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Design of conveyor table with quality function deployment method and statistical analysis of anthropometry data approach as a physical distance tool for SMEs

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Design of conveyor table with quality function deployment method and statistical analysis of anthropometry data approach as a physical distance tool for SMEs

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Abstract. The world is currently facing with COVID-19 pandemic. One way to prevent the spread of COVID-19 is to do physical distancing. However, this has an impact on the continuity of the economy and business. The Ministry of Trade, Cooperatives, SMEs, and Industry announced that the Covid-19 pandemic affected the activities of SMEs. One of the SMEs that impacted is the commercial sector, such as markets, essential food stores, food stalls, coffee shops, etc. Before the Covid-19 pandemic, the business process carried out was face-to-face with customers without any distance. So that when the physical distancing rules are implemented, the service flow will be disrupted. With this conveyor, the SMEs service process flow can support business process activities properly and smoothly while still complying with physical distancing rules. The process of moving business products from the seller to the consumer is done automatically. Based on these problems, it is necessary to design a conveyor table that will be used as a media for physical distancing tools that are in according needs of the user using the Quality Function Deployment method and statistical analysis of anthropometric data approach.

1. Introduction

The world is currently struggling with the COVID-19 pandemic. Covid-19 is an infectious disease caused by the SARS-CoV2 virus. Symptoms of COVID-19 include fever, cough, and shortness of breath. The symptoms caused by COVID-19 are serious enough to be able to paralyze all activities in the community [1]. The Covid-19 pandemic cannot be controlled quickly, so it requires proper management from both the government and the community. One of the preventions to stop the transmission of Covid-19 that is recommended by the government is to carry out physical distancing [2].

The Ministry of Trade, Cooperatives, SMEs, and Industry, stated the Corona Virus Disease (Covid-19) pandemic affects the activities of micro, small and medium enterprises and cooperatives. Business actors are encouraged to make business adjustments so that they are still able to increase public trust in business actors who strictly adhere to health protocols by doing physical distancing [3].

One of the SMEs that has an impact is in the trade sector is a shop, a basic food agent, a food stall, a coffee shop, etc. So far, prior to the Covid-19 pandemic, the business processes carried out by SMEs were face-to-face with customers without any distance.

Figure 1. SMEs business process.

Based on interviews and observations at the related SMEs, their business operations were disrupted due to the call for physical distancing. With this conveyor tool, the SME's service process flow can support business process activities well and smoothly while still complying with physical distancing rules. The process of moving workpieces or business products from the desk of the business actor to the table of the consumer is carried out automatically.

Based on these problems, it is necessary to design a conveyor table that will be used as a medium for physical distancing tools that are in accordance with the needs of the user based on an approach to statistical analysis of anthropometric data [4-5] .

The design of the conveyor table in this research will use the Quality Function Deployment method to identify needs so that it is in accordance with the expectations of the user, and this study also uses an approach to statistical analysis of anthropometric data to obtain dimensions that are in accordance with the characteristics of the user's body size. The QFD method itself is a method used in the process of planning and developing a product to determine the specifications of consumer needs and desires, as well as systematically evaluating the capabilities of a product or service in meeting consumer needs and desires [6]. QFD is one of its functions as a communication tool to connect product designers and conveyor table users so that the product design and development process can be carried out effectively and efficiently [7-8].

After obtaining the product design in accordance with the expectations and desires of the customer, it is necessary to design dimensions that are suitable for the user using statistical analysis of anthropometric data. This statistical application can help designers research human variability and use this information in product design [9].

The system to be built is to create an intelligent conveyor that is able to work according to specifications, namely a) Arduino-based so it can be programmed speed and moving patterns, b) can be controlled through automatic control and can also be controlled manually.

2. Problem Formulation

Based on the background and identification of the problem above, the authors formulate how to design a conveyor table tool according to the needs of SMEs activities and how to design a conveyor table tool according to the dimensions of the user's body. A conveyor table tool is needed by paying attention to problems and consistency in the implementation of government programs in the form of physical distancing in economic activities, with QFD (Quality Function Deployment) method to suit the needs of SMEs activities and with an approach to statistical analysis of anthropometric data to suit the needs of SMEs user dimensions.

The benefits to be achieved are obtaining an effective, comfortable, safe, and efficient conveyor table tool, obtaining a conveyor table tool for SMEs, obtaining a new business process flow method that emphasizes physical distancing to reduce the spread of Covid-19.

2.1 Research Position

This research requires input from previous research. Then it requires a research position.

Table 1. Research position.

No.	Author	Topics	Objective
1.	Nurrohman, and Yohanes [10].	Design of a jenang pressing device using anthropometric and ergonomic methods (Case Study at UKM Pemalang). (2017)	Improved work efficiency.
2.	Montororing, Y.D.R., and Sihombing, S [11].	Design of Work Aids With Ergonomics Principles in Weighing at PT. BPI. (2020)	Increased work productivity.
3.	Widyantoro, M., et al [12].	Proposed Alcon Engine Design at the South Jakarta Forestry Service Using the Reba Method (2020)	Elimination of work risk.

3. Methodology

In this study, the type used is exploratory and descriptive. The research data collection was carried out at SMEs located in the District of North Bekasi, Bekasi City, West Java. Data collection and research data processing activities were carried out in the period from May to July 2021.

Data collection was carried out by the method of a) observation which was carried out by observing objects directly related to research. This method was carried out by the author by observing the existing facilities at SMEs, b) Interviews with direct questions and answers to SMEs business actors to provide questions about the need for additional facilities for assistive devices c) Questionnaires to obtain information from respondents.

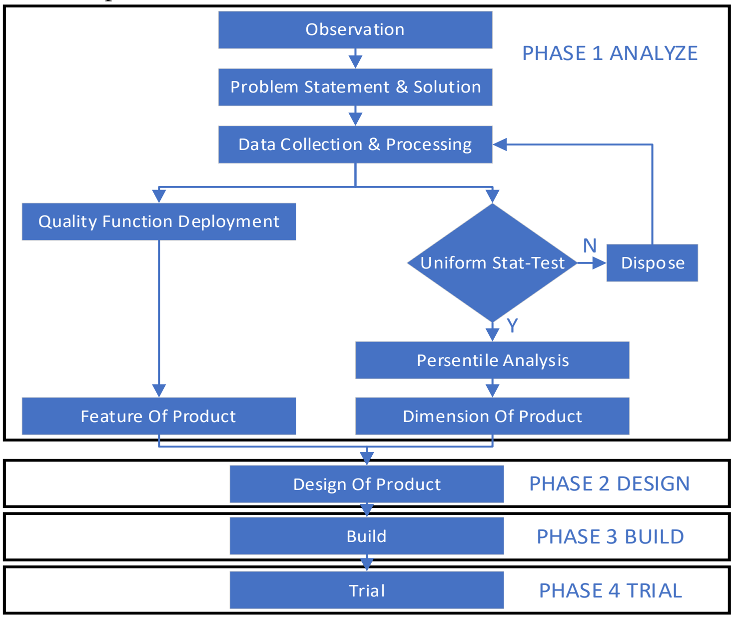

Figure 2. Research framework.

4. Result and Discussion

Stages of the conveyor table making process in this study went through several stages, describe inflow process bellow:

Figure 3. Flow process.

The Analysis stage is where the designer (writer) collects information from the Voice Of Customer, which is very important to the Voice Of Customer in obtaining a conveyor table that suits the needs of MSME business actors.

The Design Stage is the concept stage used as a designer's description in designing a conveyor table that suits the needs of business people and the goods that will be served to customers.

The assembly stage is the design stage of the conveyor table, where at this stage, the conveyor table that was selected was designed according to the specifications of the voice of the customer and the parameters of the anthropometry of the conveyor table user.

The trial stage is the last stage, where at this stage, the conveyor table that has been designed and tested is then tested to ensure whether the conveyor table can operate properly and provide training on how to operate the tool.

4.1 Quality Function Deployment

In designing a conveyor table, it takes some data on the characteristics of respondents. It is obtained from the user, namely a) Respondents level of need to determine how much procurement a conveyor table design is needed, b) Respondents level of desire to determine what kind of conveyor table the respondent wants, c) Respondent satisfaction to determine how much is the respondents satisfied using the conveyor table [13].

The number of respondents in this study amounted to 10 respondents. The characteristics of the respondents were based on gender and age to determine the Voice of Customer and anthropometry, which would be used as a benchmark in the design of the conveyor table.

4.1.1 Gender Based

Based on the gender of the respondents in this study, the author requires percentage of respondents based on gender in designing this conveyor table. The following is the respondent's data in Table 2.

Table 2. Characteristics of respondents by gender.

Gender	Responden Number	Presentage
Male	3	30 %
Female	7	70 %
Total	10	100 %

4.1.2 Age Based

Based on the age of the respondents in this study consisting of ages ranging from 19 years to 22 years, the authors need to know the percentage of respondents based on age. The following is the respondent's data in Table 3.

Table 3. Characteristics of respondents based on age.

Age (yrs)	Responden Number	Presentage
19	2	20%
20	3	30%
21	3	30%
22	2	20%
Total	10	100%

4.2 Smart Conveyor Table Design Design

In designing a conveyor table, the first step is to design the conveyor table because the conveyor table design is the initial concept in designing based on the dimensional parameters above.

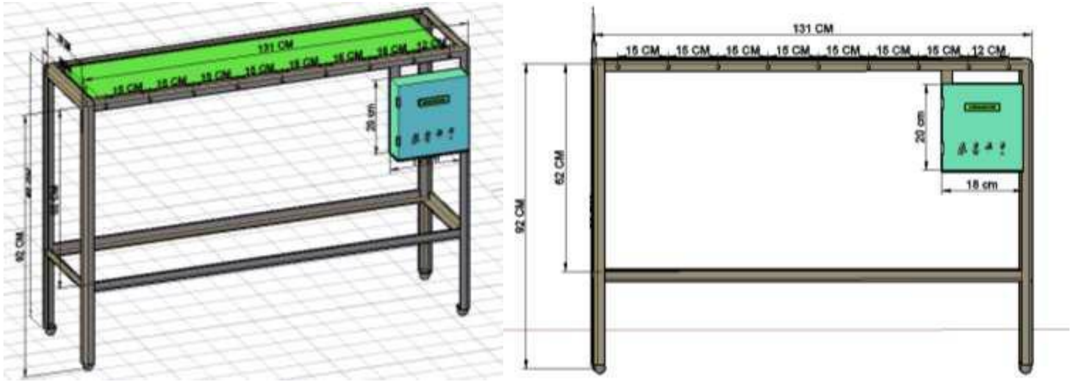

Figure 4. Conveyor table design.

To meet the needs of SMEs, a conveyor table is needed that can meet business activities and according to the user's body dimensions. In designing this conveyor table, a conveyor table design is very necessary because the conveyor table design is an initial concept for the author in designing a conveyor table that the author will design. This designed Conveyor table has the following specifications in Table 4.

Table 4. Conveyor table specifications.

No	Specifications
1	Flexible in moving process
2	Dimension designs that match anthropometric
3	Easy to operating
4	Has Features, Variable Speed Control, Forward Reverse Control, and Nonstation and With Station
5	Only required 5V DC voltage and can use a battery

4.3. Statistical analysis of anthropometric data with Percentiles
Percentile analysis of anthropometric data obtained from questionnaires that have been filled out by business and user respondents with a total of 10 respondents focusing on the age and gender of users can be seen in Table 5.

4.3.1 Height (D1)
The anthropometric data from height and the results of percentile calculations are as follows in Table 5.

Table 5. Height Anthropometry Data (D1).

No	Gender	Age (yrs)	Height (D1)
1	Male	19	170 cm
2	Male	19	165 cm
3	Male	20	162 cm
4	Female	20	160 cm
5	Female	20	160 cm
6	Female	21	146 cm
7	Female	21	162 cm
8	Female	21	160 cm
9	Female	22	146 cm
10	Female	22	161 cm

1. Average (X)
   The average value of the respondent's height is obtained:

$$X = \frac{\sum(X_i)}{N} \quad (1)$$

$$= \frac{170+165+162+160+160+\cdots.+161}{10} = 159{,}2\ cm \quad (2)$$

2. Standard Deviation (SD)
   The value of the standard deviation of height was obtained;

$$\sigma = \sqrt{\frac{\sum(X_i - X)^2}{N-1}} \quad (3)$$

$$= \sqrt{\frac{(170-159{,}2)^2+\cdots.+(161-159{,}2)^2}{10-1}} = 7{,}6 \quad (4)$$

3. Persentil 50th
   Anthropometric percentile calculations obtained;
   Persentil 50th = X – 0 (σ (5)
   = 159,2 – 0 (7,6) = 159,2 cm (6)
4. Upper Control Limit (UCL) and Lower Control Limit (LCL)
   UCL = X + *k* (σ) = 159,2 + 3 (7,6) = 182 cm (7)
   LCL = X – k (σ) = 159,2 – 3 (7,6) = 136,4 cm (8)

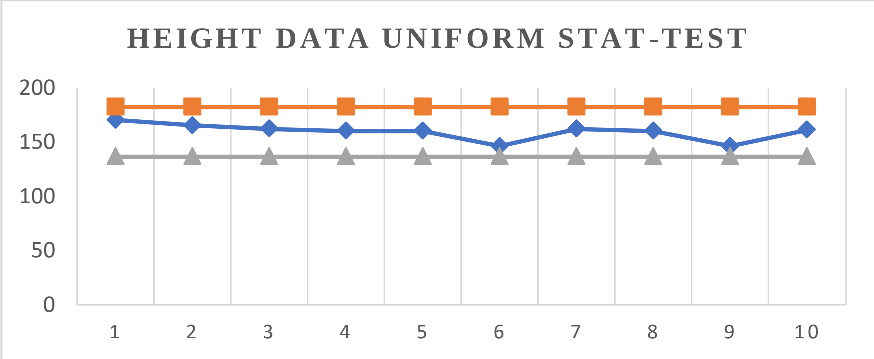

Figure 5. Height data uniformity test.

In figure 4, The uniformity of the respondent's height data can be concluded that the respondent's height value does not exceed the upper control limit or lower control limit, with a UCL value of 182 cm, a LCL value of 136.4 cm and a 50th percentile value of the respondent's height 159.2 cm.

4.3.2 Elbow Height (D4)

The anthropometric data from height and the results of percentile calculations are as follows:

Table 6. Elbow Height Anthropometry Data (D4).

No	Gender	Age (yrs)	Elbow Height (D4)
1	Male	19	102 cm
2	Male	19	97 cm
3	Male	20	95 cm
4	Female	20	80 cm
5	Female	20	80 cm
6	Female	21	75 cm
7	Female	21	95 cm
8	Female	21	82 cm
9	Female	22	75 cm
10	Female	22	77 cm

1. Average (X)
   The average value of the respondent's elbow height is obtained:

$$X = \frac{\Sigma(X_i)}{N} \quad (9)$$
$$= \frac{102+97+95+80+80+\cdots+77}{10} = 85{,}8\ cm \quad (10)$$

2. Standard Deviation (SD)
The value of the standard deviation of height was obtained;

$$\sigma = \sqrt{\frac{\Sigma(X_i - X)^2}{N-1}} \quad (11)$$
$$= \sqrt{\frac{(102-85{,}8)^2+\cdots+(77-85{,}8)^2}{10-1}} = 10{,}27 \quad (12)$$

3. Persentil 50th
Anthropometric percentile calculations obtained;
Persentil 50th = X – 0 (σ) (13)
= 85,8 – 0 (10,27) = 85,8 cm (14)
4. Upper Control Limit (UCL) and Lower Upper Control Limit (LCL)
UCL = X + *k* (σ) = 85,8 + 3 (10,27) = 116,61 cm (15)
CLC = X – k (σ) = 85,8 – 3 (10,27) = 54,99 cm (16)

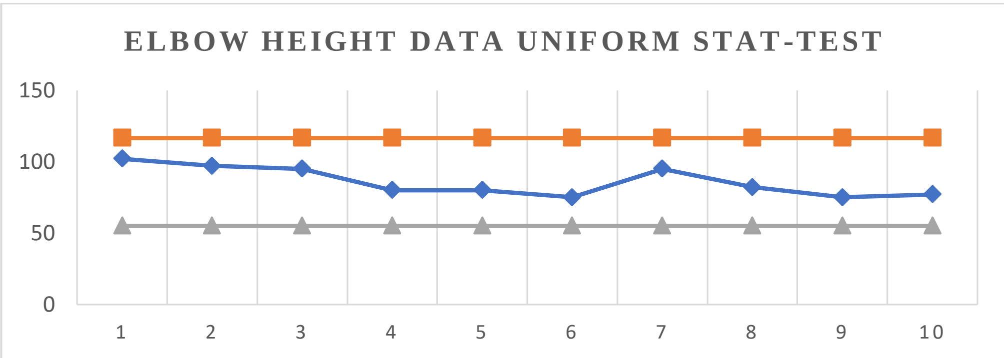

Figure 6. Elbow height data uniformity test.

In Figure 5, the uniformity of the respondent's elbow height data can be concluded that the respondent's elbow height value does not exceed the upper control limit or lower control limit, with a UCL value of 116.61 cm, a LCL value of 54.99 cm, and a 50th percentile value of respondent's elbow height of 85.8 cm.

4.3.3 Hip Height (D5)
The anthropometric data from height and the results of percentile calculations are as follows:

Table 7. Hip Height Anthropometry Data (D5)

No	Gender	Age (yrs)	Hip Height (D5)
1	Male	19	93 cm
2	Male	19	88 cm
3	Male	20	85 cm
4	Female	20	73 cm
5	Female	20	73 cm
6	Female	21	70 cm
7	Female	21	88 cm
8	Female	21	75 cm
9	Female	22	70 cm
10	Female	22	74 cm

1. Average (X)
   The average value of the respondent's elbow height is obtained:
   $$X = \frac{\sum(X_i)}{N} \quad (17)$$
   $$= \frac{93+88+85+73+73+\cdots.+74}{10} = 78{,}9\ cm \quad (18)$$
2. Standard Deviation (SD)
   The value of the standard deviation of height was obtained;
   $$\sigma = \sqrt{\frac{\sum(X_i - X)^2}{N-1}} \quad (19)$$
   $$= \sqrt{\frac{(93-78{,}9)^2+\cdots.+(74-78{,}9)^2}{10-1}} = 8{,}62 \quad (20)$$
3. Persentil 50th
   Anthropometric percentile calculations obtained;
   Persentil 50th = X – 0 (σ) (21)
   = 78,9 – 0 (8,62) = 78,9 cm (22)
4. Upper Control Limit (UCL) and Lower Upper Control Limit (LCL)
   UCL = X + *k* (σ) = 78,9 + 3 (8,62) = 104,76 cm (23)
   LCL = X – k (σ) = 78,9 – 3 (8,62) = 53,04 cm (24)

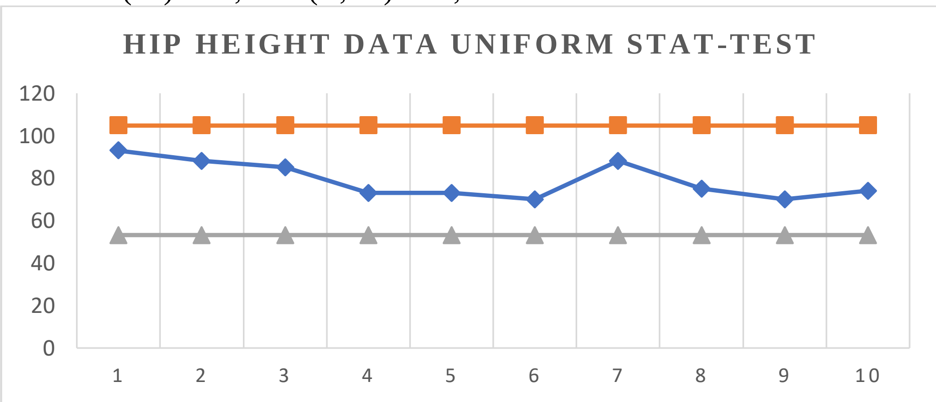

Figure 7. Hip height data respondent uniformity test.

In figure 6, the uniformity of the hip height data of respondents can be concluded that the hip height value of the respondent does not exceed the upper control limit or lower control limit, with a UCL value of 104.76 cm, a LCL value of 53.04 cm, and a 50th percentile value of respondent's hip height of 78.9 cm.

4.3.4 Arm Length Forward (D24)
The anthropometric data from height and the results of percentile calculations are as follows:

Table 8. Long-Span Anthropometric Data (D5).

No	Gender	Age (yrs)	Length Forward (D24)
1	Male	19	70 cm
2	Male	19	65 cm
3	Male	20	65 cm
4	Female	20	60 cm
5	Female	20	60 cm
6	Female	21	62 cm
7	Female	21	63 cm
8	Female	21	60 cm

No	Gender	Age (yrs)	Length Forward (D24)
9	Female	22	60 cm
10	Female	22	62 cm

1. Average (X)
   The average value of the respondents' hip height was obtained:

$$X = \frac{\sum(X_i)}{N} \quad (25)$$

$$= \frac{70+65+65+60+60+\cdots.+62}{10} = 62{,}7\ cm \quad (26)$$

2. Standar Deviation (SD)
   The value of the standard deviation of height was obtained;

$$\sigma = \sqrt{\frac{\sum(X_i - X)^2}{N-1}} \quad (27)$$

$$= \sqrt{\frac{(70-62{,}7)^2+\cdots.+(62-62{,}7)^2}{10-1}} = 3{,}23 \quad (28)$$

3. Persentil 50^{th}
   Anthropometric percentile calculations obtained;
   Persentil 50^{th} = X – 0 (σ) (29)
   = 62,7 – 0 (3,23) = 62,7 cm (30)
4. Upper Control Limit (UCL) and Lower Control Limit (LCL)
   UCL = X + *k* (σ) = 62,7 + 3 (3,23) = 72,39 cm (31)
   LCL = X – k (σ) = 62,7 – 3 (3,23) = 53,01 cm (32)

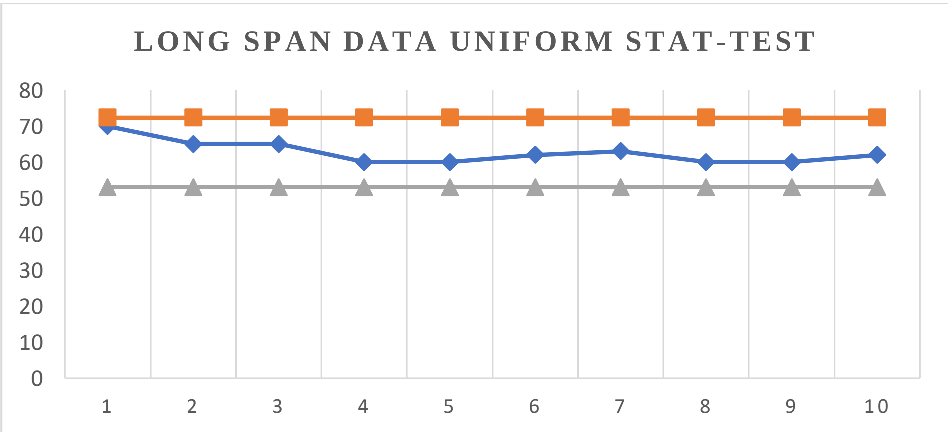

Figure 8. Data uniformity of respondent length range.

In figure 7, the uniformity of the respondent's front arm length data can be concluded that the respondent's front arm length does not exceed the upper control limit or lower control limit, with a UCL value of 72.39 cm, a LCL value of 53.01 cm, and a 50th percentile value of span length. hands in front of respondents 62.7 cm.

4.4 Design Dimension Parameters
In designing this conveyor table, the author, in calculating the percentile, used the 50th percentile because the 50th percentile is a moderate value so that the conveyor table users from the smallest and largest percentiles can use a conveyor table from the design results.

Table 9. Recaps of antropometry data.

Dimension	X	D	Pnth	UCL	LCL	Uniform Stat-Test
Height (D1)	159,2	7,6	P50=159,2	182	36,4	Uniform
Elbow Height(D4)	85,8	10,27	P50=85,8	116,61	4,99	Uniform
Hip Height(D5)	78,9	8,62	P50=78,9	104,76	3,04	Uniform
Forward Hand Span (D24)	62,7	3,23	P50=62,7	72,39	3,01	Uniform

The following are the design specifications for the conveyor table.

Table 10. Design specification.

Spesification	Quality Dimension	Description
Conveyor table is durable and long lasting	Durability	The material on this conveyor table is made of 3mm thick angled iron so that it is strong enough to support a load weighing 2-3kg, and on the type controller, the designer chooses a type controller that is durable and not easily damaged. The durable and long-lasting conveyor table is designed according to the type of workpiece used by business people.
Uncomplicated conveyor table operation	Conformance	This conveyor table is easy to operate because it is equipped with buttons (settings) that can be easily understood by users.
Flexible conveyor table	Conformance	This conveyor table is equipped with caster wheels, and this conveyor table is light enough so that users can adjust the position of the conveyor table easily.
	Reliability	This conveyor table is reliable in moving, no need for tools in the process of moving.
Electricity-saving conveyor table	Performance	The conveyor table can operate with a small voltage of 5V DC, and the electricity consumption on this conveyor table is also relatively cheap, around Rp. 7,500 in operating the conveyor table for 12 hours/day.
Effective and efficient conveyor table design	Conformance	This conveyor table has a design size that adapts to the anthropometry of the user's body, making it comfortable to use.
	Aesthetics	The design of this conveyor table is also not inferior to the conveyor table design in the industry in general.
Conveyor table is easy to repair	Servicebility	This conveyor table has materials that are widely sold in the market, and the price of the material is also affordable, making it easy to repair.
	Conformance	In this case, the conveyor table is also easy to repair and adjust the expertise of the maintenance side.
The conveyor table have features	Conformace	This conveyor table can adjust the settings desired by the user.
	Features	This conveyor table has features, speed, forward & reverse control, continuous & noncontinuous.
	Perceived Quality	The quality of this conveyor table feature is quite good from the satisfaction rating. It gets a value of 4.3 from users and is under what the user wants.
	Reliability	The features of this conveyor table are reliable enough so that the conveyor table can work as desired by its users.

5. Conclusions

From the results of this study, the design of a conveyor table using the QFD method results from an approach between the design and the respondent's anthropometric dimension parameters to get the conveyor table results according to the user's needs. The results of the design of the conveyor table with specifications; durable, uncomplicated, flexible, energy-efficient, easy to maintain, and has features. The suggestion of the conveyor design, obtained a height of 159.2 cm, elbow height of 85.8 cm, hip height of 78.9 cm, and length of arm forward 62.7 cm.

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