Contents list avaliable at Directory of Open Access Journals (DOAJ)

JUTIN : Jurnal Teknik Industri Terintegrasi

Volume 7 Issue 1 2024, Page 235-240

ISSN: 2620-8962 (Online)

Journal Homepage: https://journal.universitaspahlawan.ac.id/index.php/jutin/index

Evaluation Of The Capability of Gas Producer Tools Using a Combination Of QFD and MCDM

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DOI: 10.31004/jutin.v7i1.23236

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Article Info

Keywords:
Gas transportation equipment;
QFD;
MCDM

Abstract

The LPG gas base carries gas to homes and shops using a two-wheeled motorcycle fitted with an iron basket to have gas. A design needs to be designed to make it easier to transport gas. This study aims to determine the weight of criteria that are important for consideration of design design for a gas conveyor. Quality Function Deployment (QFD) is a structured methodology used in product planning and development to obtain consumer needs and wishes specifications. Multi-Criteria Decision Making (MCDM) is a method for making alternative decisions based on specific criteria. The result of this study is the weighting of measures necessary for consideration of design for a gas conveyor of the most crucial sequence, namely: type of material used, weight, strength, size and dimensions, flexibility, maximum capacity, durability, comfort, attractive graphic design, efficiency (gallons, gas 3kg, 5.5kg, 12kg), and thickness.

1. INTRODUCTION

Indonesia has enormous natural resources (Hidayati & Panama, 2019). One of these natural resources is gas (Sembiring et al., 2019). Using gas in Indonesia is not only for the industrial sector but also for the household needs sector (Syukur, 2016). Gas in the household sector uses Liquefied Petroleum Gas (LPG) (Subakdo & Nugroho, 2016). Usually, Liquefied Petroleum Gas (LPG) cylinders are widely used for household purposes, such as, for cooking (Sultan et al., 2015).

The phenomena in the field of LPG distribution are very varied, for example, when the government restricts the transfer from a terminal to an agent in gas refueling (RAW, 2023). Then, agents supplying gas to the base are also prohibited. So, the floor also bans gas from being sold to buyers or retailers. Besides, the ground also delivered gas to homes and shops using a two-wheeled motorcycle fitted with an iron basket to provide gas. A design needs to be designed to make it easier to transport gas. Design presents an idea to create a tool or product for the market's needs (Poesokokeo, 2018). This study aims to determine the weight of criteria that are important for consideration of design design for a gas conveyor.

One method commonly used to design a product is Quality Function Deployment (QFD). In reality, the QFD method can be done in everyday life, such as applying the design of steel compression stamp wheels based

Received 23 December 2023; Received in revised form 28 December 2023 year; Accepted 6 January 2024
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on consumer demand information (Rossanty et al., 2018), supporting the improvement of the quality of the compressed product (Suryaningrat, 2013), and designing the reverse milling machine (Ummi et al., 2017). In addition, another method used for design is the Multi-criteria Decision-Making (MCDM) method, which can be used to compare and analyze various combinations of design of disc brake design in cars (Maheshwari et al., 2021), explore the latest and sustainable energy (Kumar et al., 2017), produce kitchen appliances (Kurniasih & Kurniawan, 2023), and assess the earthquake vulnerability of residential homes in urban areas (Alizadeh et al., 2018).

Although the QFD method has been widely used for product design, things could often be improved (Rossanty et al., 2018; Suryaningrat, 2013; Ummi et al., 2017). Thus, this research combines the QFD method and the MCDM method. The study involves a combination of the technique of QF D and the method MCD M for product development, where the concept of design gives some design to the product so that it helps in summarizing and following the needs of the customer. The method is a tool for interpreting the voice of customers into the specifications of the engineering field. In contrast, the technique allows the designer to decide the best design and material for the product (Marini et al., 2016). Other research results on QFD and MCDM methods provide a creative integrated model using SWARA, QFD, and a new MCDM tool called WASPAS (Yazdani et al., 2016).

2. METHODS

The concept of a combination method between QFD and the MCDM method is limited, so the researchers will investigate using the combined methods of QFD and MCDM for a gas conveyor.

2.1. Quality Function Deployment (QFD)

Quality Function Deployment (QFD) is a structured methodology used in product planning and development to obtain specifications of the needs and wishes of consumers (Puji Priyono & Yuamita, 2022). Yoji Akao, the original developer, describes QFD as transforming consumer qualitative wishes into parameters so that quality-forming functions and methods in achieving design quality in subsystems and parts can spread and form quality, eventually, into specific manufacturing process elements. There are some benefits of using the QFD method are as follows: focus on customers, analysis of VOC competitors, shorter development times and lower costs, then structure and documentation.

2.2. Multi-Criteria Decision Making (MCDM)

Multi-Criteria Decision Making (MCDM) is a method for making alternative decisions based on specific criteria. It is stated that the measure stems from human needs and desires. MCDM consists of techniques that allow specialists to consider and allocate values or classify set criteria related to a specific problem. Therefore, the analytical hierarchical process combines MCDM and the most commonly applied methods in the literature. (AHP). During the decomposition phase, decision-making problems are divided into hierarchical forms based on various types. An analytical hierarchy process model (AHP) is used to make decisions based on weighting with quantitative and qualitative inputs. The concept of AHP is complex and unstructured problem solving into its components, existing components structured in a hierarchy.

3. RESULT AND DISCUSSION

3.1. Identify Design Needs (QFD)

The first step is to look for the design, which needs to determine the design criteria to perform as follows:

Table 1. Design Criteria

Criteria 1	Criteria 2
Type of material used	Material Thickness
Maximum capacity	Size or dimension
Flexibility	Weight
Comfortability	Strength
Interesting shape design	Durability
Efficiency (galLons, gas 3kg, 5.5 kg, 12 kg)	

3.2. Design Criteria Setting (QFD)

The second phase is the establishment of design criteria as well as the granting of the weighting value of the criteria to be considered, weighting the criterion value as follows:

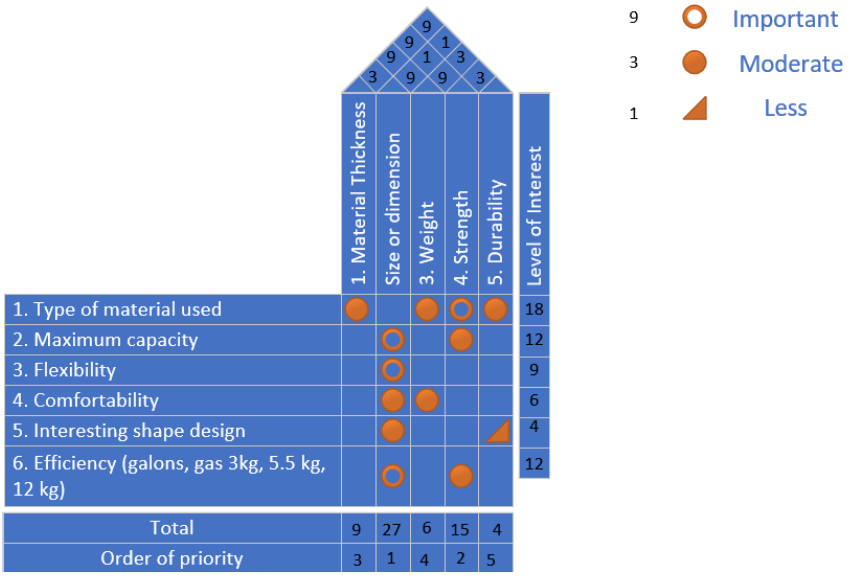

Fig. 1. Design Assessment of QFD

Based on the Fig 1, the specification needs criteria against the desires of the consumer. The type of material used has a level of importance of 18, with priority given to strength. Maximum capacity has a level of importance of 12, with priority given to size or dimension. Flexibility has a level of importance of 9, with priority given to size or dimension. Comfort has a level of importance of 6, with a medium priority for size, dimension, and weight. Efficiency (gallons, gases of 3kg, 5.5kg, and 12kg) has a level of importance of 12 with priority in size or weight. The order of priorities starts with size or dimensions, strength, material thickness, weight, and durability.

3.3. Criteria Weight Alignment (MCDM)

The third stage is the calculation of the weighting of the MCDM criteria in order to know the weight of each criterion, as can be seen from some of the following tables:

Table 2. Criteria 1 of Weight Alignment MCDM

Criteria 1	Material Thickness	Size or dimension	Weight of each criterion	Strength	Durability	Geomean	Weight	Lamda
Material Thickness	1	0.3333	0.1667	0.1111	0.3333	0.290	0.041	0.154
Size or dimension	3	1	0,5	03333	1	0.871	0.122	0.463
Weight	6	1	1	0.6667	2	1.516	0.213	0.804
Strength	9	3	3	1	1	2.408	0.338	1.708
Durability	3	3	4	1	1	2.048	0.287	1.676
					Total	7.132	1	0

Lambda Max	1.707527
n	5
CI	-1.65849
RI	0.58
cr	-2.85947

Table 3. Criteria 2 of Weight Alignment MCDM

Criteria 2	Type of material used	Maximum capacity	Flexibility	Comfortability	Interesting shape design	Efficiency (gallons, gas 3kg, 5.5 kg, 12kg)	Geomean	Weight	Lamda
Type of material used	1	3	1	3	3	8	2.449	0.229	1.804
Maximum capacity	0.33	1	3	6	1	9	1.944	0.182	1.607
Flexibility	1	3	1	3	9	9	3.000	0.218	2.694
Comfortability	0.33	3	3	1	1	6	1.348	0.126	1.485
Interesting shape design	0.33	1	4	1	3	3	1.513	0.142	1.927
Efficiency (gallons, gas 3kg, 5.5 kg, 12kg)	0.13	0.38	1	0.38	0.38	1	0.433	0.041	0.471
						Total	10.688	1.000	0.000

Lambda Max	2.694379
n	6
CI	-1.55094
RI	0.58
cr	-2.67403

From the results of the above calculation, take the weight calculation data of criterion 1 with the development of the weight 0.041, 0.122, 0.213, 0.338, 0.287 and the weight criterion 2 are 0.229, 0.182, 0.281, 0.126, 0.142, and 0.041 the weight data subsequently.

3.4. Verification of QFD and MCDM

The fourth stage is the verification of the combination of the two methods QFD and MCDM as follows:

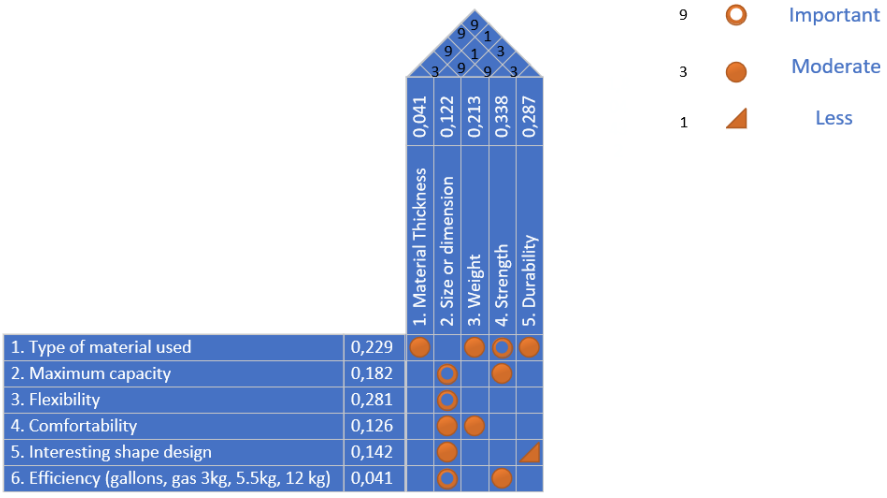

Fig. 1. Verification of QFD

Table 4. Verification of MCDM

	0.041	0.122	0.213	0.338	0.287	Total
0.229	0.028	0.009	0.867	0.696	0.197	1.798
0.182	0.007	0.200	0.039	0.184	0.052	0.482
0.281	0.011	0.308	0.060	0.095	0.081	0.555
0.126	0.005	0.046	0.080	0.043	0.036	0.211
0.142	0.006	0.052	0.030	0.048	0.041	0.176
0.041	0.002	0.045	0.009	0.041	0.012	0.107
Total	0.059	0.660	1.084	1.107	0.419	

Table 4 shows that the combination of the two methods, QFD and MCDM, the priority criterion 1 is strength, weight, dimensional size, durability, and material thickness. Priority criteria 2 includes the type of material used, flexibility, maximum capacity, comfort, attractive shape design, and efficiency. (gallon, gas 3kg, 5,5kg, 12 kg).

4. CONCLUSION

From some calculations of the QFD and MCDM methods based on the results and explanation above, the weight of criterion 1 is material thickness (0,059), size or dimensions (0,660), weight (1,084), strength (1,107), and durability (0,419). Criteria 2 is the type of material used, maximum capacity (1,798), flexibility (0,482), comfort (0,555), attractive shape design (0,176), and efficiency (3 gallon gas, 5.5kg, 12, 12 kg) (0,107). Then we can conclude the weight criteria that are important for consideration of design design for a gas conveyor from the most important order of the material type used, weight, strength, size and dimensions, flexibility, maximal capacity, durability, comfort, attractive design, efficiency (3 gallon gas, 5.5kg, 12, 12 kg), and thickening.

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