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Innovative Design of Practical Tools for Umrah Training using QFD and TRIZ

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Abstract: Product enhancement is important to keep a product on the market and to suit changes in customers demand. To remain competitive with other competitors, the product quality and performance must be consistently improved. In this study, the practical tools for Umrah training had been chosen for improvement. The objectives of this study were: (1) identify customer requirements of practical tools for Umrah training, (2) evaluate the importance of product requirements and existing product performance, as well as (3) propose innovative design by using Quality Function Deployment (QFD) and Theory of Inventive Problem Solving (TRIZ). This study focuses on users of existing practical tool products. A survey was conducted involving 60 users of practical tools in order to obtain feedback on the existing product performance and potential areas for improvement. Based on the survey feedback, analysis was performed by constructing a QFD table and using the TRIZ design principles. The new practical tools design was finalised based on the customer and technical requirements. The proposed new design enables the product to be used indoor, outdoor or on any flat surfaces. Other than that, the new product was proposed using a foldable tent concept which made it compact for storage, portable, light and easy to set up. SolidWorks software was used to draw the final version of the innovative product design.

Keywords: Quality Function Deployment (QFD), Theory of Inventive Problem Solving (TRIZ)

1. Introduction

Practical tools are the replica models that have been used during the practical sessions of Umrah course in order to give better understanding on the situation while performing Umrah. There are some

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existing practical tools designs that are available in the market like the iron material structure model and the inflatable concept model [1]. However, the existing products come with some limitations such as the current product may be weak in features and inconvenient to transport, but still can be improved in the future. There is no study related in combination of QFD and TRIZ in improving practical tools for Umrah training. To address this issue, a new innovative design is developed by using the QFD and TRIZ approaches.

The objectives of this project were: (1) to identify the customer requirements of the practical tools for Umrah training, (2) to evaluate the importance of product requirements and the performance of existing products and (3) to propose innovative design by using QFD and TRIZ. This project focuses on creating an innovative design of practical tools based on the customer requirements and aligned with technical requirements by implementing the QFD and TRIZ.

2. Literature Review

To be competitive, products being produced must suit the needs of the customers. It is critical to stay current on how to meet expectations and changing demands in order to compete, as customer demands of tomorrow differ from those of today [2]. QFD and TRIZ are examples of relevant product improvement techniques and processes that can be implemented for product improvement. The product being improved is the practical tool for Umrah training. This practical tool consists of the replica model of Ka'bah, one unit of Hijr Ismail and one unit of Maqame Ibrahim. The first model of existing practical tool uses the iron material structure that comes with some limitations such as heavy and not portable, requires many workers to install and unload the replica and is expensive on transportation cost. The second model was invented as an improvement to the previous one, which used the inflatable concept model. Even while this model seemed to be better than the previous one, it has its own constraints, such as the replica model taking time to set up as air is pumped into it, which also causes the model to be heavy. Improvement can still be implemented to propose new designs in the future.

QFD and TRIZ are some of the tools that can assist businesses in producing products that meet the requirements of the customers. Verma [2], Amalia [3] and Ramli [4] had developed product improvement using the combination of QFD, TRIZ and ergonomics approaches. Integrated QFD and TRIZ research therefore plays a big role in supporting the product innovation design [5]. It can be seen that the implementation of tools provides good results in improvement for both process and product. However, there is no research found related to practical tools that use combinations of QFD and TRIZ. These two tools may become an appropriate combination as the design improvement of practical tools is based on customer demands and technical requirements are essential in producing a good product.

3. Research Methodology

Figure 1 shows the overall procedures of this research. It starts with conducting pilot interviews in order to identify the customer requirements of the product. Final questionnaire was developed based on the pilot interview feedback. Final design of practical tools was created based on the survey analysis as well as application of QFD and TRIZ methods.

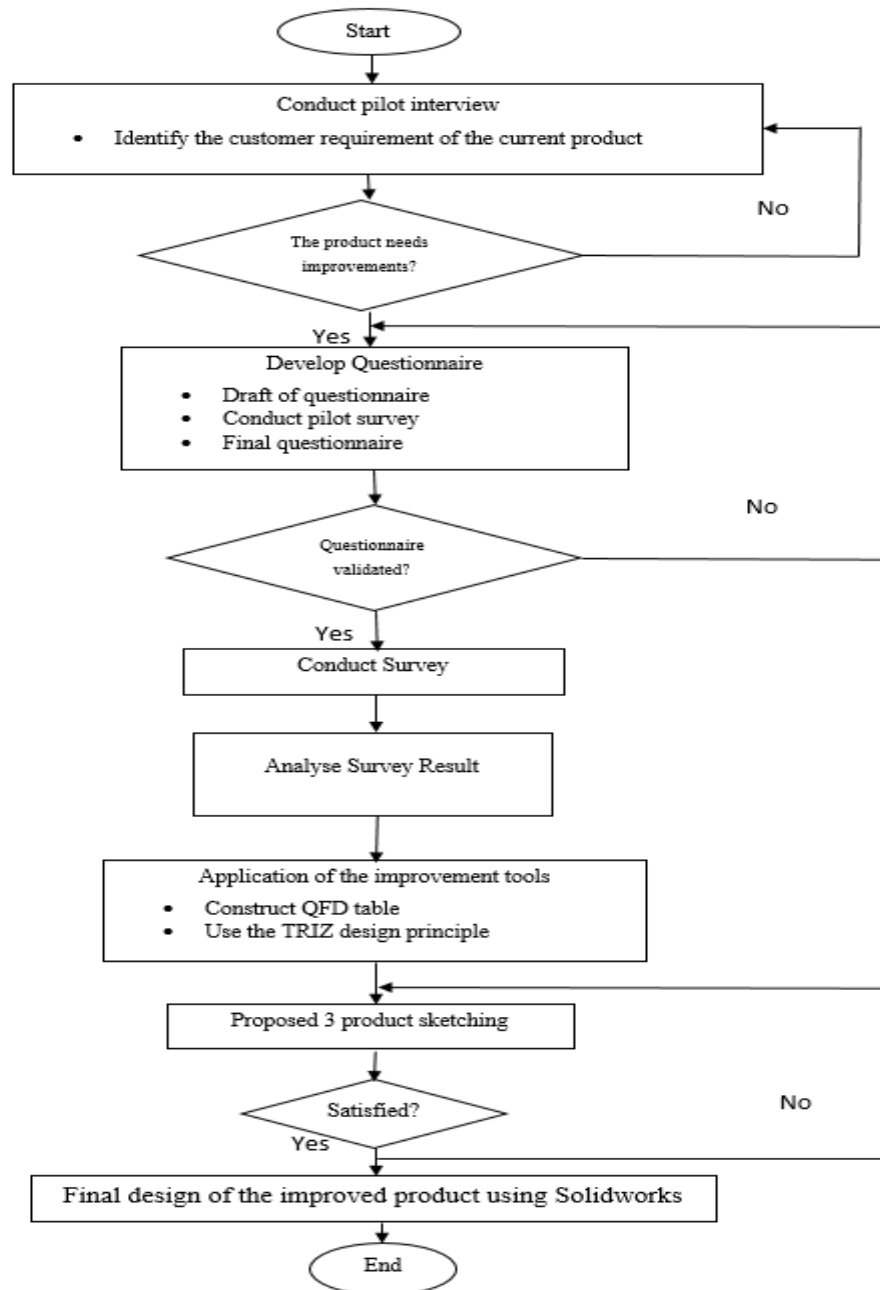


Figure 1: Procedures of Research

The survey was conducted through a purposive sample. The questionnaire consists of three main sections: (1) Background of the respondent, (2) Evaluation of the importance and current performance of practical tools, and (3) Product improvement suggestion. Based on purposive sampling, the questionnaire was distributed to the respondents who use the practical tools while organizing and participating in the practical session of the Umrah course. All the respondents were contacted through email and WhatsApp.

4. Results and Discussion

The proposed innovative model is based on QFD and TRIZ includes three key steps which are analysis of needs, translation of requirements and resolution of conflicts [6]. The second section of the questionnaire related to the assessment of the product performance and importance of the product requirement which were crucial in the process of the product improvement. In this section, the product

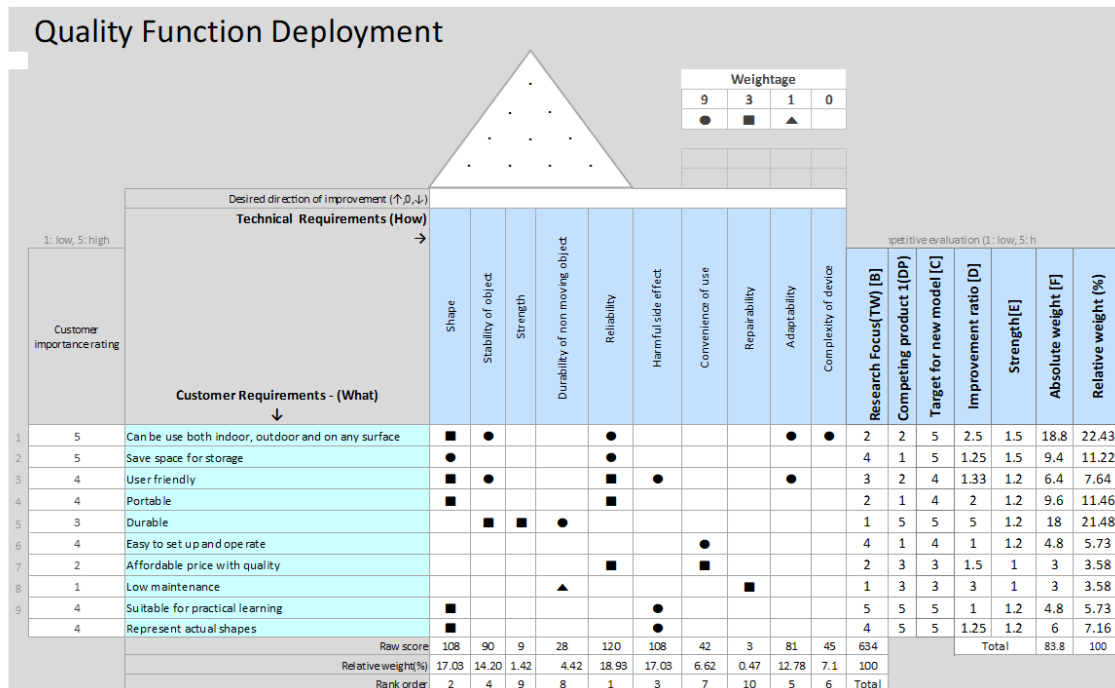
performance and perceived importance of product requirement data were collected. Rating scale question was used to indicate the degree of agreement of the respondents on the criteria given. All the customer requirements were transferred into House of Quality (HoQ) for analysis in order to improve the practical tools. The ranking rating for the highest is five (5) while the lowest was one (1) representing the QFD matrix rating. Table 1 shows the ranking rating of the importance and performance product rating that had been converted for the QFD matrix. Results in Table 1 reveals that the majority of the respondents chose that the practical tools design can be used for both indoor, outdoor or on any surface, save space for storage, easy to set up and operate as the most important factor to be improved while for the performance of the existing practical tools also been summarized as been rated by respondents.

Table 1: Rating of the importance and performance product of QFD matrix

No.	CUSTOMER REQUIREMENTS	IMPORTANCE RATING	PERFORMANCE RATING (MEAN)	
			IRON MATERIAL STRUCTURE	INFLATABLE CONCEPTS
1.	Can be used both indoor, outdoor and on any surface	5	2	2
2.	Save space for storage	5	1	4
3.	User friendly	4	2	3
4.	Portable	4	1	2
5.	Durable	3	5	1
6.	Easy to set up and operate	4	1	4
7.	Affordable price with quality	2	3	2
8.	Low maintenance	1	3	1
9.	Suitable for practical learning	4	5	5
10.	Represent actual shapes of Ka'bah, Hijr Ismail, Jamarat and Maqame Ebrahim.	4	5	4

The relationship matrix was developed after completion of selection for technical requirements using 39 engineering parameters of TRIZ. This matrix was located at the central body of the house which contains the assessment of the strength of the relationship between the customer requirements and technical requirements. Some of the highest score of relative weight for customer requirements were (1) can be used both indoor, outdoor or on any surface, (2) durable and (3) portable, while the highest relative weight of technical requirements were (1) reliability, (2) shape, and (3) harmful side effect. Table 2 below shows the House of Quality for improvement of practical tools.


Table 2: House of Quality for improvement of practical tools



Apart from the QFD method, product improvement could be done by applying the TRIZ method which involved 39 contradiction matrices and 40 inventive principles. From the comparison, some technical requirements were improved and others were eliminated for the improvement of the product. There were few principles that had been chosen from 40 Inventive Principles using 39 Conflict Matrix by referring to the first design sketching recommendation. These principles were implemented for the improvement of practical tools as Table 3.

Table 3: Improved design using 40 Inventive Principle

No.	INVENTIVE PRINCIPLE	PROPOSED IMPROVEMENT
1.	Segmentation (2)	<ul style="list-style-type: none"> ➤ The flexible poles can be shortened and removed from the main frame for storage. ➤ The main frames and clothes can be folded together.
Ka'bah design and frame		
2.	Combining (5)	<ul style="list-style-type: none"> ➤ The flexible poles can be combined to the main frame in order to set up the tent. Refer Figure 5.4.
3.	Dynamicity (15)	<ul style="list-style-type: none"> ➤ The tent can be folded into smaller size during storage and expand when been set up for use.

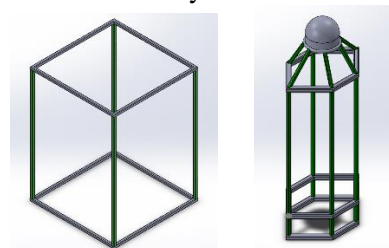
- 4. Copying (26)
 - The improved design uses the same concept as foldable tent for kids.
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Foldable tent concept.
- 5. Porous material (31)
 - The frame and flexible poles can be combined together through holes on the frame body that act as joints.
 - Materials used are anti-rust material.
 - The use of aluminium alloy coated with PVC in order to avoid corrosion and long lasting application.
 - 6. Transformation of physical and chemical states of an object/changing parameter (35)

From the combination of QFD and TRIZ, an improved practical tools design had been created which fulfils the customer requirement [5]. Table 4 shows the comparison between current and improved design. The innovative design suitable to be used indoor, outdoor or on any surface; came with a light and simple set up concept that was suitable with height and length for users; as well as can be folded together and compact.

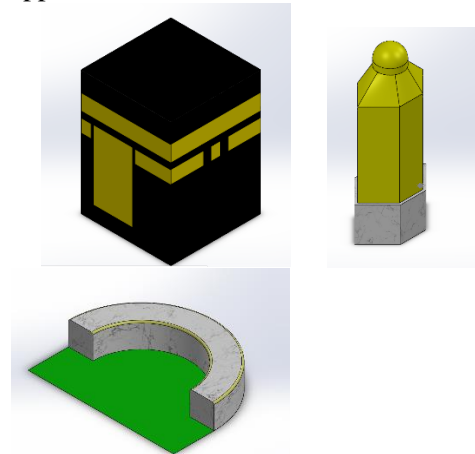
Table 4: Comparison between current practical tools and improved practical tools.

CUSTOMER REQUIREMENTS	CURRENT PRACTICAL TOOLS	IMPROVED PRACTICAL TOOLS
Can be used both indoor, outdoor and on any surface.	The product is only suitable for flat ground and outdoor, for indoor usage is depending on the space size.	The improved design is suitable for both indoor, outdoor and flat surface. Iron pegs can be used while setting up on unsmooth surface.
Save space for storage	Need large space for storage.	The product can be fold together and compact.
User friendly	The design is quite heavy and big in size, so these may cause some difficulties for the users.	The improved design comes with light and simple set up concept that suitable with height and length for users.
Portable	Hard to carry due to its big structure.	The improved design more compact, light and have foldable structure which can be carry anywhere.
Durable	Low durability.	Strong joint structure which made from aluminium alloy.



Practical tools frames

Easy to set up and operate	Takes time for inflating air to fill the space.	Simple mechanism that only need to plug in the flexible poles to the tent.
Affordable price with quality	Reasonable price.	Reasonable price.
Low maintenance	Maintenance required if the air blower is broken.	Maintenance maybe needed after a few years if the tent is torn or the flexible poles are broken.
Suitable for practical learning	Suitable.	Suitable.
Represent actual shapes of Ka'bah, Hijr Ismail and Maqame Ebrahim.	Resembles to the actual shapes and appearances.	Resembles to the actual shapes and appearances.



Practical tools appearances

From the combination QFD and TRIZ methos, the improvement of the product design had been proposed to fulfill customer requirements. The improved design of the practical tools had been drawn using SolidWorks software.

Conclusion

Overall, the objectives of this study had been achieved. The first objective of this research was to identify the customer requirements of the practical tools which were (1) able to be used both indoor, outdoor and on any surfaces, (2) save space for storage, (3) portable, (4) durable, (5) user friendly, (6) easy to set up and operate, (7) affordable price with quality, (8) low maintenance, (9) suitable for practical learning and (10) represent actual shapes of Ka'bah, Hijr Ismail and Maqame Ebrahim. This objective had been achieved by conducting the pilot interview in order to obtain the customer requirements.

The second objective of this research was to evaluate the importance of the product requirements and performance of existing products. This objective had been achieved after conducting a survey. Based on the findings of the survey, the highest important score of the requirement were: (1) can be used for both indoor, outdoor or on any surface, (2) save space for storage, (3) suitable for practical learning. The result of the survey also showed the highest performance score of the requirement for both iron material structure material and inflatable concept of practical tools. For the iron material structure, the higher performance scores were: (1) suitable for practical learning, (2) representing actual shapes, (3) durable. Meanwhile, the highest performance scores for the inflatable concept practical tools were: (1) suitable for practical learning, (2) save space for storage, (3) easy to set up and operate.

The final objective was to propose innovative design by using QFD and TRIZ. The innovative design was done based on the customer requirements and technical requirements to produce better design than before. Some of the improvements by the new design were its suitability to be installed whether indoor, outdoor or on any surfaces. Other than that, the design was made in a foldable tent

concept which made it compact for storage, portable, light and easy to set up. With the usage of aluminium alloy and polyester materials of the design, it was hoped that it would be a high endurance product, safe for users to use and still represents the actual shapes of Ka'bah, Hijr Ismail and Maqame Ebrahim.

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