Analysis of Quality Function Deployment (QFD) and Analytical Network Process (ANP) Methods at PT. XYZ

R Ginting¹, A Ishak¹, R Y Tarigan¹ and Alfin F. Malik¹

¹Department of Industrial Engineering, Faculty of Engineering, Universitas Sumatera Utara, Medan, Indonesia 20155

Corresponding author: rosnani@usu.ac.id

Abstract. The product under study is a mattress product. The problem at hand is a mismatch with consumer desires. To minimize this mismatch, an analysis was carried out using the Quality Function Deployment (QFD) and Analytical Network Process (ANP) methods. Where QFD is used to determine customer technical desires and then weighting is carried out using the ANP method. From the calculation results, the highest to the lowest technical characteristics are cutting speed, cutting accuracy, product dimensions, component composition, machine capacity, and durability. The value of the difficulty level of cutting speed is 4 and the importance level is 23% and the estimated cost is 20%. Then from these results, the company must pay more attention to these characteristics because it can have a direct effect on the product. The wrong cutting speed will result in reject products so that it can reduce profits for the company or harm the company.

1. Introduction

PT. XYZ is a company in the bedding industry. The products produced are pillows, bolsters, mattresses, and folding mattresses. The raw materials of this product are pads, fabrics, and threads. One of the company’s products that are used as an example of design improvement is a mattress. Mattress products have several types of defects such as broken stitches, skewed stitches, wrong size cuts, dirty fabrics, and uneven foam contents. Disabilities can be influenced by several factors, namely machines/equipment, work methods, people, and materials. Therefore, it is necessary to improve the quality by taking into account several factors.

Previous researchers conducted by Singh, et al. [1] described the application of ANP with QFD. This study discusses the combination of two techniques, namely Quality Function Deployment (QFD) and Analytic Network Process (ANP) which are used in the product development process. Combine QFD and ANP methods to prioritize Technical Characteristics. ANP is a multi-criteria decision-making method used to derive relative priority from individual assessments, which can systematically handle all types of dependency. ANP assists in the QFD matrix which obtains a pairwise comparison matrix and checks the consistency ratio for the level of customer interest, the relationship between Customer Requirements (CR) and Technical Characteristics (EC), and the internal dependence between CR and EC.

The method used in QFD (Quality Function Deployment) and ANP Analytical Network Process). QFD is used to determine consumer desires, while ANP is to look for value and the relationship between technical characteristics and customer needs.
QFD is defined as a structured process or mechanism for determining customer requirements and translating those needs into relevant technical requirements where each functional area at the organizational level can understand and act according to procedures. QFD translates what customers need into the results of an organization. [2-7]

ANP is a qualitative approach method used to find values and relationships between variables horizontally, vertically, and loops. ANP basically has a shape similar to AHP where AHP shows the relationship between variables that form a hierarchy. Not all decision-making problems are based on hierarchy only, but also have dependencies between components in the cluster. In such a problem, Network Process Analytics is used where the network is spread out in all directions and includes rotation between clusters and loops within the same cluster [8].

2. Materials and methods
The research location chosen was PT. XYZ. The types of data used are primary data and secondary data. Primary data sources come from direct interviews with workers or production managers who are people who are directly related to product quality. Primary data is data from open questionnaires, closed questionnaires, technical characteristics questionnaires, technical characteristics relationship questionnaires, and ANP questionnaires, while secondary data sources are data obtained through companies and employees using interview techniques [9].

The data used in this study have data sources that can be primary data and secondary data. Primary data collected by direct observation is data on consumer desires related to the mat production process. The instruments used in collecting data on consumer desires are open questionnaires and closed questionnaires. The data collected are as follows:

- Open Questionnaire
- Closed Questionnaire
- Technical Characteristics Questionnaire
- Relationship Questionnaire Technical Characteristics
- Critical Part Questionnaire
- ANP Questionnaire

Secondary data were obtained based on company documentation data, and obtained by interview with the production department.
QFD-ANP steps [10]:

- Step 1: Identify the CR and the importance of each CR
- Step 2: Determine the dependency matrix of parts in CRs with respect to each CR.
- Step 3: Identify technical characteristics
- Step 4: Determine the dependency matrix in the EC associated with each EC
- Step 5: Determine the relationship between ECs associated with each CR by assuming that there is no dependency between ECs
- Step 6: Determine the interdependent priorities of the CR
- Step 7: Determine the interdependent priorities of the EC
- Step 8: determine the overall priority of the EC

3. Results and Discussion
Open and closed questionnaires are used to determine consumer desires. Respondents' answers to the preliminary or open questionnaires obtained several modes that support the question attributes in the second stage questionnaire, namely the closed questionnaire. An open questionnaire provides results in the form of a mode which is then converted into technical characteristics through discussions and interviews with managers. Open and closed questionnaires were distributed to 30 respondents, namely
production workers. The ANP questionnaire was given to 1 respondent, namely the Head of Padding Production Manager.

**Table 1.** Analytical Network Process (ANP) questionnaire recapitulation.

| Consumer Voice Cluster   | Foam Padding                                                                 |
|--------------------------|-----------------------------------------------------------------------------|
|                          | Component Composition | Engine Capacity | Durability |
| Component Composition    | 1                        | 5              | 3          |
| Engine Capacity          | 1/5                      | 1              | 1/4        |
| Durability               | 1/3                      | 4              | 1          |

| Consumer Voice Cluster   | Knitting Fabric           |
|--------------------------|----------------------------|
|                          | Component Composition | Durability |
| Component Composition    | 1                        | 3          |
| Durability               | 1/3                      | 1          |

| Consumer Voice Cluster   | Size 100 x 200 cm         |
|--------------------------|----------------------------|
|                          | Cutting Speed | Accuracy of Cutting | Product Dimensions |
| Cutting Speed            | 1/7          | 1/7                  | 1/7                  |
| Accuracy of Cutting      | 7            | 1                    | 3                    |
| Product Dimensions       | 5            | 1/3                  | 1                    |

| Consumer Voice Cluster   | Foam thickness 7 cm       |
|--------------------------|----------------------------|
|                          | Component Composition | Engine Capacity | Durability |
| Component Composition    | 1                        | 5              | 3          |
| Engine Capacity          | 1/5                      | 1              | 1/3        |
| Durability               | 1/3                      | 3              | 1          |

| Consumer Voice Cluster   | Cream cloth color         |
|--------------------------|----------------------------|
|                          | Component Composition | Durability |
| Component Composition    | 1                        | 2          |
| Durability               | 1/2                      | 1          |

| Consumer Voice Cluster   | Foam As A Endurance Factor|
|--------------------------|----------------------------|
|                          | Component Composition | Engine Capacity | Durability |
| Component Composition    | 1                        | 1/4          | 1/2        |
| Engine Capacity          | 4                        | 1            | 3          |
| Durability               | 2                        | 1/3          | 1          |

| Consumer Voice Cluster   | Average 2 Year Product Life|
|--------------------------|----------------------------|
|                          | Component Composition | Durability |
| Component Composition    | 1                        | 4          |
| Durability               | 1/4                      | 1          |

| Consumer Voice Cluster   | Foam Quality as a Factor of Technical Specifications |
|--------------------------|------------------------------------------------------|
|                          | Component Composition | Durability |
| Component Composition    | 1                        | 1/5        |
| Durability               | 5                        | 1          |

| Cluster Technical Characteristic | Component Composition |
|----------------------------------|------------------------|
| Foam Padding                      | Knitting Fabric        | Cream cloth color | Foam Quality |
| Foam Padding                      | 1                      | 3              | 5            | 1/3          |
| Knitting Fabric                   | 1/3                    | 1              | 5            | 1/5          |
| Cream cloth color                 | 1/5                    | 1/5            | 1            | 1/7          |
| Foam Quality                      | 3                      | 5              | 7            | 1            |

| Cluster Technical Characteristic | Cutting Speed |
|----------------------------------|---------------|
| Knitting Fabric                   | Size 100 x 200 cm | Foam thickness 7 cm |
| Knitting Fabric                   | 1              | 1/5             | 1/3          |
| Size 100 x 200 cm                 | 5              | 1              | 5            |
| Foam thickness 7 cm               | 3              | 1/5            | 1            |

| Cluster Technical Characteristic | Accuracy of Cutting |
|----------------------------------|---------------------|
| Size 100 x 200 cm                 | Foam thickness 7 cm | Foam thickness 7 cm |
| Size 100 x 200 cm                 | 1                  | 5              |
| Foam thickness 7 cm               | 1/5                | 1              |

| Cluster Technical Characteristic | Engine Capacity |
|----------------------------------|-----------------|
| Knitting Fabric                   | Foam thickness 7 cm |
| Knitting Fabric                   | 1               | 3              |
| Foam thickness 7 cm               | 1/3             | 1              |

| Cluster Technical Characteristic | Durability |
|----------------------------------|------------|
| Foam As A Endurance Factor Produk | Average 2 Year Product Life |
Table 2. Summary of Analytical Network Process (ANP) questionnaire among priorities.

| Cluster Technical Characteristic | Product Dimensions |
|----------------------------------|--------------------|
| Size 100 x 200 cm                | Foam thickness 7 cm |
| Foam As A Endurance Factor       | 1                  |
| Average 2 Year Product Life      | 1/4                |

The next step after obtaining the mode of each open and closed questionnaire, the next step in building HoQ is to determine the characteristics needed to meet the variable consumer needs for mattress products. Determination of product characteristics based on interviews and discussions with factory production supervisors. The technical characteristics of the product are as follows: (a) Component Composition, (b) Cutting Speed, (c) Cutting Accuracy, (d) Machine Capacity, (f) Durability, and (g) Product Dimensions.

The next stage is to determine the level of relationship between technical characteristics. After determining the relationship between technical characteristics, then determining the level of relationship between the technical characteristics of the product and consumer desires. The relationship level is obtained from the weights which are then calculated using the priority weights which are then calculated using the ANP priority weights for each relationship characteristic with the consumer's voice based on the ANP questionnaire.

The priority weight between elements is arranged into a matrix called a super matrix. Super matrix is used to get the limit of the super matrix using super decision software. Super matrix tables and super matrix constraints can be seen in table 3.

Table 3. Global Weight.

| No. | Element                                      | Weight   |
|-----|----------------------------------------------|----------|
| 1   | Foam Padding                                 | 0.053363 |
| 2   | Knitting Fabric                              | 0.105433 |
| 3   | Size 100 x 200 cm                           | 0.032457 |
| 4   | Foam thickness 7 cm                         | 0.025774 |
| 5   | Cream Cloth Color                           | 0.010079 |
| 6   | Foam As A Endurance Factor                  | 0.152637 |
| 7   | Average 2 Year Product Life                 | 0.038159 |
| 8   | Foam Quality as a Factor of Technical Specifications | 0.114555 |

Before building a quality house (HOQ) it is necessary to calculate the HoQ performance measurement which consists of three aspects, namely the level of difficulty, the level of importance and the estimated cost. The calculation of these three aspects can be seen in the following description:

- Determination of the level of difficulty. The level of difficulty is determined by the relationship of technical characteristics. The calculation is done by translating all the weights of the
relationship value then dividing the weights of each technical characteristic by the number of weights earlier. Furthermore, the level of difficulty is given based on the range of percentages obtained.

- Determination of the degree of importance. Degree of importance is a value indicating the importance of a technical characteristic based on limiting super matrix.
- Cost estimation. The difficulty level factor is used as the basis for cost estimates because the more difficult a technical characteristic is made, the more expensive the allocation of costs will be.

| Degree of relationship | Weight |
|------------------------|--------|
| Strong positive relationship | 4 |
| Weak positive relationship | 3 |
| Weak negative relationship | 2 |
| Strong negative relationship | 1 |
| No relationship | 0 |

Determination of the level of difficulty, degree of importance and estimated costs can be seen in table 4. HoQ matrix is made based on data that has been obtained in the previous steps. QFD Mattress products can be seen in figure 1.

Figure 1. QFD of mattress products

Determination of the level of difficulty, degree of importance and estimated costs can be seen in table 4. HoQ matrix is made based on data that has been obtained in the previous steps. QFD Mattress products can be seen in figure 1.
Table 4. Difficulty levels, interests, and estimated costs.

| Difficulty level | 3 | 4 | 4 | 3 | 3 | 4 |
|------------------|---|---|---|---|---|---|
| Degree of importance | 14 | 23 | 21 | 11 | 11 | 20 |
| Cost estimation | 15 | 20 | 20 | 15 | 15 | 20 |

4. Conclusion
The results of QFD mattress products show that the attributes that have the highest degree of difficulty are the cutting speed, cutting accuracy, product dimensions, component composition, machine capacity and durability. The value of the difficulty level of cutting speed is 4 and the degree of importance is 23% and the estimated cost is 20%. The results of weighting technical characteristics using the Analytical Network Process (ANP) method of the largest weight value are cutting speed, cutting accuracy, product dimensions, component composition, machine capacity and durability.

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