83	-0.37
CR 20	3	5	2	3	0.27	-0.23
CR 21	17	8	3	2	0.83	-0.37

4.1.Step To Build The House of Quality Using Quality Function Deployment (QFD)



HOUSE OF QUALITY

● strong relationship (9)
■ medium relationship (3)
Δ weak relationship (1)

HOW / WHAT

No.	Atribut	Joinery System	Safety Attachment lock system	Material	Position Adjuster System	Joining steps	Adjusting steps	Cable Management system	Structure system design	Skala Kepentingan	Inovasi Meja komputer	Wilkahn	Haworth	Harapan	Gap	Goal	Improvement ratio	sales point	raw weight	normalized raw weight	KANO CATEGORY
		CUSTOMER SATISFACTION PERFORMANCE																			
1	Comfortable, with enough surface area	● 0.756	■ 0.252	● 0.756	● 0.756	■ 0.252	■ 0.252	● 0.756	● 0.756	4.44	3.28	1.96	2.24	3.96	-0.68	4	1.22	1.5	8.125	0.084	M
2	Corner of the table is not sharp	● 9.918	■ 3.306		Δ 1.102	■ 3.306	■ 3.306	● 9.918		4.28	1.56	2.76	3.2	4.12	-2.56	5	1.106	1.2	9.877	1.102	A
3	Strong and durable				■ 0.255	● 0.756				4.32	3.12	3.12	3.16	3.68	-0.56	5	1.238	1.5	8.307	0.085	M
4	Easy to move	● 0.63		Δ 0.07	Δ 0.07	● 0.63			● 0.63	4.2	2.96	2.72	2.76	4	-1.04	4	1.282	1.2	6.809	0.07	O
5	Easy to install	● 0.747	● 0.747		● 0.747	● 0.747				4.36	4.04	4.04	4.04	4.08	-0.04	4	1.099	1.5	8.097	0.083	M
6	Easy to arrange according to office space	● 0.675							● 0.675	4.4	4.52	1.92	2	4.2	0.32	3	1.923	1.5	7.3	0.075	O
7	Save place	■ 0.219	■ 0.219	■ 0.219						4.32	3.64	3.04	3.04	4.04	-0.4	3	1.744	1.5	7.122	0.073	O
8	There is a special place for the keyboard								■ 0.162	4.16	3.16	2.6	2.8	4.24	-1.08	3	1.54	1	5.267	0.054	A
9	Fixed cable tidy	■ 0.18						● 0.54		4.24	2.6	2.44	2.52	4.08	-1.48	3	0.87	1.2	5.872	0.06	O
10	Height of a table can be adjusted		● 0.405		● 0.405	● 0.405				4.2	3.44	3.24	3.28	4.32	-0.88	4	1.351	1.2	4.395	0.045	A
11	Materials used are environment-friendly			● 0.828						4.28	1.72	1.64	1.68	4	-2.28	4	1.266	1.2	8.957	0.092	A
	Contribution (sum score)	13.125	4.929	1.873	3.335	5.835	3.558	10.674	2.223	**45.552**								14.5	80.128		
	Priority	28.813	10.82	4.111	7.321	12.7.81	7.81	23.432	4.88	**100**											
	Measurement unit	type	type	type	type	step	step	type	type												
	Modular Computer Table	brackets	x	x	avail	2 brackets	3	clip	cantilever												
	competitive product 1 (wilkahn)	magnetic	no	y	no	magnetic	no	clip	standard												
	competitive product 2 (haworth)	brackets	no	z	no	2brackets	no	clip	standard												

4.2 The Modular Computer Desk Functional Breakdown using FAST methods

As already explained in the previous chapter, Functional Analysis System Technique (FAST)method is used to define, analyze and understand the function of a product, how a product functions related with one another and explore the function which must be developed to get the value of the product. FAST is used to show the logical steps, to create and test the level of priority. The first step is to brainstorm all the functions and products in the consumer, in this research to take a vote and synthesize consumers use questioner Kano Model. Results from the consumer voice will explain the functions that each component in the product or products that have different levels of interest. Function of the overall computer products there is the main function of a computer product called basic function or as a main product module which is then divided into several sub-modules or sub functions that support. This computer table product has some basic functions. Once identified the basic function of the subsystem functions and Subordinate determined to support the basic function and helps the product to work better and have more high-value selling, sub-function is called secondary function. Secondary function can be categorized into three category they are required ,aesthetic and not required (unwanted).

4.3. Analysis of Environmental Impact

Analysis of the environmental impact of materials from various forms of alternative and this material is influenced by the weight of each material multiplied by the indicator (indicator value of data obtained from this eco indicator 99).

Poll = weight x indicator

Pollution Index (Pt) is represents one per thousand of the environmental burden per year in average living needs of people of Europe. Weight is the weight of all components are measured in kilograms (kg), and Indicator pollution index is a unit of each component that does not have a particular dimension. To calculate the weight of components made in a manner as shown in the table 4.2. And the result to get the least material impact and the price of material is shown in table 4.3.

Table 4.2 Weight calculation for each computer table components

Material Alternative	Tickness (mm)	Approx Weight (Kg/m^3)	Volume (m^3)	Weight (kg)	Indikator	Polutant	Material Price1 (Rp)
1. woodboard	19	240-520	0.1925	46.2	39	1801.8	26000
	25		0.2508	60.2	39	2347.8	27000
	30		0.3271	78.5	39	3061.5	28000
Lapisan LDL	1	1	0.3366	0.3366	76	25.5816	50000
2. Particle Board	19	240-520	0.192	46.08	441	20321.28	18000
	25		0.3	72	441	31752	20000
	30		0.3366	80.78	441	35623.98	22000
Lapisan HDL	1		0.3366	0.3366	119	40.0554	60000
3. Solidwoodboard	19	630-720	0.1938	122.08	6.6	805.728	30000
	25	(teakwood)	0.2549	160.6	6.6	1059.96	34000
	30		0.3366	212.04	6.6	1399.464	38000
Finishing WV	spray	1	0.3366	0.3366	238	80.1108	20000
4. Glass	12	31,2	0.1218	3.8	49	186.2	60000
	16	39,5	0.1620	6.4	49	313.6	70000
	19	47,5	0.1937	9.2	49	450.8	80000
1. Aluminium 100%rec	1.2	2560-2640	0.0137	35	60	2100	374000
	2		0.0180	46	60	2760	390000
	2.25		0.0203	52	60	3120	450000
2. DieCast Iron		6800-7800	0.0079	54	240	12960	460000
3. SolidWoodboard	19	630-720	0.0306	19.25	6.6	127.05	81000
	25	(teakwood)	0.0416	26.2	6.6	172.92	92000
	30		0.0479	30.2	6.6	199.32	100000

Table 4.3 Price and the least material impact module

MODUL	The Least Environment Impact	Pollutant Index (Pt)	Material Price (Rp)
Modul A (Top Table)	Glass	93.10	30000
Modul B (kaki Meja)	Aluminium 100%rec	1530.00	187000
Modul C (Cable Management)	Aluminium 100%rec	19.20	55000
Modul D (KeyBoard Tray)	Woodboard Lapisan LDL	206.70 24.07	15000 23000
Modul E (Front Cover)	Aluminium 100%rec	282.00	49000
Modul F (Joinery)	Aluminium 100%rec Bracket	12.00	20000
	TOTAL	2167.07	379000

4.4 Analysis of Assembly Line Modules using Genetic Algorithm

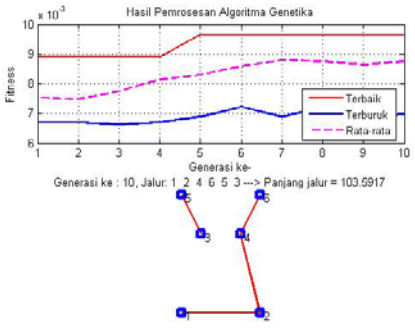
After we get what modules must be develop then we must decide which modules must be made first. We obtained six modules which is each modules is developed into different machine. And the machine position are can be drawing into coordinate below:

Table 4.4 coordinate for assembly machine for each modules

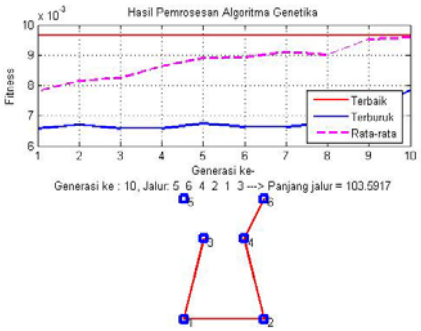
Module assembly	Module	coordinates	
		x	y
1	Top table	10.00	0.00
2	table feet	30.00	0.00
3	Cable management	15.00	0.00
4	Keyboard tray	25.00	20.00
5	Front cover	10.00	30.00
6	joinery system	30.00	30.00

By using genetic algorithm we can obtained the most optimum modules line assembly, we can have several alternatives assembly line which is very helpful to decide which module must be arranged first. From 10 times running, the result are :

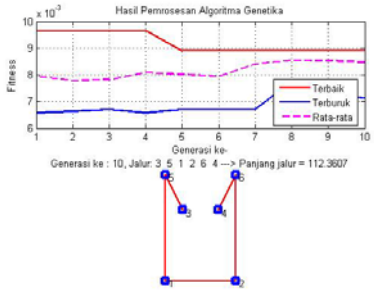
Assembly line 1 : Generation 10 with assembly lines is 1-2-4-6-5-3



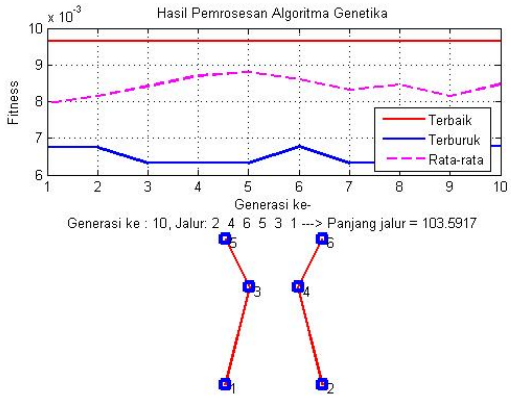
Assembly line 2 : Generation with assembly lines is 5-6-4-2-1-3



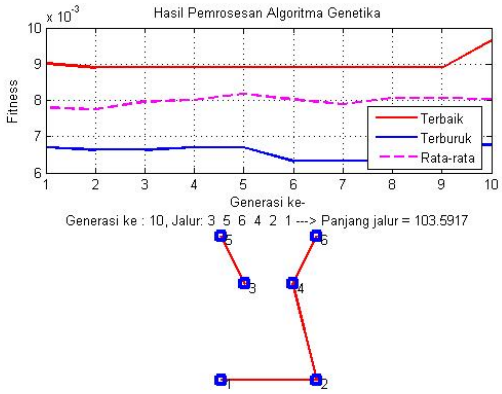
Assembly line 3 : Generation 10 with assembly lines is 3-5-1-2-6-4



Assembly Line 4 : with assembly lines is 2-4-6-5-3-1



Assembly Line 5 : with assembly lines is 3-5-6-4-2-1



We can see that the best assembly lines are alternative 1, 2, 4 and 5 with assembly path is 103.5 long.

5. CONCLUSION

1. Product development process model, modular computer tables based on the level of interest and level of user satisfaction can be obtained from the Kano-QFD model.
2. Kano model is used to find the level of user satisfaction in terms of positive and negative of the product. Results from the Kano model is an attribute-the attribute that can increase user satisfaction, and attributes
3. This will be part of the QFD is the voice of the customer.
4. To develop a product based on consumers' willingness to use the Kano-QFD model was able to summarize the attributes-attributes-attributes if the attribute is present then that too is not able to increase user satisfaction.
5. House of Quality was developed to explore the technical requirement products table does not facilitate the computer how modular product must be developed and what functions must be fulfilled by the modules and components of the product.
6. To answer the module what that must have to fulfill the functions of the computer desk (functional base), FAST method is used to find the structure of the hierarchy of components composing a product.
7. Component that is designed must be evaluated whether the material composing them dangerous for the environment, before the product is manufactured in a way to evaluate some of the alternative materials used is selected based on the smallest index of pollutant materials.
8. How to evaluate the impact of material for the furniture products is to know first of each component in kilograms (Kg). Then multiplied with each pollutant index material, it will be found how much the components and materials component negative effect on the environment. Pollutant index value of each material used in the design of this eco data obtained from the indicator 99.
9. Genetic algorithm can be use to find the most optimum assembly path line for every modules that has been developed.

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