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Layout of Conveyor Production Facilities With Craft Method

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Abstract - ***CV. Frontec Agritama Engineering is a company engaged in manufacturing, the increasing demand for products makes the company lack a place for production activities and a place to store raw materials and finished materials, thus the company plans to move to a wider area so that the production process runs effectively. This research will use the CRAFT method. The purpose of the CRAFT method is to evaluate the factory layout to get the most optimal results that are harmonized with the ARC method. Data collection in this study is through measuring the distance between stations and the number of stations in the company. The results of research using the CRAFT method resulted in a layout of proposed production areas with a total FTC distance of 807.88 meters.***

Keywords: Facility Layout, From to Chart, Craft Method, Activity Relation Chart

I. INTRODUCTION

A conveyor is a machine that has a mechanical system that can move bulk materials from one place to another with a predetermined small to large capacity [1]. *Conveyorsare* chosen as a fast and effective means of transportation. There are several types of *Conveyors* Including *belt conveyors*, *Chain conveyors*, *screw conveyors*, *gravity conveyors,* and *bucket conveyors*[2]. In an industry sometimes some materials are vulnerable, and people cannot move them. Therefore, a means of transportation that can overcome human limitations is needed to protect the safety and security of workers. Because of this *Conveyor* Often chosen as a means of transporting large-sized production materials.

CV. Frontec Agritama Engineering is a company engaged in manufacturing. As an economic activity, manufacturing accounts for 20-30% of the value of domestically produced goods and services. The company produces machine*feed mills* like *Chain Conveyor*, *bucket conveyors*, *Pneumatic Slidegate,* and others. In the last 2 years, the demand for machines has increased by an average of around 60%, with this increasing demand making the company lack a place for production activities and storage of raw materials and finished materials, thus the company plans to move to a wider area so that the production process continues. With the movement of production sites, it requires companies to design the layout of production machines optimally so that the production process can run efficiently [3].

Based on the description, Preparation *Layout* Production is very important for companies which includes optimizing time, with a layout that has been arranged can save time in doing work and then can also expedite the process of work and material transportation so that no goods or work goes back and forth, intersects and cuts the flow of work. So the design and layout of machines, equipment, or rooms are very influential for the continuity of the production process in a company because the factors that affect the efficiency of the production process are the layout design and warehouse design [4]. The layout design of this production facility can be done by the CRAFT method. The choice of the CRAFT method is because the method has advantages in determining locations with simple and short computational time [5].

II. LITERATURE REVIEW

a. Conveyor

The conveyor is a mechanical system with the function of moving material from one process to another [6]. Conveyors are often used in industry to move heavy loads of goods, many

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continuously [7]. In certain situations, conveyors are widely used because they offer greater economic advantages than other modes of transportation such as trucks and motor vehicles. The conveyor can move objects quickly and continuously from one location to another. In an industry, sometimes the raw materials produced are materials that are harmful to humans or have abundant quantities. For that reason, a means of transportation is needed to move materials, considering the maximum capacity of human labor both in terms of the ability of objects to be transported and the safety of workers.

b. Feature Layout

Facility layout is an integrated planning of the flow of components of a product (goods or services) in an operating system (manufacturing and/or non-manufacturing) to obtain efficient linkages between workers, materials, machinery, and equipment as well as the transfer and handling of materials, semi-finished goods, from one department to another [8]. Facility layout is one of the important points in the design of production systems and the key to increasing factory productivity. The purpose of processing facilities is to increase the efficiency of several facilities or machines in one production line or production area, thereby reducing material costs and increasing the productivity of an industry [9]. There are four basic types of production floor layouts, namely:

1. Product Layout

A product-based layout is often referred to as a production line layout. This layout uses a method in which the arrangement and placement of all facilities are placed according to the order of the production process. The main purpose of this layout is to minimize the movement of materials and facilitate the monitoring of the production process.

2. Process Layout

Process-based layout, often referred to as process or function layout, is a method of organizing all similar production machinery and equipment within a department.

3. Fixed Position Layout

Fixed position layout, often referredto as *fixed position layout,* is a method of arrangement in which the main materials or components remain in their location or position, while production facilities such as tools, machinery, workers, and other components move toward the position of the main components.

4. Group Technology Layout

This type of layout is based on grouping the components or products to be manufactured. Identical products are collected based on classification, type, machinery, or equipment. This type of layout also groups all production systems into "*manufacturing cells*". By grouping and organizing production equipment, it will be able to achieve smooth workflow and achieve high efficiency.

c. Activity Relation Chart

Activity Relation Chart (ARC) is a way to plan the relationship between workstations based on the degree of activity relationship. This method can provide new configurations when laying out production facilities so that it can be used to increase productivity and efficiency [10]. In ARC, there are variables in the form of alphabetical symbols that indicate the degree of closeness between one department and another department, and numerical symbols that indicate the reason for closeness [11], which can be seen in Tables 1 and 2.

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Table 1 Relationship Degree Symbol

Symbol	Description
A	Close
E	It is very important to bring it closer
I	Important to be close
O	Usual
U	It is not important to bring it closer
X	It is not desirable to be brought close

Table 2 Symbol of Proximity Reasons

Symbol	Description
1	Material flow
2	Administration
3	Visual checking
4	Necessity
5	Dangerous

d. From to Chart

From to chart (FTC) is a traditional method used to plan plant layout and material transfer in the production process. From to chart is an adaptation of a distance chart that is usually applied to a certain route (road map), resulting in a total load weight. FTC is also known as a trip frequency chart or Travel Chart. FTC is a graph used to show the flow of material from one department to another [12]. This technique is quite useful in situations where many goods move through a certain space, such as job shops, machinery workshops, offices, and so on. The calculation of FTC distance in this study uses the euclidian method with the formula [8].

$$d_{i} = \sqrt{(x^{i} - x^{j})^2 + (y^{i} - y^{j})^2} \quad (1)$$

Where:

d_{ij} = distance between
(x^i, y^i) = coordinates of one point
(x^j, y^j) = coordinates of the other point

e. Craft Methode

Computerized Relative Allocation of Facilities Techniques (CRAFT) was developed in 1983 aiming to reduce material moving costs, where material moving costs are defined as product flow, distance, and unit transport costs [13]. The CRAFT method is an improvement program, this program aims to find the optimum design by interchanging each department. Optimum or optimal means best or highest [14]. So the word optimal here means the closer or the less the distance of movement between departments, it can be said *Layout* has reached the optimal. The principle of departmental exchange according to the CRAFT method must meet one of the following three conditions, namely, departments must have the same borders, departments must have the same size and departments must have both boundaries in the same three departments [15].

III. RESEARCH METHOD

This research was carried out in CV. Frontec Agritama Engineering with a research time of 6 months, namely from November 2022 to April 2023. Data was obtained using observation and interview

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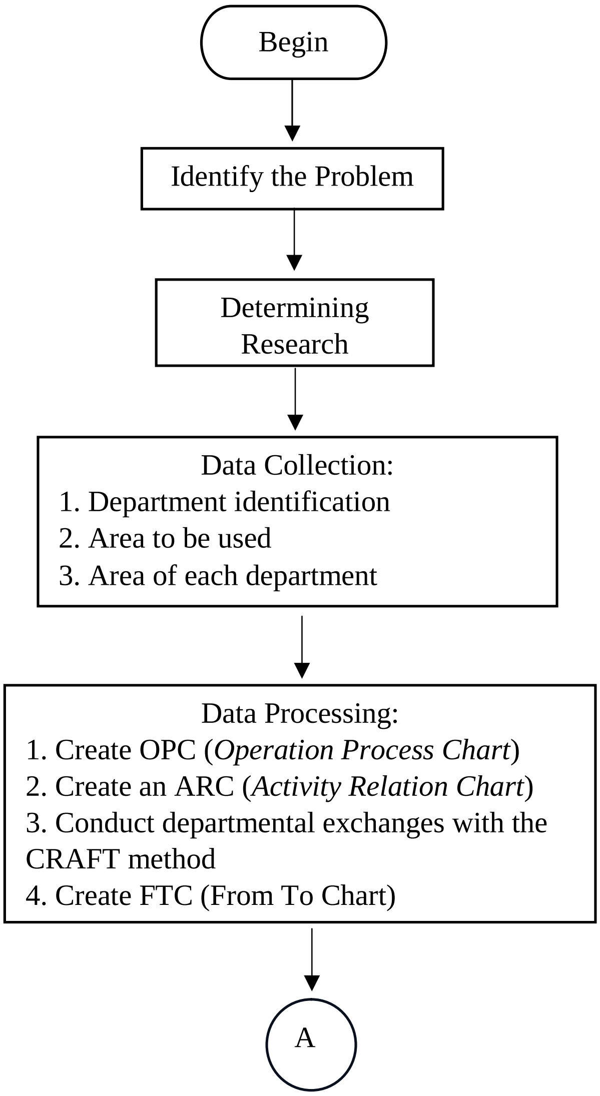
techniques. The observations made in this study are unstructured observations, where the process makes observational observations freely without using observation guidelines. Interviews are conducted directly with production managers, production supervisors, and production employees. This interview aims to find out the data on the area of the machine area as well as the data on the area that will be used as a new area. The research flow can be seen in Figure 1.



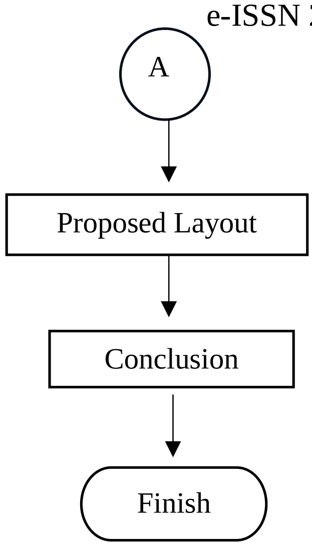


Figure 1. Flow Diagram

The steps taken in the data processing process include:

1. Identify departments in the production area

   This identification aims to find out what departments are in the production area.
2. Calculating the area of each department in the production area

   Area calculation aims to find out the area of each department so that when exchanging blocks, the area of the department remains the same as the initial data.
3. Create an ARC

   The relationship between departments is measured qualitatively using a benchmark of the degree of proximity between one facility and another. Also included are the reasons underlying the relationship between these departments.
4. Design layouts based on ARC

   Describe the position of each department by taking into account the relationship between departments.
5. Create FTC distance per department

   Calculate the distance between one department and another. The calculation of this distance uses the Euclidian method.
6. Exchange individual departments

   Perform trial and error to find the optimal layout.

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IV. ANALYSIS AND DISCUSSION

4.1 Data Collection

From the results of observations and interviews, results were obtained in the form of the production process seen in Figure 2 and there are 8 departments in the production area shown in Table 3. These departments are planned to occupy a production area of 600m^2.

Table 3 Production Area Department

Code	Department	Function
A	Office	Office space for information collection such as planning, and decision-making.
B	Raw Material Warehouse	Raw material warehouse for storing raw materials.
C	*Cutting*	Cutting area for cutting raw materials or parts to be produced.
D	*Bending*	Bending area *for bending raw materials or parts to be produced.*
E	*Rolling*	Bending area to roll raw materials or parts to be produced.
F	*Fabrication*	Fabrication area to combine several parts into subassembly.
G	*Finishing*	Finishing areafor part painting or subassembly.
H	Finished Goods Area	Finished material area to store parts or *subassemblies* that have been completed.

As an illustration of conveyor production in CV. Frontec Agritama Engineering, the manufacturing process flow is depicted in the form of an operation process diagram which can be seen in Figure 2.

Figure 2. Operation Process Chart Drive Chain Conveyor

Based on the data in Table 3, the company wants the area of each department to be adjusted so that the production area can run optimally in an area of 600m2. From the results of interviews with production managers and production heads, data were obtained in Table 4.

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Table 4 Department Area Production Area

Department Code	Department	P (m)	×	L(m)	Area (m2)
A	Office	7	×	6	42
B	Raw Material Warehouse	6	×	13	78
C	*Cutting*	16	×	7	112
D	*Bending*	7	×	8	56
E	*Rolling*	7	×	5	35
F	*Fabrication*	7	×	19	133
G	*Finishing*	6	×	5	30
H	Finished Goods Area	19	×	6	114

4.2 Data Processing

1. Activity Relation Chart (ARC)

The ARC diagram is arranged based on the degree of proximity, the value of the degree of proximity is shown in Table 1. While the reasons for closeness between departments and the reasons for closeness are obtained from interviews and observations with the head of production, the ARC diagram is shown in Figure 3.

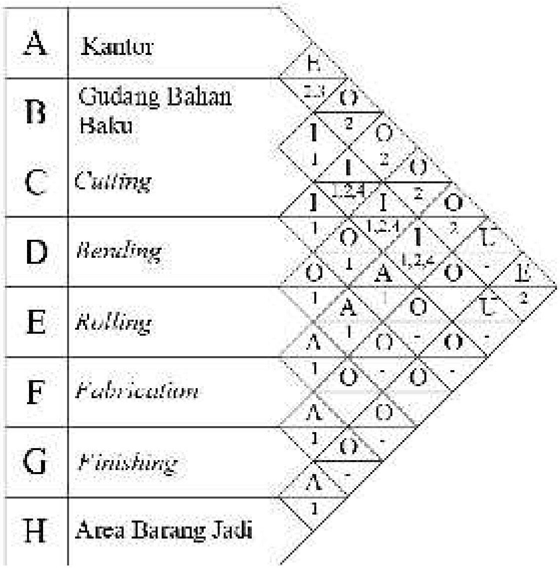

Figure 3. Activity relation Chart

2. Data processing using Autocad software.

a. Layout proposal 1

Based on the ARC diagram, several departments are absolutely closer to the fabrication department, namely the cutting, bending, rolling and finishing departments because they are related to material flow. Then the office department is very important to be close to the raw material warehouse department and finished goods area because it is related to administration and visual checking.

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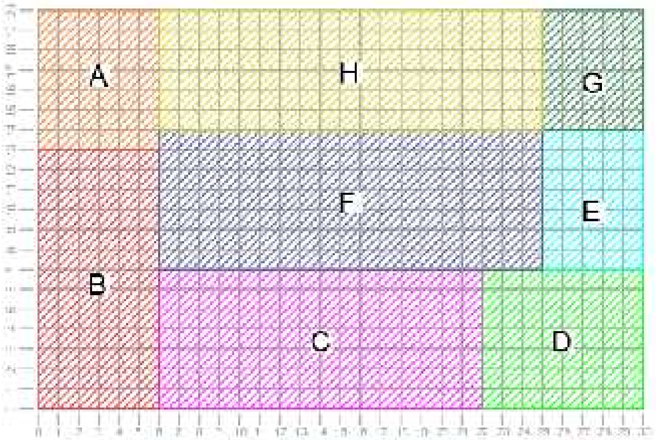

Figure 4. Layout Proposal 1

Furthermore, from the layout of Figure 4 a calculation is made for From To Chart (FTC) distance. As for the FTC layout, proposal 1 is prepared in Table 5.

Table 5 From to Chart Distance in Proposal Layout 1 (in m)

	To A	To B	To C	To D	To E	To F	To G	To H	Sub Total
From A	0	10,00	17,03	26,42	25,22	13,87	24,51	12,51	129,56
From B	10,00	0	11,40	23,19	24,82	13,12	26,66	16,32	125,51
From C	17,03	11,40	0	12,00	15,21	7,16	19,09	13,58	95,47
From D	26,42	23,19	12,00	0	7,16	12,62	13,58	17,10	112,07
From E	25,22	24,82	15,21	7,16	0	12,00	6,50	13,65	104,56
By F	13,87	13,12	7,16	12,62	12,00	0	13,65	6,50	78,92
From G	24,51	26,66	19,09	13,58	6,50	13,65	0	12,00	115,99
From H	12,51	16,32	13,58	17,10	13,65	6,50	12,00	0	91,66
Sub Total	129,56	125,51	95,47	112,07	104,56	78,92	115,99	91,66	853,74

b. Layout Proposal 2

In the proposed layout 2 cutting departments (C) shifted closer to the fabrication (F) and finishing (G) departments, while the bending (D) and rolling (E) departments shifted closer to the raw material warehouse department (B).

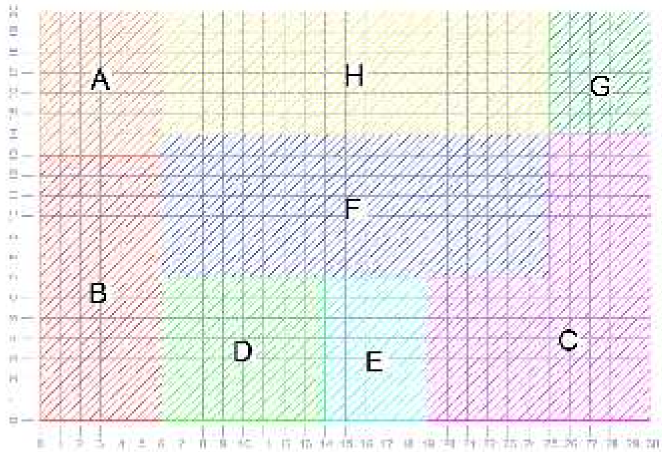

Figure 5. Layout Proposal 2

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Furthermore, from the layout of Figure 5 a calculation is made for From To Chart (FTC) distance. Table 6 is FTC layout proposal 2.

Table 6 From to Chart Distance in Proposal Layout 2 (in m)

	To A	To B	To C	To D	To E	To F	To G	To H	Sub Total
From A	0	10,00	24,91	14,76	18,74	13,87	24,51	12,51	119,30
From B	10,00	0	22,45	7,62	13,83	13,12	26,66	16,32	110,00
From C	24,91	22,45	0	15,59	9,20	11,04	11,50	15,06	109,75
From D	14,76	7,62	15,59	0	6,50	8,90	22,10	14,58	90,05
From E	18,74	13,83	9,20	6,50	0	7,07	17,41	13,54	86,29
By F	13,87	13,12	11,04	8,90	7,07	0	13,65	6,50	74,15
From G	24,51	26,66	11,50	22,10	17,41	13,65	0	12,00	127,83
From H	12,51	16,32	15,06	14,58	13,54	6,50	12,00	0	90,51
Sub Total	119,30	110,00	109,75	90,05	86,29	74,15	127,83	90,51	807,88

c. Layout Proposal 3

In the proposed layout, 3 bending departments (D) were exchanged for rolling departments (E).

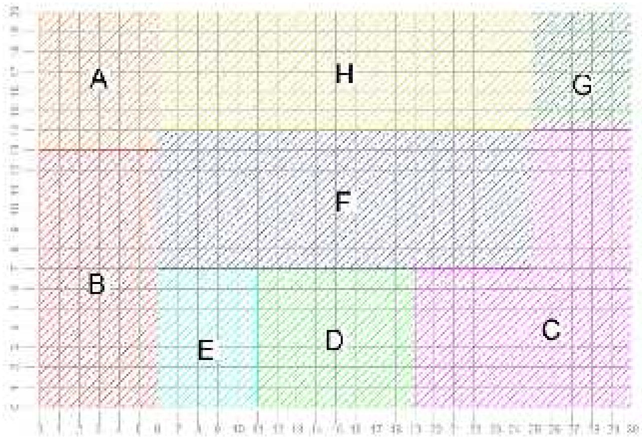

Figure 6. Layout Proposal 3

Furthermore, from the layout of Figure 6 a calculation is made for From To Chart (FTC) distance. As for the FTC layout proposal 3 is seen in table 7.

Table 7 From to Chart Distance in Proposal Layout 3 (in m)

	To A	To B	To C	To D	To E	To F	To G	To H	Sub Total
From A	0	10,00	24,91	17,69	14,12	13,87	24,51	12,51	117,61
From B	10,00	0	22,45	12,37	6,27	13,12	26,66	16,32	107,19
From C	24,91	22,45	0	10,66	17,08	11,04	11,50	15,06	112,70
From D	17,69	12,37	10,66	0	6,50	7,02	18,40	13,51	86,15
From E	14,12	6,27	17,08	6,50	0	9,90	23,31	15,21	92,39
By F	13,87	13,12	11,04	7,02	9,90	0	13,65	6,50	75,10
From G	24,51	26,66	11,50	18,40	23,31	13,65	0	12,00	130,03
From H	12,51	16,32	15,06	13,51	15,21	6,50	12,00	0	91,11
Sub Total	117,61	107,19	112,70	86,15	92,39	75,10	130,03	91,11	812,28

4.3 Discussion

In the layout proposal 1 is the output based on ARC, where A is the office department, B is the raw materials department, C is the cutting department, D is the bending department, E is the rolling department, F is

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the fabrication department, G is the finishing department and H is the finished goods department, then from the layout is calculated FTC distance of each department. The calculation of FTC distance uses the Euclidean distance technique where the measurement measures the line from the midpoint of the department to the midpoint of another department. The FTC distance results in the proposed layout 1 get a total of 853.74m.

Then in the layout of proposal 2 the FTC results changed because the cutting department moved its position under the finishing department while the bending and rolling department shifted closer to the raw material warehouse, the FTC results in the distance in the layout of proposal 2 got a total of 807.88m. From the proposed layouts 1 and 2, there is a significant distance difference of 45.86m.

In the proposed layout 3 bending department positions were exchanged for rolling departments, from these exchanges resulted in a total FTC distance of 812.28m. Compared to the proposed layout 2, the proposed layout 3 has a larger distance with a distance difference of 4.4m.

V. CONCLUSION

From research using the CRAFT method that utilizes AutoCAD software, several proposed layouts were produced, namely proposal layout 1 got a total FTC distance of 853.74 m, proposal layout 2 got a total FTC distance of 807.88 m and proposal layout 3 got a total FTC distance of 812.28 m. of the three proposals, proposal layout 2 is the optimal layout because the FTC subtotal results the distance is the smallest at 807.88 meters. It can be seen in Figure 7.

With the absence of material handling costs making this study less complete, it is hoped that in future studies material handling costs can be added to see the level of cost savings in the production area.

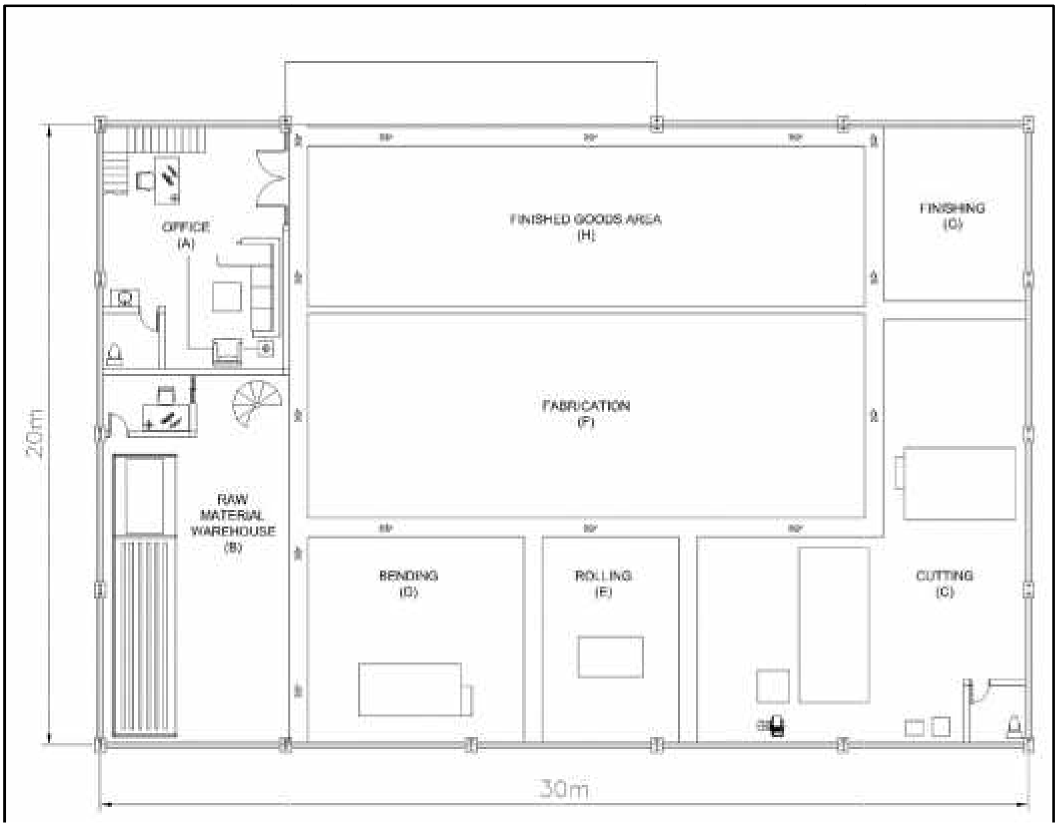

Figure 7. Proposed Production Area Layout

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