Lead Time Reduction Through Production Process Analysis of XYZ E-Commerce Company Using Simulation Model

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Abstract- XYZ is an e-commerce company which offers a fashionable product from clothes, shoes and accessories for Indonesia' mass market, women and man customer. Recently, company would like to increase its competitiveness in Indonesia. One of the way is by increasing its production constraint for producing style collection, such as lead time. According o interview session with production division, the lead time for producing style collection is 60 days. However, the data is different between expected and analysis. Based on the data, the lead time of producing style collection is 73.7 dan 82.7 days. Therefore, business issue is long lead time in producing style collection and unpredictable lead time. The business process is drawn by using Business Process Modelling and Notation (BPMN) diagram, while Igrafx software is used for analyzing and resolving business issue. The objective of this research is to reduce lead time of producing style collection for at least 60 days. The research shows that there are three root causes for long and unpredictable lead time: (1) design; (2) unmonitored process; (3) limited resource. Thus business solution has been developed for resolving issues which are: (1) moving sample room; (2) adding overtime in working days; (3) improving dashboard.

Keywords—lead time, e-commerce

I. INTRODUCTION

Electronic commerce refers to purchase and sale of goods or service via electronic channel such as internet. XYZ is one of the leading e-commerce in Indonesia which focuses its business on fashionable industry. The products which are offered by company ranging from clothing, shoes, beauty product and accessories for women and man. The website carries various brands from their own-label, international brands to rising designers and indie brands. The channels which are used to engage customer:

- Daily newsletter
- Online promotions
- Social media
- B magazine
- Mobile application

The products are sold by cash on delivery (COD), bank transfer and credit card purchases. They also offer a free return for up to 30 days and free shipping for a purchase above IDR 300,000. Currently, they also have some offline stores where are located on provinces in Indonesia. These offline stores offer some services such as return goods which are ordered online and paying it on the store which is said as the first time service in Indonesia.

Since 2015 XYZ had introduced its private label. The label is produced by using some production strategies which are third-parties (supplier) and under its own manufacture (called in-house). These two production strategies give advantages and disadvantages. In general, using third party to produce a product will share the risk of the mass production while the cost also might be lower. According to the cost of goods sold (COGS) which XYZ has, the lowest COGS is by using third party production strategy. Although the risk can be transferred and resulted lowest COGS in average, it is hard to maintain and control as well as finding the appropriate supplier for fulfilling those clothing lines. On the other hand, the research shows a significant different of lead time for both production strategies, in which third party production needs a longer time to produce the private label. Despite of in-house production does not category as the lowest cost of goods sold, it is still competitive and also has a better lead time than using third party option. However, some improvements is still needed by in-house manufacture as it will become a major strategy for XYZ in producing style collections. Thus one of the improvements is the production lead time. [1]

Based on the interview with supply chain production (SCP) division, the expected lead time for producing style should be in 60 days. However, the data shows that the lead time for producing those styles were 73.7 days and 82.5

days for in-house manufacture and using CMT, respectively. Table I shows the lead time for both sourcing strategy. It was calculated by using style producing in April. In fact, the difference was around 10 days for in-house manufacture while the third parties or CMT was around 20 days comparing with expected lead time. Thus, the business issue is long and unpredictable lead time in producing style collection

TABLE I. LEAD TIME PRODUCTION

Process	In-House	CMT
Design	7	7
Pre-production	44.7	62.5
Production	22	13
Total	73.7	82.5

II. BUSINESS ISSUE EXPLORATION

A. Conceptual Framework

The conceptual framework is created for resolving XYZ business issue which are long and unpredictable lead time in producing style collection. The framework is developed by using business process improvement as a basis. [2,3,4,5]

A theory describes process improvement as *"All process that support production process. A business process consist of group of logically related tasks that use the resources of the organization objectives"*. In order to conduct process improvement, Harrington (1991) determines characteristic that should be recognized to identify the problem areas within the process, making a decision about improvements and it will be used also as a basis for setting targets and evaluating the result of improvement:

- flow
- effectiveness
- efficiency
- cost

Flow describes the methods for transforming input into output. Meanwhile, effectiveness determines how well customer expectations are met. Efficiency describes how resources are used to produce an output. In other hand, cycle time is the time taken for transforming input into output while cost determines the expenses for the process.

Harrington (1991) established the requirements for efficiency focusing on use of money, time and other resources. Therefore the key measurement of efficiency process should be:

- processing time
- resources
- poor quality cost
- wait time per unit

In this research, the conceptual framework shows the five following elements which are wait time per process, production cost, process flow, production resource and production capacity.

B. Business Situation

As it has already mentioned on Chapter I, XYZ company uses four sourcing strategy to produce style collection:

- cut, make, trim (CMT)
- free on board (FOB)
- buying
- in-house

CMT means that company uses a third party to produce its clothing lines, but raw material is selected by XYZ company. The advantage is less expense or cost as XYZ does not need to provide labor in producing collection. Although labor cost has been eliminated, the production cost might be still higher than other sourcing strategy depending on production volume. On the other hand, lead time might be longer too. Meanwhile, FOB and buying is a sourcing strategy in which company buys on free market within minimum order and quantity. The difference locates on contract payment for buying and FOB. The advantage of using FOB or buying that it will reduce complexity of managing production process and eliminate risk on production area such as less operational cost and design process. Conversely, all production process is conducted by XYZ company for in-house manufacture. Even though operational cost might increase, the lead time for producing style collection should be seen as competitive element. Comparing lead time of third party manufacture and in-house manufacture as it is shown having faster lead time than CMT.

C. Production Flow

In order to explain the production process in XYZ company, Business Process Model and Notation (BPMN) will be used to determine the process which is described on Figure 3.[6] There are three major processes for producing a style collection, which are design process, pre-production process and production process.

The design process is done by two parties which are designer and fabric admin. The first task is by designing a style collection. After the design of collection has been approved then designer will inform to fabric admin for

creating a fabric order.. Then it will determine the appropriate fabric material of the design including fabric's quantity, colour and types. Finally, the fabric order will be used as a report for sending a request fabric material to supplier.

The pre-production process is done by admin meruya, merchandiser production, fabric storage, sample labor and grading labor. After the raw material (fabric) is received on in-house manufacture, it will be checked by checking it with fabric order. All the differences will be informed to fabric admin for ensuring. After that, simply it will be followed up to production area based on its sourcing strategies. Then, it will enter pattern and sample area for creating the collection' sample. A sample will be reviewed and checked by designer to compare with technical drawing. If the sample does not need to be revised, then it will enter grading step clearly.

The production process is done by cutting labor, sewing labor, finishing labor and admin meruya. The cutting labor will receive the raw material (fabric) and grading stuff which will be marked and cut. Before the fabric is cut, it will be marked to create the boundary for cutting process. Then, the cutting process will be done easily by following the marked lines. After the fabric is cut into pieces of components, it will be sent to sewing area. The sewing process will combine all the cutting components to become a clothes. This finished goods (clothes) will be finished by adding the button, cleaning its thread, ironing and packaging. Finally, it will be delivered to XYZ warehouse which is located on Serpong.

Fig. 1. Storage A

Fig. 2. Storage C

Production Resource

In-house manufacture has some following machineries which are used for producing the collection. These machineries are located on sample, cutting and production area. According to XYZ company's directory, there are four sewing machines and one overlock machine which are stated on sample area. On the other hand, 18 sewing machines, two specialized machines, three overlock machine, one thread winder machine and one snapping machine are located on production area. Moreover, two fabric cutting machine is placed on cutting area.

Meanwhile, in house manufacture has 42 human resources. Based on the collected data, 24 people is paid by using fixed based salary while other is by using variable income matching with number of quantity produced within a day. Labor who works on production area for sewing is paid by this variable scheme.

D. Production Lead Time

The lead time of in-house manufacture and CMT are different. The data that is shown on TABLE II is by using 46% sample of data.

TABLE II. PRODUCTION LEAD TIME

Design Process	**In-House**	**CMT**
Design creation	3	3
Design approval	4	4
Technical drawing creation		
Lead time	7	7
Pre-Production Process		
Raw material received	8	8
Work order creation	9.7	6.3
Work order received in house	2	2
CMT confirmation	1	1
CMT pick-up		3
Sample pattern (SP) created	9.6	17.6
Sample review (SR) created	7	14.6
Mass production (MP) created	7.4	10
Lead time	44.7	62.5
Production Process		
Waiting time in cutting room	1	
Cutting process	1	
Style received in production room		
Waiting time sewing process	4	
Sewing process	2	

Design Process	In-House	CMT
Finishing process	12	
Warehouse delivery	2	
Lead time	22	13
Lead time production average	73.7	82.5

The production lead time is above 2 (two) months for both sourcing strategies. In-house has shorter lead time than CMT. Based on the TABLE II, designer needs 7 days to create a design for both processes. However, the longest lead time's is located on the pre-production process. It requires 44.7 days and 62.5 days for in-house and CMT, respectively. On other hand, production process requires 22 days and 13 days for in-house and CMT, respectively.

The pre-production process consists of some following sub-processes from raw material received to mass production process. Each of those following sub-processes has its own lead time which differ each other. Looking to in house production system, the time to make work order and finishing sample of product are 9.7 days and 9.6 days, respectively. Thus, both of the sub-process used a high percentage of lead time's pre-production. Meanwhile, the delivery of raw material from supplier to company became the second contributor for lead time process in pre-production. Mass production process and sample review positioned as the second and third contributor for lead time in pre-production. On other hand, the process of making a sample is categorized as a major problem in lead time's CMT for pre-production process, 17.6 days. Reviewing sample needs 14.6 days while mass production needs 10 days of working

The production process needs 22 days and 13 days for in house and CMT, respectively. However, the lead time can be only breakdown for in house production. The sub-process can be said that has a waiting time in each. The major contributor of lead time is located on finishing process which is 12 days.

In the production process, there are some common process which are called as sample process (SP) created, sample review (SR) created and mass production (MP) created. Those names is commonly mentioned in pre-production process. SP created means a process for making sample. SR created means a process for reviewing sample while MP created means a process after reviewing sample and sending it to cutting room. The lead calculation of SP, SR and MP created are slightly different.

In-house manufacture, calculate lead time of SP created from time when fabric is already available on sample area while SR created is calculated from the time when sample is already sent to head office as well sending it back to in-house manufacture. Moreover, MP created is calculated from the time when sample is already sent to cutting area.

On the other hand, SP created is calculated from a time when sample is already sent to CMT while SR created is calculated from the time when sample is received in head office as well sending it back to CMT for mass production. Furthermore, MP created is calculated from sample is received in CMT for mass production to become valuable finished goods then it is received in XYZ warehouse.

E. Production Cost

Production cost is different between those following sourcing strategies. TABLE III. Shows the difference between it.

TABLE III. PRODUCTION COST

Category	In House	CMT	FOB	Buying
Top	71,892	63,293	75,450	67,133
Bottom	75,669	81,187	81,448	85,528
Outer	88,347	70,701	89,752	95,800
Dress	84,005	88,132	100,874	82,339
Average	79,978	75,828	86,881	82,700

F. Production Capacity

The production capacity is calculated by using manual calculation. According to TABLE III. cutting process is shown as the lowest throughput rate in which it can only produce for 5.4 styles per day. [7] Although other process can produce above the throughput rate of cutting process, the in-house manufacture will be only capable to produce 5.4 styles per day as the bottleneck limits production's capacity. [8] If company has 26 pieces per style, in-house will produce 130 pieces per day. Assume, company has 22 days per month so in-house will only produce 3088 pieces which is below statement of division's head.

TABLE IV. PRODUCTION CAPACITY

Process	Style/Day	Piece/Day
Pattern	6	
Sewing Sample	6	
Grading	6	
Cutting	5.4	
Sewing MP		203
Pairing Button		183
Disposing Thread		182
Ironing		190
Packaging		183

G. Root Cause Analysis

As the business issues are the long lead time and unpredictable lead time for the producing a collection, the current tree analysis will be conducted to determine the root causes of the following business issues.

According to current tree analysis which is shown on Fig.4., there are three root causes combined for long and unpredictable lead time in the production of XYZ company collections. The root causes of long lead time are located on design itself, unmonitored process and limited resource. Meanwhile, the root cause of unpredictable lead time is caused by limited resource on production area. Furthermore, this research will explain more about root causes in long lead time process.

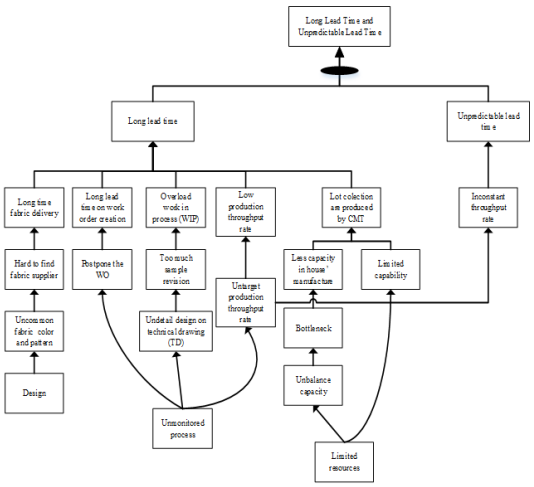

Fig. 4. Root Cause Analysis

The unmonitored process means that some process in producing style collection had been miss monitored. In the designing process, the miss monitored is located on the process of creating technical drawing. Sometimes designer is false in calculating its fabric design required. Moreover, the design itself is not drafted clearly so the pattern and sewing sample labor is mistaken when creating it. The parts that need to be improved are located on size of the each segment and color selection. This should be seen as critical cause due to cost of disposing fabric material. Every cut inside is a money. On the other hand, the unmonitored process is placed also on creating work order. According to interview with division, they just need two days of working for creating requested work order while different lead time is shown on TABLE II for work order creation. Moreover, in the process of making a sample shows an inconstant throughput rate from four styles per days to ten styles per days. On the month that is used as a basis, the in-house collections was targeted to produce 4000 pieces so it should be produced five styles per days to accomplish target of production. Commonly, the monthly working days is counted as much as 22 days. Therefore, the monthly throughput rate should be multiple by monthly working days.

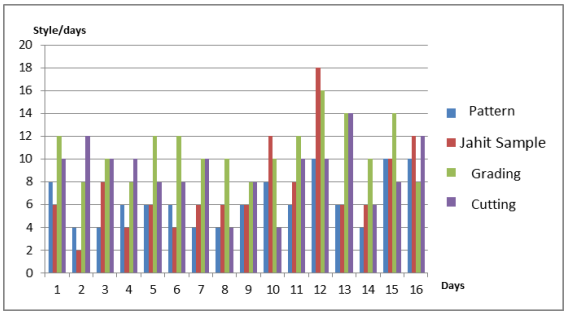

Fig. 5. Throughput Rate Styles Collections.

Meanwhile, the limited resource refers to lack of capacity that XYZ in-house manufacture has. As it is mentioned already on previous chapter, the in-house manufacture can only produce 3088 pieces per month because of the bottleneck on cutting process. This should be perceived as faster lead time can be achieved by lowering work-in-process (WIP) or increasing throughput rate.

The design itself creates a longer lead time for producing style collections. Often design requires a complex sketch as well as color and pattern. Thus, it will require an extraordinary fabric color and pattern. In the market, each of the fabric material has different availability, while this

availability will affect lead time of delivering the required fabric.

Furthermore, a business solution will be given for the unmonitored process and limited resource factor.

CHAPTER III BUSINESS SOLUTION

A. Analysis Process Model

Although the business issue is located on the production process for style collection, process simulation will be conducted without adding design process and deliver time of ordering fabric due to its fixed time process. Therefore, the process simulation will be started since the merchandiser receives fabric material until it is packed by finishing labor. The current process model simulation is conducted by using following conditions. In-house manufacture operates for eight hours from Monday to Friday.

The number of employee and labor are counted as mentioned before. The number of collection is 220 styles while per style consists of 26 pieces so if in-house manufacture would like to produce 4000 pieces monthly, it needs to produce 182 pieces per day. Each of the following process have different throughput rate. Commonly it result from two to nine styles per day. Therefore, the simulation will be conducted using triangle distribution in the expression column.

TABLE V. CURRENT PROCESS SIMULATION

	Count	Avg Cycle	Avg Work	Avg Wait	Avg Res Wait	Avg Block	Avg Inact	Avg Serv
Sim #1	5720	8,31	0,62	7,69	0,42	4,68	2,59	5,72
Sim #2	5720	8,25	0,62	7,63	0,40	4,69	2,54	5,71
Sim #3	5720	8,25	0,62	7,63	0,40	4,68	2,55	5,70
Sim #4	5720	8,26	0,62	7,64	0,40	4,69	2,55	5,71
Sim #5	5720	8,35	0,62	7,73	0,42	4,70	2,61	5,74
Sim #6	5720	8,36	0,62	7,74	0,42	4,70	2,62	5,74
Sim #7	5720	8,23	0,62	7,61	0,40	4,68	2,54	5,70
Sim #8	5720	8,37	0,62	7,75	0,43	4,68	2,64	5,73
Sim #9	5720	8,30	0,62	7,68	0,41	4,69	2,58	5,72
Sim #10	5720	8,34	0,62	7,72	0,42	4,69	2,61	5,73

Table V. shows the report of ten times simulation. In average, the lead time of production process is 56.01 days without adding design process and delivery time of fabric ordered. Therefore, if the design and delivery process is added into simulation results it will be accounted for 71.01 days for production process while real one is 73.7 days.

B. Propose Business Solution

First business solution will be delivered for the limited resource that in-house manufacture has. This will be overcome by:

1. Move sample process from in-house manufacture to head office
2. Add overtime for sewing process
3. Combine both solution

Moving sample process is simulated by moving sample area from in-house manufacture to head office. All default condition of working days, number of employee or labor and collection produced will not be changed.

After ten times operated process simulation, the average of lead time overall is 51.25 days without adding the activities of design process and delivering fabric order. By inputting those two related activities, the lead time is 66.25 days. In detail, the average cycle time is reduced to 7.92 days. The average wait has been reduced also to 6.90 days. Table 3.8 shows the difference of proposed solution and current production process. TABLE VI. shows the result.

TABLE VI. MOVING SAMPLE PROCESS

	Count	Avg Cycle	Avg Work	Avg Wait	Avg Res Wait	Avg Block	Avg Inact	Avg Serv
Sim #1	5720	7,92	1,03	6,89	0,74	3,12	3,03	4,90
Sim #2	5720	7,93	1,03	6,89	0,74	3,13	3,03	4,90
Sim #3	5720	7,93	1,03	6,89	0,74	3,13	3,03	4,90
Sim #4	5720	7,93	1,03	6,90	0,74	3,13	3,03	4,90
Sim #5	5720	7,93	1,03	6,90	0,74	3,13	3,03	4,90
Sim #6	5720	7,93	1,03	6,89	0,74	3,12	3,03	4,90
Sim #7	5720	7,92	1,03	6,89	0,74	3,12	3,03	4,90
Sim #8	5720	7,93	1,03	6,90	0,74	3,13	3,03	4,90
Sim #9	5720	7,93	1,03	6,89	0,74	3,12	3,03	4,90
Sim #10	5720	7,93	1,03	6,90	0,74	3,13	3,03	4,90

Meanwhile, reduction in time can be counted for potential revenue. According to XYZ company target sales, company would like to achieve 6 billion rupiah per month. If it converts to daily sales target, company would like to have 272 million rupiah per day. Therefore, 5 days difference of lead time might be calculated as potential revenue for 1.3 billion rupiah.

According to process simulation, the bottleneck is located on the sewing process. Therefore, adding overtime in sewing process might be a possible solution. In this propose business solution, sewing labor will work on Saturday as well with other constraints is same within default.

TABLE VII. ADDING OVERTIME

	Count	Avg Cycle	Avg Work	Avg Wait	Avg Res Wait	Avg Block	Avg Inact	Avg Serv
Sim #1	5720	6,67	1,20	5,47	0,16	5,20	0,11	6,56
Sim #2	5720	6,67	1,20	5,47	0,16	5,20	0,11	6,56
Sim #3	5720	6,67	1,20	5,47	0,16	5,20	0,11	6,56
Sim #4	5720	6,67	1,20	5,47	0,16	5,20	0,11	6,56
Sim #5	5720	6,67	1,20	5,47	0,16	5,20	0,11	6,56
Sim #6	5720	6,67	1,20	5,47	0,16	5,20	0,11	6,56
Sim #7	5720	6,66	1,20	5,47	0,16	5,20	0,11	6,56
Sim #8	5720	6,67	1,20	5,47	0,16	5,20	0,11	6,56
Sim #9	5720	6,67	1,20	5,47	0,16	5,20	0,11	6,56
Sim #10	5720	6,67	1,20	5,47	0,16	5,20	0,11	6,56

By adding overtime for sewing labor to work on Saturday, the average lead time of production is reduced to

47.01 days so it is become 62.01 days after adding process design and delivery of fabric material.

Although the time that has been reduced giving potential revenue for company, it comes up with a cost. Based on data, average cost of sewing labor is 13500 rupiah per piece. In one day, they can produce 10 pieces so it will cost 130500 rupiah per day. There are 18 labors for sewing process. Thus, total cost of sewing labor per day is IDR 2,349,000. Meanwhile, the potential revenue that company can achieve is IDR 272 million per day. It means that cost of working on Saturday will contribute to only 0.7% of company potential revenue.

The last business solution of limited resource is by combining both business solutions before. TABLE VIII. shows the result of process simulation

TABLE VII. COMBINATION SOLUTIONS

	Count	Avg Cycle	Avg Work	Avg Wait	Avg Res Wait	Avg Block	Avg Inact	Avg Serv
Sim #1	5720	7,42	1,03	6,38	0,85	3,54	2,00	5,42
Sim #2	5720	7,42	1,03	6,39	0,85	3,54	2,00	5,42
Sim #3	5720	7,42	1,03	6,38	0,85	3,54	2,00	5,42
Sim #4	5720	7,42	1,03	6,39	0,85	3,54	2,00	5,42
Sim #5	5720	7,42	1,03	6,39	0,85	3,54	2,00	5,42
Sim #6	5720	7,42	1,03	6,39	0,85	3,54	2,00	5,42
Sim #7	5720	7,42	1,03	6,39	0,85	3,54	2,00	5,42
Sim #8	5720	7,42	1,03	6,39	0,85	3,54	2,00	5,42
Sim #9	5720	7,42	1,03	6,38	0,85	3,54	2,00	5,42
Sim #10	5720	7,42	1,03	6,39	0,85	3,54	2,00	5,42

According to simulation, the combination of both solution will reduce the lead time into 44.17 days. After combining it with design process and delivery fabric, the production lead time is 59.17 days. Looking to detail of processes, the average cycle time and average wait of overall process are reduced to 7.42 days and 6.38 days, respectively.

By having 59.22 days for producing style collections, company can sell its product faster which will gain company's revenue. Although it is not stated the price of moving sample room, the cost should not be contributed significantly to company because it can gain revenue for 272 million per day. Thus by using the combination of business' solutions, company can gain a potential revenue as much as around three million rupiah.

On the other hand, the unmonitored proposed business solution for unmonitored process is by improving current dashboard. The current dashboard does not mention about minimum throughput rate that should be achieved by each of division.

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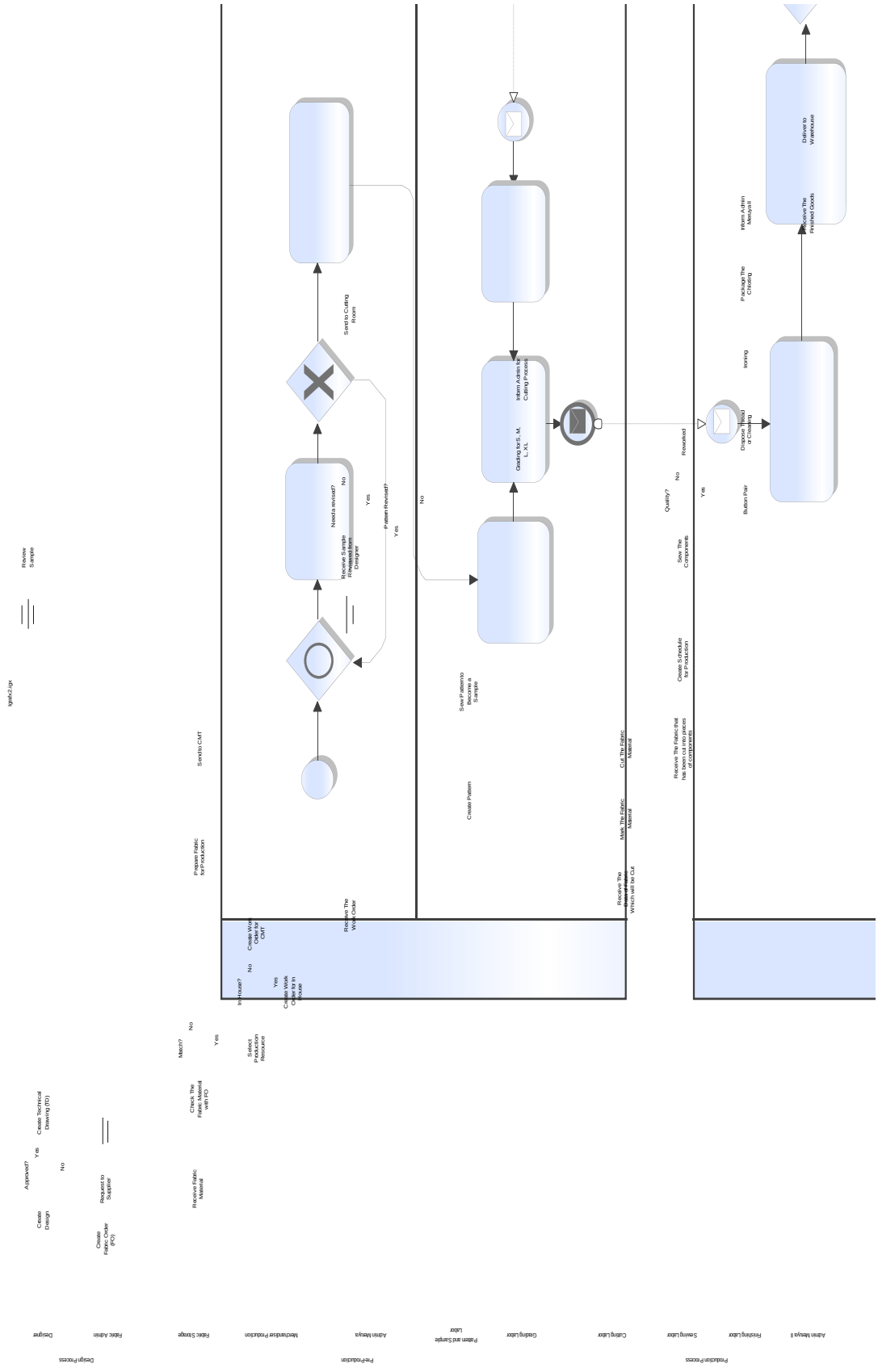

Fig. 3. BPMN Diagram