QFD Based Product Design and Development of Weight Measuring Chair for the Benefits of Physically Challenged Person

Mustafizur Rahman*, Md. Tahiduzzaman, Samrat Kumar Dey

[1]Department of Industrial and Production Engineering, Jessore University of Science and Technology, Jessore-7408, Bangladesh
*Corresponding author: mostafizkuet09@gmail.com

Abstract In the age of industrialization, it is very difficult to sustain in the market without challenging products. For that purposes, most of companies are trying to introduce new product design concept. Product designs have focused on customer needs concerning functionality and utility. For the success of a product in the marketplace may be determined by its aesthetic appeal, emotions, the pleasure it creates, and the satisfaction it brings to the customer. Considering all factors, we develop a product design concept is in new product platform categories as Weight Measuring Chair. It is used to measure the weight especially for the old man and children who are not able to stand over the weight measurement machine. This type of product can be used in clinic and hospital for measuring the weight comfortably. We think that the product have the ability to create a revolution in weight measuring technique. Therefore, an attempt has been made to discuss easy measure of the weight of all kind of physically hazard persons.

Keywords: product specification, customer satisfaction, QFD, product design

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1. Introduction

There are four types of product development project. The development of our product is in new product platform categories. Weight measuring chair is used to measure the weight especially for the old man and children who are not able to stand over the weight measurement machine. This type of product can be used in clinic, home and hospital for measuring weight. Weight can be measured comfortably by using this product. The new product development platform can be easily motivated the customer expectation.

2. Significance of Research Methodology

The primary goal of this research in Product Design and Development is to apply, analyze, and evaluate a variety of techniques that enable designers to develop high-quality products. A quality product must meet the customer's requirements, perform to specifications, be cost effective, safe to operate, and have minimal negative impact on the environment during production, use or disposal. The formal design methods and the application of supporting tools introduced to create the documentation and communicate key design decisions to the customer or client. Designing a "quality product" for function, cost and manufacturability involves a variety of tools and structured techniques ensuring that all elements of the product life -cycle from conception through to final disposal are systematically addressed by the engineer during the product design process. Although the act of doing design is restricted to the first three phases, critical design issues arise from all six phases of the product's life -cycle.

3. Feature Planning

At first, we need a chair whose weight is applied at the centroid rod. The rod must have the ability to carry the weight of the person. The chair must have the handle so that the physically displace person can seat comfortably like paralyzed person, weak person, old person and for the children. Then we need a digital weight measurement machine and we have to find out the center position of the machine where the load is applied for showing of weight .After that rod of the chair is placed to the center position of weight measuring machine. The rod of the chair is attached to the machine by welding and the welding portion must be polished and colored to attract the customers. Previously weight of the machine is subtracted and the machine is set to zero kg.

4. Identifying Customer Needs

Identifying customer needs is itself a process, for which we present a five-step method. We believe that a little structure goes a long way in facilitating effective product

development practices and we hope and expect that this method will be viewed by those who employ it not as a rigid process but rather as a starting point for continuous improvement and refinement. Interpret Raw Data in Terms of Customer Need that are collect from customer face to face interviews and mobile contact with customer are shown in below Table 1.

We discuss in the below table different customer opinions, specifications, requirements & analysis this factors for their importance.

Table 1. Interpreting Raw Data in Terms of Customer Needs

Guide line	Customer statement	Need Statement Right	Need Statement Wrong
"What" not "how"	Why do not you use the comfortable sponge to set in the chair?	To use a single cover sponge this helps to measure the weight easily.	High comfortable sponge removes the weight of little children.
Specificity	I need long height chair to measure weight for young.	The height of the chair is variable that use both young and children.	Special long height chair is not possible.
Positive not negative	The body of the chair needs plastic.	The body of the chair needs to make by metal.	Plastic chair are usually ductile.
An attribute of the product	I would like the chair move from one to another.	Wheel is used of Bottom of the chair.	The chair is not possible to move from one to another place without wheel.
Avoiding "must" and "should"	I would not like use to handle than belt.	The chair must contain both belt and handle.	The chair should provide not only belt.

5. Product Specifications

The voice of customer is the term used for the need described by the customers. Product specifications mean the precise description of what the product has to do. It is also termed as "product requirements" or "engineering characteristics". A specification consists of a metric and a value. The product specifications are simply the set of the individual specifications. The process of establishing target specifications contains four steps:

   i. Preparation of the list of metrics
  ii. Collection of the competitive benchmarking information
 iii. Setting ideal and marginally acceptable target values for each metric
 iv. Reflection on the results and the process

A simple needs matrices matrix Table 2 represents the relationship between needs and matrices. The rows of the matrix correspond to the customer's needs and the column of the matrix corresponds to the matrices. A mark in a cell

of matrix means that the need and the metric associated with the cell are related. This matrix is a key of house of quality (HOQ) shown in below appendix A.

Table 2. A lists of matrices is shown below

Selection Criteria	Seat (A)	Handle(B)	Measuring machine(C)	Adjustable screw(D)	Height(E)	Centroid Rod(F)	Digital Screen(g)
Ease to use	0	+	+	+	0	-	+
Ease to handling	-	0	0	0	+	+	0
Readability of setting	0	-	0	0	0	0	0
Controlling height	-	0	0	0	0	0	-
Ease of manufacturer	+	+	+	+	-	-	0
Sum '+'s	1	2	2	2	1	1	1
Sum '0's	2	3	3	3	3	2	3
Sum '-'s	2	1	0	0	1	2	1
Net score	-1	1	2	2	0	-1	0
Rank	6	1	2	2	4	6	4

6. Concept Generation & Screening

A product concept is an approximate description of the technology, working principles & form of the product. It is a concise description of how the product will satisfy the customer needs. A concept is usually expressed as a sketch or as a rough three-dimensional model and is often accompanied by a brief textual description. The degree to which a product satisfies customers and can be successfully commercialized depends to a large measure on the quality of the underlying concepts. Concept generation is relatively inexpensive and can be done relatively quickly in comparison to five development process are given below.

   i. Brainstorming is a process for developing creative solutions of problem.
  ii. There indicate some problem on weight measurement machine. It's difficult to find the centroid point of the chair & difficult to adjust the chair and measuring machine.
 iii. SCAMPER: It discusses all substitute, combine, and adaption, modify, eliminate etc.
 iv. Research: By researching, the problem is selected to the material selection of the stand of the chair.

If we use iron, corrosion would be occurred rather than use of plastic, which is less stable. If we use HSS in the rod there would not occur corrosion and it will be high stable. So we decided to use High speed Steel in the Centroid rod of the chair.

  v. Brain Writing: we discuss different problems to design the product.

vi. Problem Decomposition: Two kinds of decompositions:
- Domain decomposition: These are divided into pieces of the chair and mapped to different the chair. The chair works only when the parts are assigned to it.
- Functional decomposition: It is used when pieces of parts require different processing times.
  *performance limited by the slowest process.
  *the process decomposed into a number of small tasks.

7. Concept Selection

Concept selection is an integral part of the product development process. It is the process of evaluating concepts with respect to customer needs and other criteria, comparing the relative strengths and weakness of the concepts, and selection one or more concepts for further investigation, testing, or development. There are some methods for choosing a concept. Such as- External decision, Product champion, Intuition, Multi-voting, Pros and cons, Prototype and test, Decision matrices etc. The purpose of "Concept Screening" is to narrow the number of concepts quickly and improve the concepts. The concept screening includes the following six steps that is –

- Preparing the selection matrix
- Rating the concepts
- Ranking the concepts
- Combining and improve the concepts
- Selecting one or more concepts
- Reflecting on the result and the process

Above six steps are shown in Table 3 for product concept selection.

Table 3. Concept screening matrix for weight measuring chair

Selection Criteria	Seat(A)	Handle(B)	Measuring m/c(C)	Adjustable screw(D)	Height(E)	Centroid Rod(F)	Digital Screen(G)
Ease to use	0	+	+	+	0	-	+
Ease to handling	-	0	0	0	+	+	0
Readability of setting	0	-	0	0	0	0	0
Controlling height	-	0	0	0	0	0	-
Sum '+'s	0	1	1	1	1	1	1
Sum'0's	2	2	3	3	2	2	2
Sum'-'s	2	1	0	0	0	1	1
Net score	-2	0	1	1	1	0	0
Rank	3	2	1	1	1	2	2
Continue?	No	Combine	Yes	Yes	Yes	Combine	Combine

8. Concept Testing

Concept testing focuses on mainly the concept development phase. This type of testing may be used to select which of two or more concepts should be purchased, to gather information from potential customers on how to improve a concept, and to estimate the sales potential of the product. Concept testing is relative to the concept development activities. These are improve identify customer needs, establish target specification, generate product concepts, select product concept etc. Seven-step method for testing product concepts:

i. Defining the purpose of the concept test
ii. Choosing a survey population
iii. Choosing a survey format
iv. Communicating the concept
v. Measuring customer response
vi. Interpreting the results
vii. Reflecting on the results and the process

8.1. Communicating the Concept

- The choice of survey format is closely linked to the way in which the concept will be communicated. Concepts can communicate in following ways.
- The product is weight-measuring chair that can be easily transferred from one place to another place. The product weight is about 15kg.It could be easily measure the correct weight of the people.
- Video image allow even the storyboard with the video the weight measuring chair is clearly communicated. The video showed prototype model and the sketch of different part of the chair with their principle.
- Sketch: We sketch an initial design of weight measuring chair by auto-cad (CAD) .The final product design given in Figure.2 that was design in Solid works.
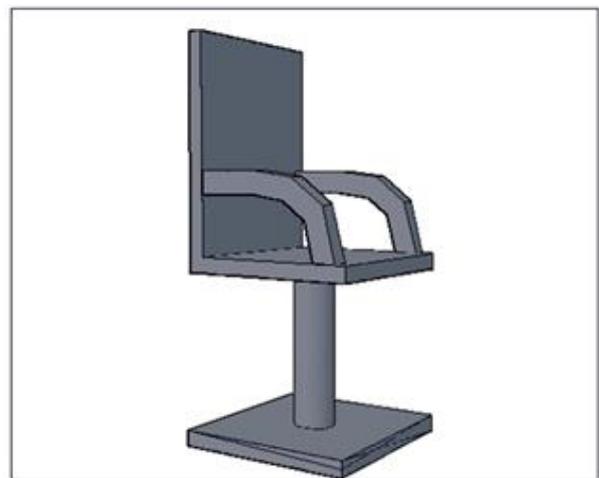
The Product figure given below:

Figure 1. Auto-CAD design

- Simulation: Simulation is generally implemented as software that mimics the function or interactive features of the weight measuring chair .Simulation would probably not be the ideal way to

communicate the key features of the weight-measuring chair.

- Working prototypes: Available working prototypes or work like models can be useful in concept testing. Prototype had better perform than the ultimate product. Prototype model that represent to the potential customers that give some problem with better solution for our weight-measuring chair.
- Measure customer response: Most concept test surveys first communicate the product concept and measure customer response. When a concept test is performed early in the concept development phase, customer response is usually measured by asking the respondent to choice form two or more alternative concepts.

8.2. Breakeven Point (BEP) Analysis

If the team simply interested in comparing two or more concepts, the calculation of the product be correct and the company must be successes. Form the data to collect from potential customer and non-potential customers that give the appropriate result to the producers.

We estimate Q, the quantity of the product is expected to be sold during a time, as

$$Q = N * A * P \qquad (1)$$

Where,

N=No. of potential customers expected to make purchases during time-period.

A=Fraction of these potential customers or purchasers for which the product is available.

P=Probability that the product is purchased if available and if customers is aware of it.

P is estimated in turn by,

$$P = C_{definitly} * F_{definitely} + C_{probably} * F_{probably.} \qquad (2)$$

Weight measuring chair sold to Hospital & clinic, Assume that the weight measuring chairs are sold in market at a rate of 15000tk. per units per year. Assume that the chair through a single distributor that accounts for 25 percent of the sales in category. Assume that results from a concept test with factory managers responsibly for purchasing transportation devices indicate a definitely would buy fraction of 0.30 and probably would buy fraction of 0.20. we use a value of 0.40 for Cdefinitly and 0.20 for $C_{probably.}$ Then,

$$P = (0.4 * 0.30) + (0.20 * 0.20) = 0.16$$

$$Q = 15000 * 0.25 * 0.16 = 600 \text{units} / \text{year}$$

We calculate the Annual sales demand 600 units that are reaches the breakeven point.

9. Schematic View
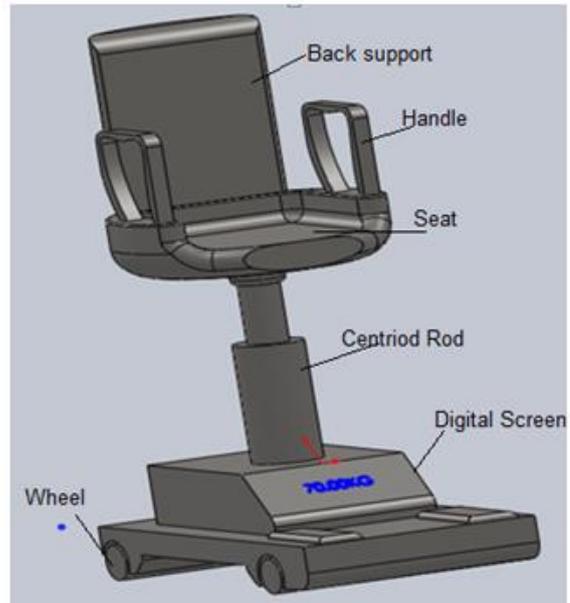
Final product schematic view is designed by solid work.

Figure 2. Design model of Weight measuring chair

10. House of Quality (HOQ)

House of Quality is a diagram, resembling a house, used for defining the relationship between customer desires and the firm/product capabilities. It is a part of the Quality Function Deployment (QFD) and it utilizes a planning matrix to relate what the customer wants to how a firm (that produces the products) is going to meet those wants. It looks like a house with a "correlation matrix" as its roof, customer wants versus product features as the main part, competitor evaluation as the porch etc. It is based on "the belief that products should be designed to reflect customers' desires and tastes". It also is reported to increase cross-functional integration within organizations using it, especially between marketing, engineering and manufacturing. We make a HOQ for weight measuring product that we can take decision to customer needs and give priority to product feature for our best performance shown in Appendix .A.

11. Discussion & Conclusion

There are different types of platform categories when we develop and design a new product. Initially we try to identify the customers' needs. Then collect raw data to evaluate concept generation and concept testing from different customer. We tried to make a House of Quality for our weight-measuring chair considering different customer needs and product features or characteristics and want to prioritize various score of HOQ. Finally, a schematic model is shown of weight measuring chair in Figure 2.

The various sectors are considered as customer of this product. Hospital, clinic, and medical center can purchase it for the measuring the weight of the old and physically challenged person. General interested person can also purchase it for their personal use.

From our above research, we can say that the product is totally based on the requirements of physically challenged person so that they can easily measure their weight comfortably without facing any kind of problem. I think that the product have the ability to create a revolution in weight measuring technique by satisfying target customers.

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Appendix

Appendix A: House of Quality of Weight Measuring Chair
x = Strong communication, 5
# = Medium, 3
*=Weak, 1

Customer Requirement \ Technical requirement	Customer performance	Adjustable screw	Handle	Centroid rod	Digital machine	Strong plate	Digital indicator	Thickness of rod	Space to sit	Flexibility	Material	Maintenance capacity	Assemble parts	Total score
Easy to use	3	*	#		x		#			*		x		18
Easy to operate	4	*		#			*	x			#			17
Low operating cost	5		#	X				*			#		x	13
Comfortable to use	3		*	x				#	*					10
Carry high load	3			*	x			#		x	*			15
Supporting handle	2		*	#		*		#			x			17
Sponge sit	3		#	X					*	#			X	13
Long life cycle	4	x		*	#	*		#			x			18
Easy to place	5		x	#				*			#	x		14
Adjustable height	4	*		#		x		*						14
Digital machine	3			#		*	#					#		14
Light weight	2		#	*		#	*							16
Safe to use	4	x		*				#			x	#		13
Low price	5			*	#			x			*		#	17
Total sum		263	329	659	138	307	261	458	115	157	327	113	77	3204