House of quality method in preliminary design of kitchen food waste composter

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Keywords: House of Quality; kitchen food waste composter; conceptual design

ABSTRACT – This work studies the conceptual design of a household kitchen food waste composter using House of Quality (HOQ) method. The scoring method is used to identify the engineering characteristic element based on customer's requirement. HOQ identifies the heating coil equipped with sensor as the most significant element while lock sensor is identified as the least one.

1. INTRODUCTION

Quality Function Deployment (QFD) is a tool developed to facilitate products' designs to improve customer satisfaction through mapping of customer requirements with engineering characteristics in House of Quality (HOQ). This product developing technique process enables essential features and specifications to be identified and target values of the designed product performance measures to be achieved.

HOQ attracts designers for a wide range of application technologies including coal pyrolysis polygeneration. HOQ evaluates the pyrolysis polygeneration process and identifies customer needs such as the product cost, investment, and waste emission.[1]. Meanwhile, HOQ is also being applied to evaluate the Building Energy Efficiency (BEE) [2]. The criteria of BEE defined by the stakeholders are used to analyse the BEE requirement for house development. Besides, the HOQ is also used to choose the seawater pretreatment technologies [3] based on customer's satisfaction. Apart from that, the HOQ tool is also useful in higher educational management system [4]. It is used to obtain the society view in managing educational services in order to improve quality and productivity.

This study aims to design a kitchen food composter that suit the customer requirements while comparing it with other benchmarks using HOQ method.

2. HOUSE OF QUALITY

House of Quality (HOQ) is used to prioritize customer requirements and engineering specifications as indicated in Figure 1. It is also used to find the correlation between customer requirements and engineering characteristics as significance factors are emphasized in this research. A HOQ comprises of six major elements which includes: customer requirements and its ratings of importance, technical requirements, co-relationships as well as relationship matrix between customer requirements and technical requirements, technical attributes and the evaluation for each of the correlations and competitive assessment through benchmarking of relevant products.

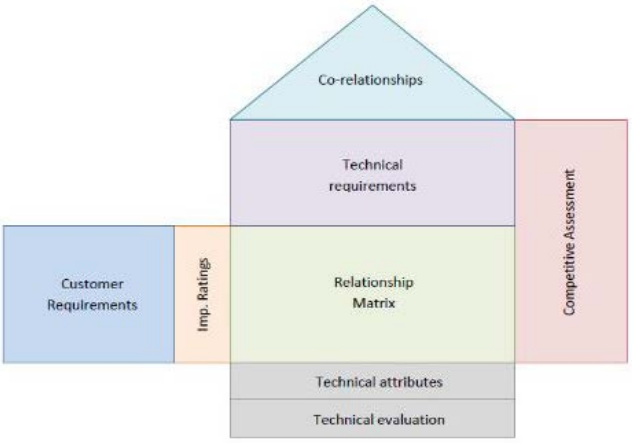


Figure 1 Elements of a HOQ.

3. RESULTS AND DISCUSSION

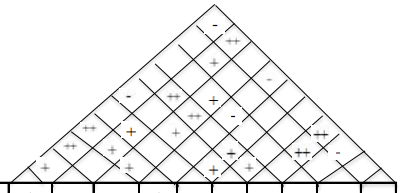
The customer requirements and engineering characteristics are tabulated accordingly to form a HOQ diagram as shown in Figure 2. The relationship between each customer requirements and each engineering characteristics are evaluated by multiplying the importance weight factor of customer requirements with their respective related engineering characteristics.

According to the rank score in Figure 2, heating coil with sensor are rated as the most important engineering characteristics with a raw score of 146 which comprises 14.3% of the relative weight. This indicates that the product development should prioritise to fulfil engineering characteristics based on the rank order. For this project, the sequence of rank order for engineering characteristics are heating coil with sensor, material toughness, shredder, corrosion resistance, mixing blade, ventilation, power consumption, volume of product, timer and lock sensor. Lock sensor is ranked as the lowest rank order because it comprises least relative weight of the total score with a value of 4.4%.

At the rightmost of the HOQ, five selected competitors served as reference for the evaluation based on the customer requirements. The five competitors include the Compost bin for Indian kitchen, Small-Scale Kitchen Waste Composting Machine, Kitchen Waste

Composting Machine, Thai household composter and the Organic Fertilizer from composting food waste are assessed from their level of satisfactions to fulfil the respective customer requirements.

Based on the evaluation parameters in this HOQ, the Small-Scale Kitchen Waste Composting Machine is ranked highest among the other competitors with a raw score of 107. This indicates that it has strong connection with the customer requirements in this project and it should be prioritised in the sequence when benchmarking is performed for reverse engineering on the related working mechanisms.



Direction of Improvements		↑	n/a	n/a	↑	n/a	↓	↓	n/a	n/a	n/a					
Units		n/a	n/a	n/a	J/m³	n/a	m³	kWh	n/a	n/a	n/a					
		Engineering Characteristics										Competitor Ranking				
Customer Requirements	Importance weight factor	Corrosion resistance	Mixing Blades	Shredder	Material toughness	Ventillation (air flow)	Volume	Power consumption	Lock sensor	Heating coil with sensor	Timer	A: Compost bin for Indian kitchen	B:Small Scale Kitchen Waste Composting Machine	C: Kitchen Waste Composting Machine	D: Thai household composter	E: Organic fertilizer from composting food waste food waste
Safety	5	3			3				9	1						
Composting speed	5		9	9		9				9			3	5		
Types of food waste	5	9	3	9	9		1					1	3	3	1	1
Automated stirring	4	3	9		1		3	3			9	3	3	3		3
Automated heating	4				3	3	3	3		9			3	3		
Automated cutting	4	9		9	9		1	3				3	3	3		
Without odour and pest	4					9		1		9		5	3		1	3
Cost	5	3			3	1		9		3	3	3	1	3	5	3
Light weight	3				3		9						3		5	
Composting capacity	3		3	3		1	9	3		3		3	5		3	3
Raw Score		123	105	135	136	101	87	94	45	146	51	73	107	91	58	53
Relative Weight %		12.0	10.3	13.2	13.3	9.9	8.5	9.2	4.4	14.3	5.0					
Rank Order		4	5	3	2	6	8	7	10	1	9					

Correlation Matrix Legend

++	Strong Positive
+	Positive
	None
-	Negative
- -	Strong Negative

Competitor Rankings

1	Poor
3	Ok
5	Excellent

Relation Matrix Legend

9	Strong
3	Medium
1	Weak

Figure 2 House of Quality for kitchen food waste composter.

4. SUMMARY

Based on the House of Quality method, the heating coil with sensor is classified as the most important engineering characteristic to be emphasized throughout the design process with the highest ranking score of 146 while lock sensor is classified as the least important engineering characteristics with relative weight of only 3.2% out of the total rank score. This engineering characteristic is fulfilled in this study where the heating base is equipped with load cell for temperature sensing.

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